# INDIGENOUS PLANTS IN THE LIMPOPO PROVINCE: POTENTIAL FOR THEIR COMMERCIAL BEVERAGE PRODUCTION

by

**ISAAC TEBOGO RAMPEDI**

submitted in accordance with the requirements
for the degree of

**DOCTOR OF PHILOSOPHY**

in the subject

**ENVIRONMENTAL MANAGEMENT**

at the

**UNIVERSITY OF SOUTH AFRICA**

**SUPERVISOR: PROF JANA OLIVIER**

**DECEMBER 2010**

**STUDENT NUMBER: 0734-731-6**

## DECLARATION

I declare that **INDIGENOUS PLANTS IN THE LIMPOPO PROVINCE: POTENTIAL FOR THEIR COMMERCIAL BEVERAGE PRODUCTION** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

____________________________
**SIGNATURE**

(MR I T RAMPEDI)

_________________________
**DATE**

## ACKNOWLEDGEMENTS

I am grateful to Professor Jana Olivier, my research supervisor, for her excellent guidance, commentary and constructive engagement during the course of the study. The National Research Foundation (NRF) as well as the University of South Africa (UNISA), through the Thuthuka Research Funding Programme, are acknowledged for financial support (GUN 207 3321).

I am also indebted to the following people and their organisations for the positive role they played during the course of the research project:

- All the local traditional chieftaincies in the Limpopo province who provided permission to conduct research in areas falling within their jurisdiction are acknowledged.
- All the individuals who assisted with data collection for surveys in the various rural communities of Venda, former Gazankulu (Mopani) region as well as Sekhukhuneland are deeply thanked.
- Dr Aubrey Parsons is thanked for sharing some of his expertise and assistance with sensory analyses on some of the selected beverages.
- Rosemary Du Preez, Agronomist and researcher at the Agricultural Research Council (ARC), Institute of Subtropical and Tropical Crops (ISTC) in Nelspruit, is acknowledged for collaboration and allowing me to read some of her work related to my study as well as constructive feedback.
- Karen De Jager, Researcher at the Agricultural Research Council (ARC), is thanked for collaboration and assistance with respect to the formulation of some of the concept products (liqueurs) piloted for the research project.
- Daisy Madisha, Researcher and biotechnologist at the Agricultural Research Council (ARC) and ITSC, is acknowledged for providing some of the snowball leads in the Venda study area in the Limpopo province.
- Prof Dr James Simon, Director of the New Use Agriculture and Natural Plant Products (NUANPP) programme at Rutgers University, New Brunswick is acknowledged for specialist training and interesting exposure gained on phytochemistry and the commercialisation of natural plant-based products during a study visit in the USA in 2008.
- Dana Robberste in the School of Environmental Sciences at UNISA Florida Campus is thanked for administrative support regarding the Thuthuka Research Grant (GUN 207 3321).
- I wish to convey my sincere thanks to all members of the College of Agriculture and Environmental Sciences (CAES) as well as the Centre for African Renaissance at UNISA who were willing to participate in the study by playing a role in the sensory characterisation and evaluation of selected beverages.
- Makro Centurion Store (Liquor Section) and their Head Office are acknowledged for granting permission to undertake market surveys and sensory analyses amongst some of their customers.
- All participating respondents in the various rural communities surveyed for the research in the Limpopo province and for assistance in the collection of voucher specimens and the preparation of (samples) traditional beverages for nutrient characterisation and evaluation as well as sensory analyses, are deeply thanked.
- I am grateful for the support of my wife, Tshepo and my daughters, Tsholofelo and Boikanyo.
- I wish to acknowledge the positive and moulding role played by my parents (Klaas Mashalane Rampedi and Mandy Mmapula Rampedi) in my early educational phase in Naledi Township, Soweto and the values of hardwork, faith and perseverance that they have inculcated.

## ABSTRACT

South Africa has over 19 500 different indigenous plant species. Most of these are of ethnobotanical significance and are still used by local rural communities as medicine, food and for making beverages. The relatively little research that has been conducted on indigenous plant species has focused mainly on their medicinal potential. However, in view of the rapidly growing size of the global and local beverage industry and their constant search for new products, beverage-making indigenous plant species may have commercial development potential. To date, no detailed studies have been conducted on these plants, especially in the species-rich Limpopo province. The aim of this study was, therefore to evaluate the potential of indigenous plants for commercial beverage production. In order to achieve this, a survey was conducted in the Limpopo province to identify beverage-making plants and to document beverage preparation methods. Selected beverages were analysed and evaluated for their nutrient and sensory characteristics and a market product acceptability survey was conducted to identify those beverages with the greatest potential for development.

Sixty three different beverage-plant species were identified in three study areas within the Limpopo province. These were used for the preparation of teas, fruit juices and alcoholic beverages. Plants that received further research attention were selected on the basis of their status as indigenous plants, frequency of use, nature of harvesting methods and availability. Some of the selected beverages were found to be rich in nutrients, especially with respect to vitamin C and mineral content. Furthermore, sensory analyses and market surveys indicated that four species, namely, *Doyvalis caffra, Garcinia livingstonei, Grewia flavescens* and *Englerophytum magalismontanum* have potential for further development for the beverage industry while *Athrixia phylicoides* has commercialisation potential as a herbal tea.

However, further research is required to improve and refine preparation methods and to ensure compliance with quality standards. The availability of sufficient plant material for the industry must also be ensured. This research has indicated that South African indigenous plants have untapped market potential for the beverage industry which, if developed sustainably, could contribute to economic growth of the rural parts of South Africa.



## KEY TERMS

Beverage-making indigenous plant species, commercial development potential, snowball sampling, tests, dietary reference intakes, teas, fruit juices, beer, spirits, new products, sensory analyses, aroma, flavour, product acceptability, hedonic scale, Limpopo province.

# LIST OF ABBREVIATIONS

ARC, Agricultural Research Council

ASNAAP, Agribusiness in Sustainable African Natural Plant Products

ACL, Amarula Cream Liqueur

AOAC, Association of Official Analytical Chemists

CGI, Clanwilliam General Info

CARA, Conservation of Agricultural Resources Act

CWNG, Cosmetic Workshop and Natures Goodness

CYP450, Cytochrome P450

DA, Department of Agriculture

DEAT, Department of Environmental Affairs and Tourism

DRIs, Dietary Reference Intakes

EU, European Union

FAO, Food and Agricultural Organisation

F/G, Fructose/Glucose

IKS, Indigenous Knowledge System

IPUF, Indigenous Plant Use Forum

ICONS, Institute of Conservation and Natural History of the Soutpansberg

ISCW, Institute of Soil, Climate and Water

ISTC, Institute of Subtropical and Tropical Crops

IAP, Invasive Alien Plant

LSOER, Limpopo State of the Environment Report

MDA, Malondialdehyde

GC, Gas Chromatography

HPLC, High Performance Liquid Chromatography

ICP-OES, Inductively Coupled Plasma Optical Emission Spectrometry

NEMBA, National Environmental Management Biodiversity Act (NEMBA)

NGOs, Non-Governmental Organisations

PPECB, Perishable Products Export Control Board

RAI, Recommended Adequate Intake

RDA, Recommended Dietary Allowance

RTD, Ready-To-Drink

RCKB, Research Centre Knowledge Base

RE, Retinol Equivalents

RTCB, Rooibos Tea Control Board

TP, Total Polyphenol

SABS, South African Bureau of Standards

SADC, Southern African Development Co-operation

SAHTA, South African Honeybush Tea Association

SANBI, South African Institute of Biodiversity

SAWB, South African Weather Bureau

Stats SA, Statistics South Africa

SOD, Super-Oxide Dismutase

TNC, Total Non-Structural Carbohydrates

UV, Use Value

# TABLE OF CONTENTS

**CHAPTER 1: RESEARCH BACKGROUND ON INDIGENOUS PLANT-BASED BEVERAGES**

1.1 INTRODUCTION 1
1.2 LITERATURE CONTEXTUALISATION OF THE STUDY AND RESEARCH MOTIVATION 2
1.3 RESEARCH AIM AND OBJECTIVES 6
1.4 SCOPE AND LIMITATIONS OF THE RESEARCH 6
1.5 ORGANISATION OF THE THESIS 7

**CHAPTER 2: LITERATURE REVIEW ON BEVERAGE-MAKING INDIGENOUS PLANTS AND ASSOCIATED DRINKS**

2.1 INTRODUCTION 8
2.2 INDIGENOUS TEAS 8
2.2.1 Rooibos tea, *Aspalathus linearis* 8
2.2.1.1 Botanical aspects 9
2.2.1.2 Production and product development trends 10
2.2.1.3 Market development aspects 16
2.2.2 Honeybush tea, *Cyclopia* species 17
2.2.2.1 Medicinal and current research findings 18
2.2.2.2 Development of honeybush into an agricultural crop 20
2.2.2.3 Markets for honeybush tea 21
2.2.3 Bush tea, *Athrixia phylicoides* 24
2.2.3.1 Botanical and ethnobotanical aspects 24
2.2.3.2 Geographical distribution and harvesting practices 24
2.2.3.3 Traditional medicinal uses and current research findings 25
2.3 ALCOHOLIC BEVERAGES 27
2.3.1 African beers 27
2.3.1.1 Sorghum beer 27
2.3.2 Indigenous spirits and wines 28
2.3.2.1 The marula tree and its fruits 29
2.3.2.2 Local and small-scale production of marula beer 30
2.3.2.3 Other marula-based beverages and propagation initiatives 32
2.3.2.4 Some commercial aspects of Amarula cream liqueur 32
2.4 BRIEF SUMMARY OF LITERATURE REVIEWED 35
2.4.1 Indigenous teas 35
2.4.2 Alcoholic beverages 36

**CHAPTER 3: DESCRIPTION OF STUDY AREA AND RESEARCH METHODOLOGY**

3.1 INTRODUCTION 37
3.2 BRIEF BACKGROUND ON THE LIMPOPO PROVINCE AND STUDY AREAS 37
3.2.1 Geographical and biophysical background 37
3.2.2 Socio-economic background 37
3.2.3 Venda-speaking study area 38

3.2.4 Tsonga-speaking study area 41
3.2.5 North-Sotho speaking study area 42
3.3 RESEARCH DESIGN, DATA COLLECTION METHODS AND ANALYSES 44
3.3.1 Survey design and data collection methods 44
3.3.1.1 First phase of data collection 45
3.3.1.2 Second phase of data collection and analyses 47
3.3.1.3 Experimental and analytical methods 49
3.3.1.4 Sensory analyses and estimation of market potential 53
3.3.1.5 Sensory analytical techniques 53
**CHAPTER 4: RESEARCH FINDINGS AND DISCUSSION: INDIGENOUS KNOWLEDGE ON BEVERAGE MAKING PLANTS**
4.1 INTRODUCTION 58
4.2 INDIGENOUS KNOWLEDGE ON BEVERAGE-MAKING PLANTS IN THE VENDA-SPEAKING REGION 58
4.2.1 Profiles of respondent's in selected rural communities 58
4.2.2 Indigenous knowledge of beverage-making plants 60
4.2.3 Diversity of beverage-making plant species 61
4.2.3.1 Local uses of plant species 63
4.2.3.2 Frequencies associated with plant species 64
4.2.3.3 The seasonal availability of plant species 66
4.2.3.4 Accessibility aspects and harvesting constraints 67
4.2.3.5 Harvesting methods and some aspects of sustainability 69
4.3 INDIGENOUS KNOWLEDGE ON BEVERAGE-MAKING PLANTS IN THE TSONGA-SPEAKING REGION 69
4.3.1 Profile of respondent's in selected Tsonga-speaking rural communities 69
4.3.2 Indigenous knowledge of beverage-making plants 71
4.3.3 Diversity of beverage-making plant species 72
4.3.3.1 Local uses and frequencies associated with individual plant species 73
4.3.3.2 The seasonal availability of plant species and harvesting patterns 75
4.3.3.3 Some harvesting constraints 76
4.4 INDIGENOUS KNOWLEDGE ON BEVERAGE-MAKING PLANTS IN THE NORTH SOTHO-SPEAKING REGION 79
4.4.1 Profiles of respondent's in selected rural communities 79
4.4.2 Indigenous knowledge of beverage-making plants 80
4.4.3 Diversity of beverage-making plant species 81
4.4.3.1 Local uses of plant species 82
4.4.3.2 Frequencies associated with individual plant species 83
4.4.3.3 The seasonal availability of plant species and their harvesting 85
4.4.3.4 Harvesting constraints 85
4.5 SUMMARY OF RESEARCH FINDINGS 86
4.5.1 Respondents' profile 86

4.5.2 Knowledge of beverage-making plants in the different areas of the Limpopo province 88

4.5.3 The identification and selection of high potential beverage-making plants 93

**CHAPTER 5: RESEARCH FINDINGS AND DISCUSSION: BEVERAGE-MAKING PLANT SPECIES, PREPARATION METHODS AND NUTRITIONAL ASPECTS**

5.1 INTRODUCTION 98

5.2 A REVIEW OF SELECTED INDIGENOUS BEVERAGE-MAKING PLANTS 98

5.2.1 Stem fruit (*Englerophytum magalismontanum*) 98

5.2.2 Corky monkey orange (*Strychnos cocculoides*) 100

5.2.3 Mobola plum (*Parinari curatellifolia*) 102

5.2.4 Blue sourplum (*Ximenia americana*) 103

5.2.5 Wild medlar (*Vanguira infausta*) 105

5.2.6 Brown ivory (*Berchemia discolor*) 107

5.2.7 Sand apricot vine (*Landolphia kirkii*) 108

5.2.8 Red milkwood (*Mimusops zeyheri*) 109

5.2.9 Kei apple (*Doyvalis caffra*) 110

5.2.10 Sand paper raisin (*Grewia flavescens*) 112

5.2.11 Magic quarri (*Euclea divinorum*) 113

5.2.12 Bush tea (*Athrixia phylicoides*) 114

5.3 BEVERAGE PREPARATION METHODS 116

5.3.1 Fruit juices 116

5.3.1.1 The traditional village-style method for preparing fruit juices 116

5.3.1.2 First non-traditional method for preparing juice from indigenous fruits 116

5.3.1.3 Second non-traditional method for preparing juice from indigenous fruits 117

5.3.2 Methods of preparing alcoholic beverages 118

5.3.2.1 Liqueurs produced from indigenous fruits 120

5.3.3 Traditional teas 120

5.4 THE NUTRITIONAL ANALYSES OF SELECTED BEVERAGES 121

5.4.1 The nutritional aspects of fruit juices 122

5.4.1.1 Fruit juices produced by traditional methods 122

5.4.1.2 Mobola-based fruit juice by a non-traditional method 127

5.4.2 Analyses of the nutritional aspects of selected alcoholic beverages 130

5.4.2.1 Protein 130

5.4.2.2 Carbohydrates 131

5.4.2.3 Total dietary fibre 132

5.4.2.4 Energy values 133

5.4.2.5 Vitamins 134

5.4.3 The nutritional properties of selected traditional teas 134

5.4.3.1 Total non-structural carbohydrates 134

5.4.3.2 Caffeine and tannins 135

5.4.3.3 Vitamins 136

5.4.3.4 Mineral elements 136

5.5 SUMMARY OF THE RESEARCH FINDINGS 137
5.5.1 Selected indigenous plant species 137
5.5.2 Beverage production methods 138
5.5.3 Nutrient aspects of selected beverages 139

**CHAPTER 6: RESEARCH FINDINGS AND DISCUSSION: ASSESSMENT OF COMMERCIAL DEVELOPMENT POTENTIAL OF SELECTED INDIGENOUS PLANT-BASED BEVERAGES**

6.1 INTRODUCTION 141
6.2 SENSORY ANALYSES AND ASSESSMENT OF MARKET POTENTIAL FOR SELECTED NON-ALCOHOLIC AND ALCOHOLIC BEVERAGES 142
6.2.1 Beverages derived from the mobola plum, *Parinari curatellifolia* 142
6.2.1.1 Sensory evaluation of the mobola fruit juice 142
6.2.1.2 Evaluation of mobola fruit-based beer 144
6.2.2 An evaluation of liqueurs 146
6.2.2.1 Liqueur produced from the berries of the sand paper raisin, *Grewia flavescens* 146
6.2.2.2 Liqueur produced from the African mangosteen, *Garcinia livingstonei* 149
6.2.2.3 Liqueur derived from the Kei apple, *Doyvalis caffra* 152
6.2.2.4 Liqueur derived from the stem fruit, *Englerophytum magalismontanum* 155
6.2.3 Herbal tea derived from the bush tea plant species, *Athrixia phylicoides* 159
6.2.3.1 An estimation of the market potential of bush tea, *Athrixia phylicoides* 160
6.2.3.2 The mass market for bush tea 161
6.2.3.3 Identifying a niche-market for bush tea 162
6.3 SUMMARY OF RESEARCH FINDINGS 164

**CHAPTER 7: SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS**

7.1 INTRODUCTION 167
7.2 SUMMARY OF RESEARCH FINDINGS 167
7.2.1 Identification and documentation of indigenous plant species and associated beverages 167
7.2.2 Beverage-preparation methods 168
7.2.3 The nutrient evaluation of selected beverages 169
7.2.4 Estimation of market development potential for selected beverages 170
7.3 CONCLUSION 171
7.4 RECOMMENDATIONS FOR FURTHER RESEARCH 173
7.4.1 Quality assurance, safety and manufacturing practices 173
7.4.2 Recommendations for further surveys and other studies 174

**REFERENCES** 175

**PERSONAL COMMUNICATIONS AND OBSERVATIONS** 201

**REFERENCES FOR WEB-IMAGES** 201

**APPENDICES** 202

## LIST OF FIGURES


| Numbers and titles of figures | Page no |
|---|---|
| Figure 2.1: Total production values of rooibos tea for the 1981-2006 period | 14 |
| Figure 2.2: Gross revenues generated from rooibos tea for the 1981-2006 period | 14 |
| Figure 2.3: Rooibos tea exports for different international market niches | 17 |
| Figure 2.4: Exports of honeybush tea from 1999 until 2005 | 23 |
| Figure 2.5: Honeybush tea exports sold into the different international markets for the year 2004 | 24 |
| Figure 2.6: The marula brewing process | 31 |
| Figure 2.7: Amarula cream liqueur promoted in gift tins known as the "Magnificent Seven Series" | 34 |
| Figure 3.1: Location of rural communities (survey points) surveyed in the Limpopo province | 39 |
| Figure 3.2: Long term mean rainfall pattern at Punda Maria weather station (altitude~462 m), in the Vhembe District of the Limpopo province, recorded during 1961-1990 | 40 |
| Figure 3.3: Mean minimum and maximums temperatures ($^0$C) associated with the Punda Maria (22$^o$68'S; 31$^o$01'E; altitude 462 m) weather station in the Vhembe District of the Limpopo province, recorded during 1961-1990 | 40 |
| Figure 3.4: The mean rainfall (mm) pattern at Giyani (altitude ~450 m) weather station for 1972-1984 | 41 |
| Figure 3.5: Long term mean temperature minimums and maximums at the Giyani (22$^o$53'S; 14$^o$26'E) weather station (altitude ~450 m) in the Limpopo province, recorded during 1972-1984 | 42 |
| Figure 3.6: The mean rainfall pattern at the Tompi Seleka weather station (altitude ~879 m), near Marble Hall in the Sekhukhune region of the Limpopo province, for 2006–2009 | 43 |
| Figure 3.7: Average temperature minimums and maximums associated with Sekhukhuneland (24$^o$45'S; 30$^o$01'E) in the Limpopo province, during 1936-1946 | 44 |
| Figure 4.1: Number and percentages of respondents per age group and gender | 58 |
| Figure 4.2: Educational profile of respondents in the study area | 59 |
| Figure 4.3: Number and percentages of plants mentioned by respondents in the Venda-speaking areas | 61 |
| Figure 4.4: Number of citations per plant species (frequencies) associated with the different tea-making plants in study area | 64 |
| Figure 4.5: The most frequently mentioned beverage-making species in the Venda study area | 65 |
| Figure 4.6: The collection of marula fruits in a plastic bag | 68 |
| Figure 4.7: Number and percentages of respondents per age group and gender | 70 |
| Figure 4.8: Educational profile of respondents in the Tsonga-speaking study area | 70 |
| Figure 4.9: Number and percentages of plants mentioned by respondents in the study area | 72 |
| Figure 4.10: Number of citations per plant species (frequencies) associated with the different plant species in the Tsonga-speaking study area | 74 |
| Figure 4.11: Damaged fruits (*Zyzigium cumini*) on the grass, after falling from the tree | 77 |
| Figure 4.12: Ripe berries on a multi-stemmed sand paper raisin (*Grewia flavescens*) shrub | 78 |
| Figure 4.13: Several sand paper raisin (*Grewia flavescens*) shrubs occurring in close proximity to a thorn (appearing in white colour to the right) bearing *Acacia* spp. | 78 |

| | |
|---|---|
| Figure 4.14: Number and percentages of respondents per age group and gender | 79 |
| Figure 4.15: Educational profile of respondents in the North-Sotho speaking areas | 80 |
| Figure 4.16: Number and percentages of plants mentioned by respondents in the North-Sotho speaking areas | 81 |
| Figure 4.17: Number of citations per plant species (frequencies) associated with the plant species in the North-Sotho-speaking study area | 84 |
| Figure 4.18: Summary of the age- and gender-related aspects of all respondents interviewed for the study | 87 |
| Figure 4.19: Generalised province-wide educational profile for all respondents interviewed for this study | 88 |
| Figure 4.20: Total number and percentages of plants mentioned by respondents in all study areas surveyed | 89 |
| Figure 5.1: Fruits of *Englerophytum magalismontanum* species | 99 |
| Figure 5.2: The corky monkey orange (*Strychnos cocculoides*) tree with several unripe fruits | 101 |
| Figure 5.3: Mobola plum (*Parinari curatellifolia*) in Venda | 103 |
| Figure 5.4: Large sourplum (*Ximenia caffra*) with fruits | 104 |
| Figure 5.5: A young wild medlar (*Vanguira infausta*) plant | 105 |
| Figure 5.6: Ripe (light brown) and unripe (still green) fruits of the wild medlar (*Vanguira infausta*) | 106 |
| Figure 5.7: Branches of the brown ivory (*Berchemia discolor*) | 107 |
| Figure 5.8: Unripe fruits of the sand apricot vine (*Landolphia kirkii*) species | 108 |
| Figure 5.9: Ripe fruits of the red milkwood (*Mimusops zeyheri*) | 109 |
| Figure 5.10: Kei apple with fruits in different stages of ripening | 111 |
| Figure 5.11: Ripe berries of the sand paper raisin (*Grewia flavescens*) | 112 |
| Figure 5.12: Magic quarri (*Euclea divinorum*) | 114 |
| Figure 5.13: The *Athrixia phylicoides* species | 115 |
| Figure 5.14: Fruits of the blue sourplum (*Ximenia americana*) immersed and soaked in water in order to extract the juice required for fermentation | 119 |
| Figure 5.15: Total non-structural carbohydrate content (TNC) (%) of fruit juices analysed | 123 |
| Figure 5.16: Detailed sugar analyses for the different indigenous fruit juices examined | 124 |
| Figure 5.17: Concentrations of total dietary fibre (mg/10ml) amongst fruit juices analysed | 125 |
| Figure 5.18: Amounts of protein (mg/100ml) in fruit juices analysed | 126 |
| Figure 5:19: Vitamin C concentrations in the various indigenous fruit juices examined | 127 |
| Figure 5.20: Protein levels (g/100ml) amongst beer samples analysed | 131 |
| Figure 5.21: Carbohydrate content (g/100ml) amongst the beer samples analysed | 132 |
| Figure 5.22: Total dietary fibre contents amongst the beers analysed | 133 |
| Figure 5.23: Energy values calculated for the different beer samples analysed | 134 |
| Figure 5.24: Amounts of total non-structural carbohydrates (%) amongst selected beverages | 135 |
| Figure 5.25: Vitamin concentrations in selected indigenous teas | 136 |
| Figure 5.26: Concentrations (mg/250ml) of six major mineral elements in bush tea, rooibos tea and honeybush tea (infusions) | 137 |

| | |
|---|---|
| Figure 6.1: The percentages of Unisa panellists who identified the aroma notes of juice derived from mobola plum (*Parinari curatellifolia*) | 143 |
| Figure 6.2: The various percentages of Unisa panellists who identified flavour attributes of mobola fruit juice | 143 |
| Figure 6.3: The percentages (%) of panelists who evaluated the mobola plum (*Parinari curatellifolia*) juice on the hedonic scale(1-9) | 144 |
| Figure 6.4: The different proportions (%) of Unisa panellists who evaluated the mobola fruit beer making use of the product acceptability scale (hedonic scale) | 145 |
| Figure 6.5: The various proportions (%) of panellists who identified the different flavour notes associated with the *Grewia flavescens* liqueur | 147 |
| Figure 6.6: The various ratings of the sand paper raisin (*Grewia flavescens*) liqueur on a hedonic scale as evaluated by all panellists involved in the evaluation | 148 |
| Figure 6.7: Ratings of the sand paper raisin (*Grewia flavescens*) on the product rating (hedonic scale) as evaluated by the three different groups of panellists | 148 |
| Figure 6.8: The overall aroma mix of the African mangosteen (*Garcinia livingstonei*) liqueur, based on the responses from all groups of panellists | 150 |
| Figure 6.9: The proportion of panellists who identified and suggested the different flavour notes associated with the African mangosteen (*Garcinia livingstonei*) | 150 |
| Figure 6.10: A summary of the different proportions of all panellists (%) who rated the African mangosteen (*Garcinia livingstonei*) liqueur on the hedonic scale | 151 |
| Figure 6.11: The aroma profile of the Kei apple (*Doyvalis caffra*) liqueur as determined from feedback obtained from Makro Centurion panellists | 152 |
| Figure 6.12: Overall proportions (%) of panellists based on the different odour notes they suggested for the Kei apple, *Doyvalis caffra* liqueur | 153 |
| Figure 6.13: Percentages of different groups of panellists based on the flavour attributes they have outlined for the Kei apple (*Doyvalis caffra*) liqueur | 154 |
| Figure 6.14: Percentages of all panellists per units on the hedonic scale regarding Kei apple (*Doyvalis caffra*) liqueur | 155 |
| Figure 6.15: Aroma profile of the stem fruit liqueur based on responses from 8 Unisa panellists | 156 |
| Figure 6.16: An aggregated set of responses made by different panellists who profiled the aroma attributes of the stem fruit liqueur | 156 |
| Figure 6.17: Flavour mix of the stem fruit based on response from Unisa panellists | 157 |
| Figure 6.18: Total flavour mix of the stem fruit liqueur suggested by all (12 of them) panellists involved | 158 |
| Figure 6.19: Percentages of panellists who rated the stem fruit on the hedonic scale | 159 |
| Figure 6.20: The different proportions of panellists who suggested the aroma notes characteristic of bush tea (*Athrixia phylicoides*) | 160 |
| Figure 6.21: Geographical location of Marabastad, Soweto and Mamelodi townships in the Gauteng province | 161 |

# LIST OF TABLES


| Numbers and titles of tables | Page no |
|---|---|
| Table 2.1:Some of the key stakeholders in the rooibos tea sector | 12 |
| Table 3.1:Level of education attained by adults in Limpopo province | 38 |
| Table 3.2: List of analytical methods and techniques used | 50 |
| Table 3.3: Tests performed on traditionally and locally prepared fruit juices from specified plant species | 51 |
| Table 3.4: Tests performed on two types of juices derived from mobola plum | 51 |
| Table 3.5: Tests performed on selected samples of beer | 51 |
| Table 3.6: Tests performed on tea samples analysed for the study | 52 |
| Table 3.7: Mineral analyses performed on three south African indigenous teas | 52 |
| Table 3.8: Odour elements selected for profiling selected beverages | 55 |
| Table 3.9: Flavor elements utilized as guidelines for the sensory characterisation of selected beverages | 56 |
| Table 3.10: A 9-point (Hedonic) acceptability scale showing measures of increasing consumer preference | 56 |
| Table 4.1: Beverage-making plants identified and collected in the Venda-speaking study area | 63 |
| Table 4.2 : Beverage-making fruits and their seasons of availability in the Venda study area | 67 |
| Table 4.3: The beverage-making plant species identified in the Tsonga-speaking (Mopani District) area of the Limpopo province | 73 |
| Table 4.4: Beverage-making fruits and their seasons of availability in the Tsonga-speaking study area | 75 |
| Table 4.5: Beverage-making plant species collected and identified in the North-Sotho speaking study area of the Limpopo province | 82 |
| Table 4.6: Beverage-producing fruits and their seasons of availability in the North-Sotho speaking study area of the Limpopo province | 85 |
| Table 4.7: A list of all plant species (63 in total) identified and collected in the study areas during surveys in the Limpopo province | 90 |
| Table 4.8:Generalised overview of the seasonality of all fruit-bearing species in all of the areas surveyed | 92 |
| Table 4.9:The final selection of potential beverage-making indigenous plant species in the Limpopo province | 96 |
| Table 5.1: Recommended dietary reference intakes (DRIs) | 121 |
| Table 5.2: List of beverages analysed for nutritional characterisation | 122 |
| Table 5.3: Mineral content of fruit juice derived from the mobola plum (*Parinari curatellifolia*) | 129 |

# CHAPTER 1

# RESEARCH BACKGROUND ON INDIGENOUS PLANT-BASED BEVERAGES

## 1.1 INTRODUCTION

Wild plants have always occupied a central role in the lives of people by satisfying their spiritual and material needs (Chadare *et al.,* 2010). This is especially true in rural areas, where indigenous plants contribute significantly as sources of shelter, clothes, firewood, medicine and food. During the last century, the southern African region has witnessed dramatic changes in socio-cultural and environmental realms (Van Wyk and Gericke, 2003). These changes have been driven by the switch from subsistence farming to cash-crop production, accelerated urbanisation, adoption of modern lifestyles and access to modern health-care, environmental degradation as well as loss of biodiversity. Inevitably, much of the indigenous and customary knowledge that has accrued over millennia is being lost (Cunningham and Pieser, 1991; Phytotrade, 2005). This is unfortunate, given that the southern African region is home to an exceptional diversity of plant species, many of which previously occurred in abundance and were distributed over vast areas (Watson and Dlamini, 2003; Scholes, 2004).

Until recently, this diversity of indigenous plants has been the subject of very little scientific interest in the use of these plants by botanists, conservationists and environmental scientists (Schwartz, 1956; Peters and Maguire, 1981; Moshe, 2004; Shackleton, 2004). However, the late 1980s witnessed a resurgence of interest and research on the sustainable use of indigenous plant species in South Africa. Most of this research has concentrated on their medicinal and pharmacological properties regarding the treatment of human and animal illnesses (Steenkamp and Gouws, 2003; Putuka *et al*., 2006; Maphosa and Masika, 2007; McGaw *et al.,* 2007a) and the specific function they play in the traditional healthcare system (Samie *et al.,* 2005; Komane *et al.*, 2008). Although there is rising scientific documentation of these species as part of indigenous knowledge system (IKS) and baseline data useful in the future monitoring of their conservation status (Botha *et al.*, 2001; Tshisikhawe, 2002), there is very little research undertaken on those that are traditionally used to produce foodstuffs such as beverages. As a result, vast natural vegetation areas around many South African rural communities remain largely unexplored for beverage-making indigenous plants. Yet in many developing countries naturally occurring beverage-making plant species have been researched in greater detail for their dietary role in local and traditional food systems (Mwesigye and Okurut, 1994; Muica and Turnock, 1996; Gadaga *et al*., 1999; Leakey, 1999; Chadare *et al*., 2008; Aloys and Angeline, 2009) as well as their commercialisation potential for new product development (Bousious *et al.* 2007; Gruenwald, 2009).

The present study is based on the documentation of native plant species in the Limpopo province as part of indigenous knowledge system (IKS) as well as examining their potential for commercial beverage production. These goals are essential in making an important contribution to the rapidly disappearing indigenous knowledge system on beverage-making plant species occurring in the wild in South Africa. Moreover, undertaking studies on the preparation of beverages from indigenous plant species has the potential to advance concept knowledge for developing agribusiness enterprises, employment opportunities and prospects for family income generation (Shackleton *et al*., 2007; Nyanga *et al*., 2008; Gruenwald, 2009). Thus, the study is making an important input geared to "steer indigenous knowledge research towards practical application initiatives" (Shava, 2009: 1).

## 1.2 LITERATURE CONTEXTUALISATION OF THE STUDY AND RESEARCH MOTIVATION

In many countries indigenous plant species and beverages derived from them have been commercialised with great success. Indeed, many beverages today are commonly associated with their country of origin. For example, the Scots lay claim to some of the earliest recorded history of fermenting and distilling whisky from malted barley. In a similar vein, "*tequila"* is an alcoholic beverage unique to Mexico and has become not only Mexico's national beverage but also a symbol of Mexican culture. The beverage is made from an indigenous plant known as blue agave (*Agave tequiliana)* (Bousios *et al.*, 2007). *Agave tequiliana* is a succulent plant species with a radiately spreading body, nearly 1.5 m tall and a short thick stem at maturity (Niguez-Covarrubias *et al*., 2001). "*Tequila"* is made from its extracted sap and is only regarded as "*tequila"* if it originates from native "*tequila"* plants which occur naturally in the Guadalajara region of South West Mexico (Biodiversity Explorer, 2009). Similarly, around the Subcarpathian region of Romania there is an indigenous plum whose fruits the locals use to brew traditional brandy known as "*tuica"* (Muica and Turnock, 1996). This "*tuica"* is widely consumed as a short drink on a casual basis in homes, bars and restaurants. Over many years it has become the national drink of Romania and it is attached to an unique cultural element associated with a distinct rural lifestyle (Muica and Turnock, 1996).

There are other examples of alcoholic and non-alcoholic beverages that are strongly associated with their countries of origin. Some of these beverages have experienced considerable commercial viability despite competition from imported products. For instance, vodka is a distilled alcoholic beverage originating from Poland and Eastern Europe. In fact, the name vodka is believed to stem from the Russian word "*voda*" which means water. Since the 14th century, the world consumption of vodka has increased to 4.5 billion litres annually and has become a multi-billion euro business (Stubb, 2006). Although modern vodka is currently produced from many different types of agricultural products, in Eastern Europe it is produced mainly from potatoes or rice (Gin and Vodka Association, 2009). This has led to the development of tighter Geographical Indications (GI) amongst the vodka-belt countries (marked by characteristically cold climates and the -2$^{o}$C January isotherm), which insist that all products branded as vodka should be restricted to only spirits (with an ethanol content of 35-50% v/v) derived from grains, potatoes and sugar beet molasses. Restrictions of this nature are instituted not only through the recognition of the traditional methods of production but also the need for original producers to gain competitive advantage in world trade (Stubb, 2006). Likewise, port is a fortified wine produced under very specific conditions in the vineyards located along the Douro Valley in Portugal (Rudnitskaya *et al.,* 2007). The production involves the traditional treading of port grapes in huge cement "*lagares*". More precisely, the terms port or "*porto*" are derived from the name of the City of Oporto in Portugal (Schuster, 2005). In keeping with traditional production procedures, it is required that once the must has reached 5-6% v/v alcohol content, the fermentation process should be stopped in order to help retain a sufficient sugar level for the wine to be sweet. Although many port-style wines are presently brewed around the world, the strict usage of the terms port or "*porto*" refer only to wines produced in Portugal.

Regarding non-alcoholic beverages, coca tea, traditionally brewed from *Erythroxylum cocoa*, is one of the best examples of an indigenous plant-based drink that is currently gaining commercial significance locally and worldwide (Nature Peru, 2007). *Erythroxylum cocoa* leaves contain a biological complex with digestive and carminative action and in the South American countries of the Andes region, they are consumed as medicinal tea. The tea is served along with meals by tourist guides on the mountainous Inca Trail to Machu Pichu because it is believed to assist sufferers of altitude sickness by increasing the absorption of oxygen in blood (Nature Peru, 2007). Coca tea has recently been introduced in South Africa and is available in original forms or as blends with cats claw, chamomile, lemon verbena and eucalyptus (Coca Tea, 2009).

Closely allied to coca tea is guarana tea. This indigenous tea is derived from the traditional use of *Paulinnia cupana*, native to Brazil and the Amazon basin (Fukumasu *et al*., 2006, Guarano Tea, 2009). The seeds of *Paulinnia cupana* have been used by the Satereˆ-Maue´ Indians living in Brazil as medicinal tea. The seeds contain a number of bioactives, including theophylline, theobromine, xanthine derivatives and tannins and also catechin, epicatechin and proanthocyanidins. According to Henman (1982), Bruneton (1999), Edwards *et al*. (2005) and Majhenicˇ *et al*. (2007), the seeds also contain saponins, starch, fats, choline and pigments, which have many favourable effects on human health, including stimulative effects on the nervous and cardiovascular system. As a result, since the mid-1900s, *Paulinnia cupana* has been cultivated on an agricultural and industrial scale in Brazil to produce not only tea, but a variety of phyto-products for the rapidly growing wellness market.

In Africa, a number of beverage-making indigenous plants have also received research attention. For instance, a survey by Mwesigye and Okurut (1994) carried out in Uganda, has identified five different traditional alcoholic beverages produced from local plant species. These beverages include *"tonto, ajon, omuramba, kweethe"* and "*waraga"* and are produced for trade at subsistence level, thus providing income for families involved. Although among these beverages, it is only Ugandan "*waragi*" which has entered international markets successfully (Uganda Waragi, 2010), their methods of production have been examined in detail. In Nigeria, beverages produced from kola nut species such as *Cola nitida* and *Cola acuminata* have demonstrated international market potential (Fayeola and Akinwale, 2002). In addition, extracts of these plants are used to flavour other beverages and to produce a range of herbal teas for local markets in Nigeria. In Zimbabwe, a number of traditionally fermented beverages have been reviewed by Gadaga *et al. (*1999). These comprise non-alcoholic cereal-based beverages such as "*mahewu/mageu, tobwa"* and *"mangisi"* as well as alcoholic varieties derived from sorghum or millet malt ("*uthwala"* and "*chikokivana"*), distilled spirits ("*kachasu"*) and those fermented from wild fruits, the so-called "*makumbi"* *(*Nyanga *et al.*, 2008*)*. The review by Gadaga *et al.* (1999) has revealed some regional variations in the preparation of these beverages and has made recommendations for potential research areas.

In South Africa, there are only a few indigenous plant-based beverages which have been commercialised successfully, despite the point that the country "has the richest temperate flora in the world" with more than 19 500 indigenous plant species (Crouch *et al*., 2008: 355; SA

Year Book, 2008/09). These include alcoholic beverages such as sorghum beer and liqueurs such as ilala and amarula cream, manufactured from sorghum (*Sorghum bicolor*), ilala palm (*Hyphaene coriacea*) and marula (*Sclerocarya birrea*) plant species, respectively (Shackleton *et al.,* 2001, Nwonwu, 2006). Sorghum beer features more prominently in the lower end of the alcoholic beverage market in South Africa while cream liqueurs are positioned for the higher end. Apart from these examples, there are indigenous plant-based non-alcoholic drinks such as "*mageu"* and a few teas (Beverage Review, 2003). "*Mageu"* is an energy giving beverage used by many of the maize consuming populations in Africa (Foodcorp, 2010) and along with sorghum beer, is closely linked to the mining industry in South Africa and the early urbanisation of black workers. In fact, in the early days of the mining industry, miners insisted that "*mageu"* be provided for them by the mines and in recent times, this beverage is packaged in convenient cartons due to a growing demand by factory workers and the urban market (Beverage Review, 2003). On the other hand, most indigenous teas in South Africa originate from plant species growing only in the Cape region and these include the famous rooibos (*Aspalathus linearis*) and honeybush (*Cyclopia* species) teas. Although these teas were initially used only locally, they are currently being exported to lucrative markets all over the world, including Japan, Germany, the United Kingdom, the Netherlands and North America, due to rapidly rising international demand (Neven *et al*., 2005, Wilson, 2005).

Although the Limpopo province is widely regarded as one of the poorest in South Africa, it produces 45% of South Africa's citrus fruits, 57% of macademia nuts, 60% of tomatoes and 70% of mangoes (Department of Agriculture (DA), 2006a). The province is also home to a rich diversity of indigenous plant species. These species are distributed in 15 different veld types (Limpopo State of the Environment Reports (LSOER), 2005). However, regarding the commercialisation of new beverages from existing indigenous plant species, it is only during the last 20 years or so that a beverage known as amarula cream liqueur (ACL) was developed successfully. This liqueur is manufactured by Distell in the Western Cape, making use of marula fruits harvested by rural communities in the Phalaborwa region of the Limpopo province. Marula fruits are greatly sought-after for their delicious pulp and nuts as well as their high vitamin C content (Van Wyk and Gericke, 2003). Amarula cream liqueur was launched into the marketplace around the mid-1980s and over the last 15 years it has become one of the world's best selling beverage in its category (Distell Annual Report, 2005). In addition, several local economic and environmental conservation offshoots in the Phalaborwa region have emerged:

- the improvement of rural livelihoods through income generation,

- increased volume of national exports and
- increased awareness initiatives for nature conservation.

*Sources*: Cunningham and Shackleton (2004); Distell Annual Report (2005); Leakey *et al*. (2005); Amarula Cream (2009).

However, such successful commercialisation ventures are rare. It appears that failure to develop new products and determine market potential as well as accessibility are some of the key factors constraining the successful commercialisation of many indigenous plant-based beverages in South Africa (Reibel, 2003; Phytotrade, 2005).

Proceeding from the context associated with the market successes of ACL as well as rooibos and honeybush teas, there could be other beverages (albeit less well known) with untapped commercial development potential in the various rural communities of the Limpopo province. Hence, the research question for the current study was stated as: are there other indigenous plant-based beverages in the Limpopo province with demonstratable market potential for small scale or large-scale commercialisation?

## 1.3 RESEARCH AIM AND OBJECTIVES

This study aimed to investigate the commercial development potential of selected indigenous plant-based beverages in the Limpopo province – the goal being to determine whether or not there is market potential for their successful commercialisation in the future. Consequently, this research aim was associated with the following research objectives, namely, to:

(1) identify and document beverage-making indigenous plants as well as alcoholic and non-alcoholic drinks derived from them in selected areas of the Limpopo province,

(2) discuss the traditional methods of preparing these beverages,

(3) evaluate their nutritional properties and

(4) assess their market potential for possible commercialisation.

## 1.4 SCOPE AND LIMITATIONS OF THE RESEARCH

Given the research aim and objectives of the study delineated above, the scope of the study entailed three aspects – the identification and documentation of indigenous plants that are traditionally used by the local rural populations in the Limpopo province for making beverages, their nutritional aspects as well as an assessment of their commercial potential through sensory analyses and a few market surveys. However, the study had a set of limitations inherent in the topic investigated. Firstly, not all of the rural communities or village settings or ecosystems in the Limpopo province could be surveyed for the research, given the nature of the survey methods used and the time-frames selected. Secondly, some of the exotic species, which have naturalised successfully in South Africa, were also documented for the study. This is because many of the respondents encountered during the surveys were not aware of their conservation nor invasive alien plant (IAP) status. Hence, a few beverages made from these (IAP) plant species were also analysed for nutrient characterisation and for making comparisons. Lastly, the estimation of market potential involved only a few beverages derived strictly from existing indigenous plant species.

## 1.5 ORGANISATION OF THE THESIS

The thesis is presented in seven chapters. Chapter 1 provides the research background on indigenous plant-beverages and the importance of the study. A brief literature contextualisation, research motivation, aim and objectives as well as limitations of the study are also provided. Chapter 2 consists of a review of the relevant literature pertaining to indigenous plants in South Africa and beverages derived from them. Chapter 3 provides a description of study areas, research design as well as methods of data collection, processing and analyses.

Chapter 4 deals with the first set of research findings, with particular reference to the local indigenous knowledge system on naturally occurring beverage-making plant species in selected rural communities of the Limpopo province. The chapter begins with an analyses and discussion of the different profiles of respondents interviewed for the study before proceeding with the identification of the most frequently cited species, local uses, plant parts used and harvesting periods, issues of sustainability and other constraints. The chapter also sheds light on species with favourable potential for making beverages, based on feedback from respondents and other relevant factors.

Chapter 5 presents the second set of research findings, mainly on selected (i) indigenous plant species, (ii) the preparation methods of beverages as well as (iii) nutrient characterisation and evaluation of some of the beverages. Chapter 6 discusses the results of descriptive sensory analyses, followed by an assessment of the market potential of selected indigenous plant-based beverages. The thesis ends with Chapter 7, comprising a summary of research findings, concluding remarks and recommendations which set research goals for further research.

# CHAPTER 2

## LITERATURE REVIEW ON BEVERAGE-MAKING INDIGENOUS PLANTS AND ASSOCIATED DRINKS

### 2.1 INTRODUCTION

The review of literature included two broad areas: non-alcoholic and alcoholic beverages derived from indigenous plants in South Africa (and Africa where applicable). Inevitably, the starting point for reviewing all of the beverages involved required a detailed literature analyses of species involved. Section 2.2 deals with indigenous teas (non-alcoholic beverages) while section 2.3 is devoted to alcoholic beverages. A brief summary of these sections is also provided.

### 2.2 INDIGENOUS TEAS

Indigenous teas in South Africa comprise a range of non-alcoholic beverages produced from plants, many of them well known to rural communities who live in and around their ecological habitats and they have been consumed as herbal teas by many generations. Consequently, they have a background of ethnobotanical history behind their utilisation and because of this, some have received scientific attention for their phytochemical, medicinal and therapeutic properties. However, only a few have undergone successful commercialisation. The rooibos tea name features prominently in this instance, followed by commercialised beverages such as honeybush and fever tea. Others have not yet been industrialised although they are believed to have commercial development potential (Van Wyk and Gericke, 2003; Olivier and Rampedi, 2008). One of these is the so-called bush tea, very popular in the eastern mountainous areas of the Limpopo, KwaZulu-Natal and Eastern Cape provinces (Van Wyk and Gericke, 2003; Olivier and De Jager, 2005; Olivier, 2001). The following subsections provide a review of the botanical and phytomedicinal attributes as well as the commercial and market-related aspects (if any) of three South African indigenous teas - rooibos, honeybush and bush tea. The review and synthesis of literature on rooibos tea has resulted in a publication in the *International Journal of African Rennaissance Studies* (Rampedi and Olivier, 2008).

#### 2.2.1 Rooibos tea, *Aspalathus linearis*

*Aspalathus linearis* is indigenous to the arid Cedarberg Mountains in the Western Cape province of South Africa (Van Wyk and Gericke, 2003). The natural vegetation in the Cedarberg region is classified as the Fynbos Biome, which is one of the sixteen broad habitat units comprising the Cape Floristic Region. The Fynbos incorporates a remarkable diversity of plant species, of which more than 6 000 are regarded as native to the area (Department of Environmental Affairs and Tourism (DEAT), 2006; SA Year Book, 2008/09). Rooibos tea is derived from *Aspalathus linearis*, first recorded in 1772 by the Swedish botanist, Carl Thunberg. It is also known by other distinctly South African names such as red tea, "*speldtee, swarttee"* or "*koopmanstee"* (Afrikaans) (Joubert *et al*., 2008). However, there are other names such as "*naaldetee",* due to its morphology and needle-like leaves. Originally, rooibos was utilised mainly by the Khoi-San people as a traditional beverage and was associated with medicinal and therapeutic properties (Van Wyk, 2008). According to Joubert *et al*. (2008), Benjamin Ginsberg, also observed this traditional practice during the early 1900s, when he met Khoi-San people in the Clanwilliam region of the Western Cape. At that time, the plant was harvested only in the wild by cutting the shoots using an axe and then crushing them with a mallet before allowing a process of "fermentation" or "sweating" to occur. This was followed by a period of sun-drying. This traditional method has provided a foundation for the modern manufacturing process of fermented rooibos (Joubert *et al*., 2008).

#### 2.2.1.1 Botanical aspects

The *Aspalathus* genus comprises over 270 plant species, mostly confined to the Cape Floristic Region. However, there are about six rooibos species with a geographical distribution extending into the KwaZulu-Natal province (Cupido, 2005). The variation amongst rooibos plants is attributed to differences in morphology, geographical distribution, mode of regeneration, genetic as well as polyphenolic differences between the various populations (Van der Bank *et al*., 1995; Van Heerden *et al*., 2003; Cupido, 2005; Joubert *et al.,* 2008). Species such as *A. callosa, A. cephalotes, A. cordata, A. quinquifolia* and *A. spinescens* are all perennial shrubs and have been differentiated on the basis of the arrangement of flowers, morphology of the leaves, flowering time and phenology as well as soil type (Cupido, 2005). Members of *Aspalathus linearis* also differ from one another on the basis of morphology and phenolic chemistry. However, most agricultural and horticultural initiatives have focused on the Red type or Rocklands type of *A. linearis* which is divided into the improved Nortier type (cultivated) and the wild-growing types earmarked for certain niche markets (Joubert *et al*., 2008). Wild types include the red-brown, grey as well as the black varieties. However, the latter two types differ markedly with the Red type in terms of flavour and colour.

#### 2.2.1.2 Production and product development trends

***Earlier commercial development***

Given its pleasant taste and purported health benefits, Benjamin Ginsberg began trading with rooibos tea around 1904 (Carter, 2005). He bought it from coloured communities and then sold it to European settlers who arrived at the Cape (Cant and Machado, 1999) – thus providing a starting point for its agricultural development. The first rooibos tea plantations were initiated by Dr P. le Fras Nortjie on the Klein Kliphuis farm at Clanwilliam in the 1930s (Rooibos Innovations, 2010). The goal was to propagate rooibos tea because wild harvesting could not be sustainable, especially if the economic demand for the tea was to increase further.

At that time (1930s), the major limiting factor was the availability of rooibos seeds. The seeds were collected by ants and were also dispersed by wind immediately after opening of pods and would not germinate without pre-treatment. However, with improved propagation methods, more farmers became interested in the crop (Cosmetic Workshop and Natures Goodness (CWNG), 2009). Later on, the cultivation spread to other areas as far away as Darling and Niewoudtville (Joubert *et al*., 2008). Average production was about 100 tons per annum, indicating that rooibos was not yet widely recognised as an agricultural crop. As a result, low agricultural supplies were augmented by wild harvesting whilst market awareness of purported health benefits, spread slowly mainly by word of mouth. No quality control measures were undertaken during this early period and inevitably, supplies were uncertain and limited. Moreover, prices fluctuated wildly from year to year (Cant and Machado, 1999). The greatest challenge the sector faced was the total collapse in the tea market prices shortly after the Second World War and the failure of the Clanwilliam Tea Co-operative, established in 1948 to revamp the industry (Rooibos Limited, 2010). These challenges prompted the establishment of the Rooibos Tea Control Board (RTCB) in 1954 (Cant and Machado, 1999).

The RTCB was expected to bring about stability in the producer prices and to ensure a standardised product quality. In addition, the RTCB would facilitate the provision of extension services and develop international markets since the role that exports could play in the sector was largely neglected (Cant and Machado, 1999). Although the RTCB did not resolve all the problems adequately, the first exports of 524 tons occurred in 1955 (Joubert *et al*., 2008) – pointing to some improvements in the production and supply chain.

***Scientific findings and medicinal attributes***

The herbal image of rooibos tea received increased impetus in 1968, when Annique Theron stumbled on the healing powers of the plant for her sick baby (African Dawn, 2009). Since then, rooibos tea has been given to babies or added to their milk to assist in the treatment of colic, insomnia and stomach cramps. Analysis of hot water extracts of fermented and unfermented rooibos tea have been shown to have a total polyphenol (TP) content ranging from 29.69-34.25% to 35.08-39.30%, respectively (Joubert *et al*., 2008). The polyphenols detected in rooibos tea are mainly flavonols (*iso*-quercetin), flavones (orientin, *iso*-orientin and luteolin) and dihydrochalcones (notably aspalathin and nothofagin) (Marnewick *et al*., 2000). The compound aspalathin has been isolated only from rooibos (Marnewick *et al*., 2003) and has been found to display the greatest antioxidant activity when compared with other rooibos flavonoids (such as *iso*quercetin and rutin) in different assays (Joubert *et al.,* 2008). Polyphenols are known to play an important role against the activity of mutagenic and carcinogenic compounds, suggesting that cells in the human body may be protected against the oxidative damage caused by free radicals (Von Gadow *et al.,* 1997).

In some of the "*in vivo"* studies conducted, rooibos tea extracts consumed immediately after weaning, markedly reduced the build-up of alkyl peroxyl radicals produced by lipid peroxidation in several areas of the brain of 24-month old rats (Joubert *et al.,* 2008). Of particular importance, however, is that during the 1980s both Japanese and American scientists discovered a powerful and stable detoxifying enzyme in rooibos tea. This enzyme has antioxidant properties and is known as super-oxide dismutase (SOD) (Wyatt-Minter, 2009). A study of the antioxidative effects of rooibos tea on workers occupationally exposed to lead, showed that affected cells recovered due to the increase of detoxifying enzymes (such as glutathione and SOD) and the reduction of lipid peroxidation-malondialdehyde (MDA) at blood lead (Pb*b*) concentration of <1.93 mol/l (Nikolova *et al.,* 2007). The propensity for decreased lipid peroxidation in these experiments suggested that rooibos tea could play a protective role in the recovery of workers exposed to lead. And, unlike ordinary green and black *Camellia sinensis* teas, rooibos is caffeine-free and has a low tannin content (Von Gadow *et al*., 1997; Wilson, 2005).

Other studies have confirmed the favourable effects of rooibos tea in the treatment of viral infections and itching sensations associated with skin disorders such as atopic dermatitis. As a result, a new range of skin care products and neutraceuticals (for instance aspalathox™) are manufactured for wellness markets in South Africa and overseas (Bezuidenhout, 2007; Red Cedar, 2007, *personal communications*; Cosmetic Web, 2008; Clanwilliam General Info (CGI), 2009). The proliferation of research findings attesting to the herbal properties of rooibos tea have increased markedly since the 1980s and is still gathering momentum in the 2000s (Joubert 1988; Nakano *et al*., 1997; Von Gadow *et al*., 1997; Marnewick *et al.,* 2000; Lee and Jang, 2004; Mashimbye *et al.,* 2006*;* Snijman *et al*., 2007; Richfield, 2008). Due to a growing number of scientific claims and increasing popularity of rooibos tea in South Africa and overseas, the sector has evolved into a fully fledged industry with numerous key stakeholders involved. The roles of the different stakeholders involved are summarised in Table 2.1.

Table 2.1: Some of the key stakeholders in the rooibos tea sector.

| Stakeholder | Entity | Main functions and responsibilities |
|---|---|---|
| National Department of Agriculture (DA). | Government | Major regulator of the sector. Provides strategic and policy direction. |
| Perishable Products Export Control Board (PPECB). | Statutory organisation | An assignee of the DA established in terms of the Perishable Product Export Control Act (PPECB Act 9 of 1988 and the Agricultural Product Standards Act (APS Act 119 of 1990). Regulates the standard of all perishable exports from South Africa. |
| Research organisations: Universities and the Agricultural Research Council (ARC). | Statutory organisations | Carries out different types of research, particularly on the propagation of rooibos tea plants and their phytochemistry. |
| Rooibos Limited (formerly RTCB). | Private firm | Established in 1954. Market leader in the domestic sector. Abroad, market share is nearly 50-60%. The firm also has state-of-the art process and product quality facilities as well as a research laboratory. |
| Commercial farmers. | Small private firms | More than 200 individual farmers and enterpreuners involved in the growing, processing, packaging and selling of rooibos tea. |
| Small-scale farmers, e.g. Wupperthal and Heiveld farming cooperatives. | Mainly-community based ventures | Responsible for nearly 3% of the total production of rooibos tea. |
| Interventionist and rural trade-promoting organisations which assist previously disadvantaged rural communities in the Cedarberg, Suid Bokkeveld and Clanwilliam region. | Various non-governmental organisations (NGOs) | Promotes the participation and enablement of small-scale community-based cooperatives as well as environmental sustainability. |

*Sources:* Arendse (2001); Wilson (2005); Hansen (2006); Nel *et al*. (2006).

Once the plant is harvested, it is sold to buyers and exporters such as Rooibos Limited (formerly Rooibos Tea Control Board until 1993) (75% market share), Khoisan Tea (9%), Coetzee and Coetzee (8%), Cape Natural Tea Products (3%), Red Tea (3%) and Kings (2%), who collectively constitute major players in the supply chain (Hansen, 2006). Figure 2.1 shows that the total production figures of rooibos tea have improved enormously between 1981 and 2006. For instance, growth has risen by approximately 250% from 1995 to 2005 (Ismail and Fakir, 2004). This upward trend began in 1981 when the total production of rooibos tea reached a high of 3 235 tons and earned R 3.2 million in gross values (Figure 2.1 and Figure 2.2). This was followed by a remarkable 112% increase in 1984, when total production reached 6 860 tons (Figure 2.1). However, these rapid increases were followed by a declining trend lasting from 1985 until 1990 (Department of Agriculture (DA), 2006b) due to the negative impacts of fragmented marketing campaigns and severe *El Niño*-related drought events which occurred between 1983 and 1992 (Rouault and Richard, 2003). Consequently, the major thrust of commercial farmers as well as agricultural boards was on the development of a viable production and supply chain. Coordinated marketing activities were also promoted in order to respond successfully to an emerging health tea market niche in South Africa and overseas (Rampedi and Olivier, 2008).

Signs of sustained recovery began in 1996 when total production reached 5 108 tons (Figure 2.1). In 1997, this value escalated to 9 000 tons (Figure 2.1) while associated gross values generated peaked at nearly R 60 million (Figure 2.2) for the very first time in the history of the rooibos tea sector (DA, 2006b). However, this cycle of increases were briefly disrupted between 1998 and 2000, by another drought phase.

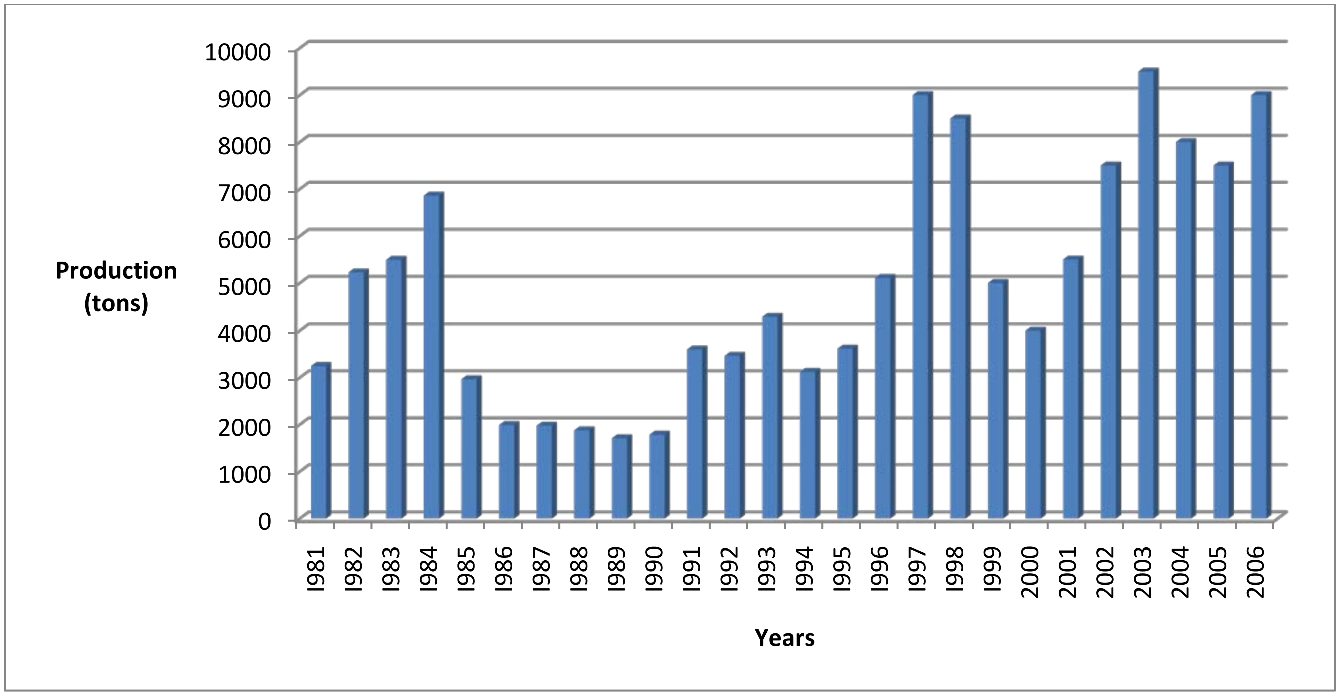



Figure 2.1: Total production values of rooibos tea for the 1981-2006 period.
*Source:* Department of Agriculture (DA) (2006b).

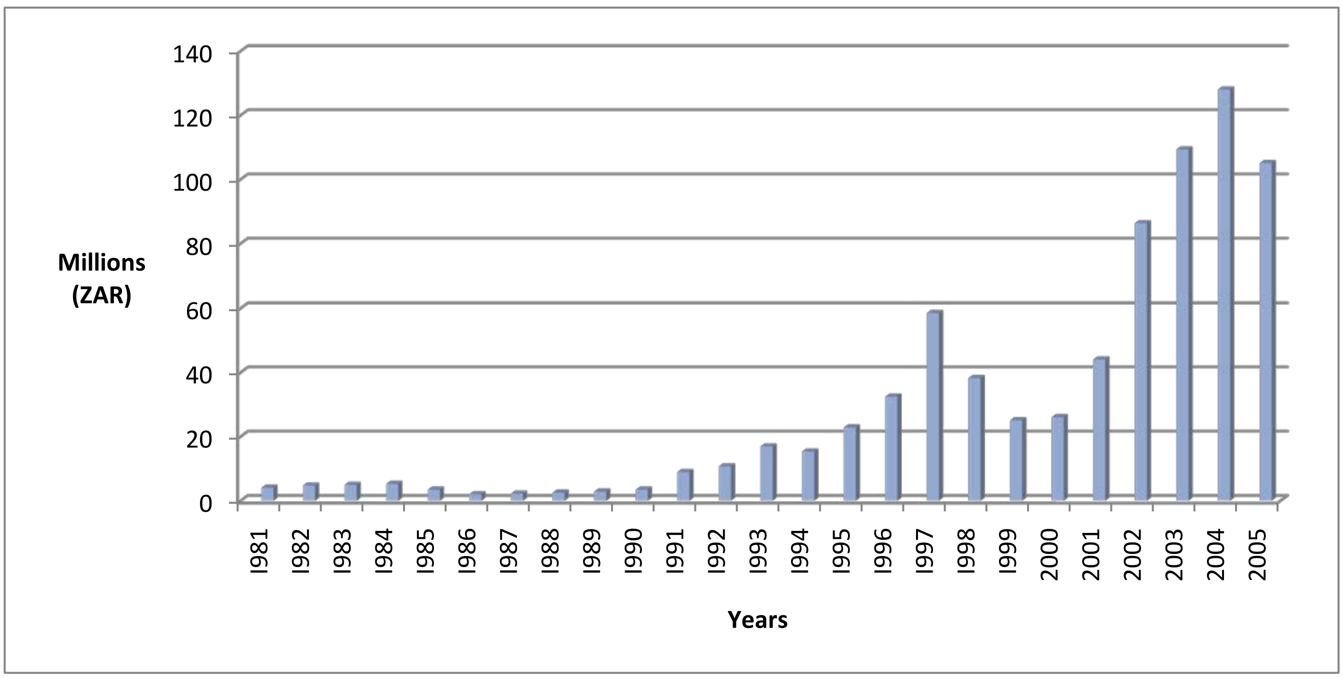



Figure 2.2: Gross revenues generated from rooibos tea for the 1981-2006 period.
*Source:* Department of Agriculture (DA) (2006b).

Since then (1998-2000), the volume of rooibos tea produced in South Africa has increased by more than 400% (Figure 2.1) (Crane, 2007). In fact, growth in total production increased to 9

500 tons in 2003 and was accompanied by a gross value of R 109 million, which increased to R 128 million in 2004. This accelerated growth in total production and gross value is also reflected by the drastic change in the amount of land utilised for cultivating rooibos plants in the Cedarberg region of the Western Cape province. For instance, between 1991 and 2006, land allocated for rooibos tea cultivation increased by more than 300%. This was partly caused by grain farmers who switched to rooibos tea in the face of growing economic demand (Business Day, 2008). This switching between crops, coupled with good rains by then, have dramatically increased the production levels of rooibos tea to approximately 16 000 tons in 2008, thus exceeding the average of 9 000 tons recorded for the previous ten years by over 70% (Ferreira, 2009).

However, some economic indicators show that this higher magnitude of production levels has resulted in a situation whereby supplies have exceeded existing economic demand, inevitably hurting producer prices (Ferreira, 2009). For instance, the attractive producer prices of R16.50 per kilogram of rooibos tea experienced five years ago have fallen to R6.50 per kilogram. In fact, in some areas, producer prices as low as R2.00 per kilogram have been observed (Ferreira, 2009).

Another concern has to do with the protection of the name “Rooibos”, which should be regarded as a Geographical Indicator by the World Trade Organisation, the European Union (EU), the United States and every country involved in international trade. So far, the South African Rooibos Council has begun some steps to have rooibos fully recognised as a Geographical Indicator. Granting indicator status on rooibos will help prevent anyone growing this crop outside of the Western Cape of South Africa from calling it rooibos. Unfortunately, this is a complex process because the EU can only recognise rooibos as a Geographical Indicator if it is already granted legislative protection in its domestic market (Ferreira, 2009).

These challenges suggests that the Department of Trade and Industry must act decisively, urgently and precisely in this matter before other international trade disputes arise (Ismail and Fakir, 2004) which threaten rooibos as a generic name native to South Africa. Around 2003, South Africa, India and China were in the process of establishing databases (of traditional knowledge involving their native fauna or flora) which document different kinds of traditional knowledge in order to assist patent officers in determining if a new international patent infringes on indigenous prior art (Ismail and Fakir, 2004). On the international front, these databases are coordinated by the World Intellectual Property Organization and access will be restricted to patent examiners in order to prevent international biopiracy.

#### 2.2.1.3 Market development aspects

In South Africa, the tea market share of rooibos consumed has risen gradually over the years. By 2001, rooibos tea held 18% of the domestic market share, whereas in 1984 it was only 12% (Arendse, 2001). This is equivalent to an incremental rate of 50% in a period of 17 years. In a three years time frame since 2001, the share of rooibos tea has increased to 20% of the total domestic tea market in South Africa (ACNielsen, 2004). The major brand during the 1970-1980 time frame was the famous "Eleven O'Clock" rooibos tea, packaged with loose tea leaves. During the 2000s, this brand has been surpassed by other leading brands such as Five Roses, Freshpak, Khoisan tea, Vital, Laager and a range of store-specific brands (Rampedi and Olivier, 2008). Companies such as National Brands and Unilever pack almost 90% of the rooibos tea consumed in the domestic market (Hansen, 2006). In addition, uniquely flavoured rooibos tea is also sold in various supermarkets - major types being apple, orange, blackcurrant, lemon and honey flavours.

The major selling point of rooibos tea appears to be around its purported health benefits, namely its antioxidant polyphenol content, lack of caffeine and a low tannin content. Given the growing health concerns amongst consumers in the worldwide wellness market, the market share of rooibos tea is likely to increase further internationally, given that a new rooibos espresso is already sold in some of the overseas market niches such as the USA, UK, Canada, Portugal, Sweden, Denmark and parts of Asia (SA Good News, 2008). The tea is specifically refined for use in an espresso machine (Health and Fitness, 2007). This latest innovation, has earned the title of the "Best New Product" in the Specialty Beverages category at the world's largest coffee exhibition held at the Speciality Coffee Association of America's Annual Conference and Exhibition in Minneapolis, USA during 2008. In 2006, this speciality beverage won the South African Food Review Product of the Year Award (SA Good News, 2008).

Internationally, the volume of export sales associated with rooibos tea have been increasing steadily over the years. Since 2 000, about 30% of the local production of rooibos tea, with an average of more than 7 000 tons, is exported to 30 different international markets (Figure 2.3). The amount of exports increased rapidly between 2001 and 2006. Amongst the different countries importing rooibos tea from South Africa, Germany is the leading export destination that has exceeded Japan in the early 1990s, when the two countries each imported about 400 tons (Business Day, 2007).

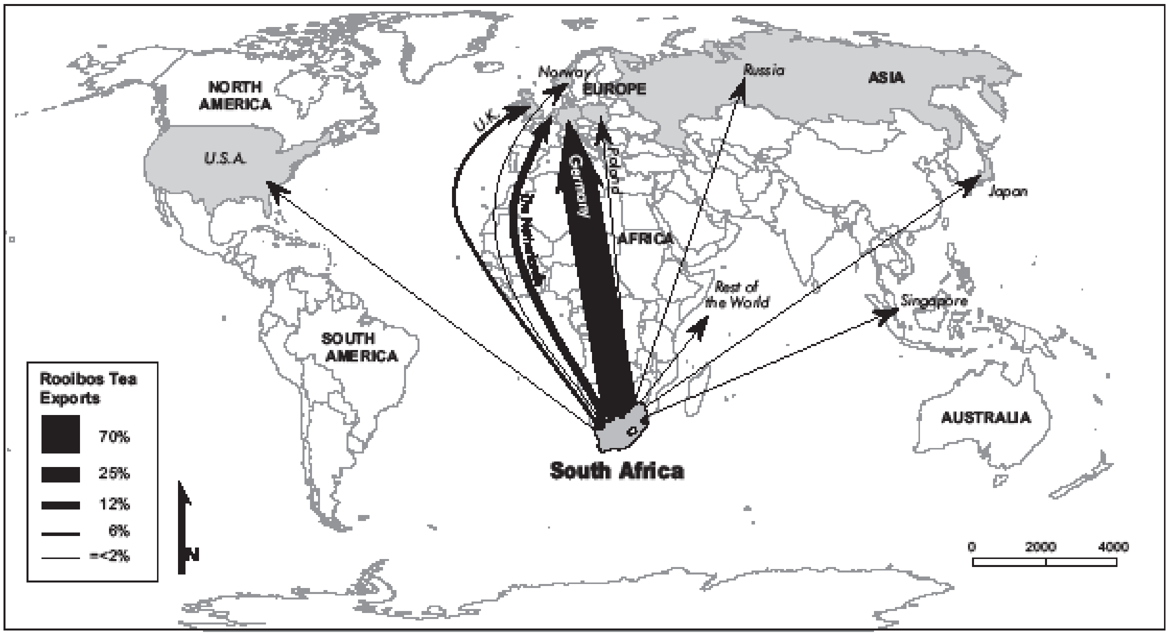



Figure 2.3: Rooibos tea exports for different international market niches.
*Sources:* Adapted from data supplied by the Department of Agriculture (DA) (2006b) and the Agricultural Research Council (ARC) (2008).

In fact, 64% of the total international sales are destined for Germany and it is followed, in descending order, by the Netherlands (10%), United Kingdom (8%) and Japan (6%) (Figure 2.3). Smaller importers include the USA (3%), Poland (2%), Russia (1%), Norway (1%) and other countries (5%) (ARC, 2008; DA, 2006b). Although the USA is currently classified as a smaller importer, overall sales of rooibos have increased dramatically during the 1993-2003 decade. For instance, in 1993 these sales amounted to $1 billion (R 6.7 billion) and by 2003 they have grown to $ 5.1 billion (R 34.1 billion) (Arendse, 2001; Carter, 2005). Due to rapidly growing rooibos tea exports, over R 300 million of foreign revenues have accrued to the South African economy between 1999 and 2005, thereby contributing substantially as a source of foreign revenue (Carter, 2005).

### 2.2.2 Honeybush tea, *Cyclopia* species

Apart from rooibos, the fynbos is also home to honeybush plants. These plants have golden yellow stems, with hairless trifoliate leaves and honey-scented flowers. A distinct type of indigenous herbal tea is produced from honeybush plants, which entail nearly 24 different species belonging to the genus *Cyclopia* (Van Wyk and Gericke, 2003). This tea has been consumed by households in South Africa since at least the 1700s (Neven *et al.,* 2005). The earliest mention of honeybush plants in the botanical literature appeared in 1705 (Du Toit *et al.*, 1998). Honeybush tea, like rooibos tea, was popularised by Carl Thunberg as an appropriate substitute for ordinary Oriental (*Camelia sinensis*) tea, possibly based on the native practices of the Khoi-San communities at the Cape (Dharmanada, 2005; Joubert *et al*., 2008). The tea has a pleasant aroma and a mildly-sweet taste.

Although some of the honeybush species are still harvested from the wild, propagation and cultivation trials have been undertaken by various stakeholders, including Dr Hannes de Lange of the National Botanical Institute of South Africa in Kirstenbosch and ARC-INFRUITEC (Du Toit *et al.,* 1998; Joubert *et al*., 2008). According to Van Wyk and Gericke (2003), De Lange has developed four species - *Cyclopia sessilifolia, C. intermedia*, *C. subternata* and *C. genistoides* - into agricultural crops. However, *C. intermedia* is no longer cultivated because it is not economically viable since it grows extremely slowly and cannot be harvested sustainably at the end of the growing season (Joubert *et al*., 2008). Species such as *C. meyeriana, C. pubescens, C. dreageana* and *C. buxifolia* are presently being assessed for possible commercialisation in the future (Matoti, 2007). The diversity of plants from which honeybush tea is brewed shows that the beverage is manufactured from wild populations and cultivated types.

2.2.2.1 Medicinal and current research findings

Traditionally, a decoction[1] of honeybush tea was used as a restorative and as an expectorant to treat chronic catarr and pulmonary tuberculosis whilst an infusion[2] of the tea was reported to assist with weak digestion, heartburn, poor appetite as well as nausea (Bowie, 1830; Van Wyk *et al*., 1997, *cited* in Joubert *et al*., 2008). Besides these claims, there are various medicinal attributes linked to consumption of this beverage. In modern times, honeybush tea is consumed as an infusion either on its own or in a blend with rooibos tea. The tea has a low tannin content

[1] Decoction means the tea is prepared by boiling leaves, roots, flowers, twigs or any suitable material in water for an extended period of time on a low source of heat to extract the flavour and desirable medicinal constituents. More water may be added during the day as is necessary (Olivier and Rampedi, 2005; Joubert *et al*., 2008: 377).

[2] Infusion applies to preparation of tea mainly by modern day consumers in the same manner as making Oriental (*Camellia sinensis*) tea. The flavour, colour and other attributes are extracted from leaves (tea bags) or any suitable material by “infusing” them with freshly boiled water for 2-6 minutes (Joubert *et al.*, 2008: 377; Olivier *et al*., 2008). Usually the tea is served hot with or without milk and sweeteners.

and lacks caffeine, making it a healthful beverage to deal with conditions such as insomnia, stomach ailments, milk production for breast feeding women and skin-related disorders such as psoriasis (Du Toit *et al*., 1998). The infusion has a purplish colour when milk is added, unlike the orange-red colour of rooibos tea (Du Toit *et al*., 1998). In addition, the major flavour notes of honeybush tea are hot apricot jam, floral, honey-like and dried fruit mix, with the overall impression of sweetness (Du Toit *et al*., 1998).

Many medicinal claims about honeybush tea have prompted a number of studies to examine the chemical composition and biological properties of this beverage. As a result, various species such as *C. intermedia, C. genistoides, C. sessiliflora* and *C. subternata* have received scientific attention (Du Toit and Joubert, 1999; Marnewick *et al.,* 2000; 2004; ARC, 2008; Joubert *et al*., 2008). According to Van Wyk and Gericke (2003), honeybush tea has several phenolic compounds such as flavonoids and xanthone C-glycosides, which are considered to be health-promoting mainly because of their antioxidant properties. Generally, all species are enriched with mangiferin and two flavonoids (De Nysschen *et al.,* 1996). Other compounds identified include xanthones, isomangiferin, flavanone and hesperidin (Joubert *et al*., 2008). In particular, hesperidin and isosakuranetin compounds have been isolated in *C. intermedia* and *C. subternata* species (De Nysschen *et al.,* 1996). However, there are some variations regarding the polyphenolic composition of *C. intermedia* and *C. subternata* (Joubert *et al*., 2008). For example, in certain assays *C. genistoides* displayed the highest concentrations of mangiferin (3.6%) and isomangiferin (0.54%) whilst *C. intermedia* carried the highest concentration (1.76%) of hesperedin (Joubert *et al*., 2008).

Joubert *et al*. (2008) have noted quantitative differences in the polyphenolic composition between two types of *C. genistoides* harvested in geographically distinct habitats. *C. genistoides* species harvested from the Overberg area displayed significantly more mangiferin and less hesperedin than the West Coast type although their isomangiferin content was nearly similar. As indicated with rooibos tea, antioxidant activity is a function of total polyphenol content in these indigenous teas. Moreover, their unfermented extracts tend to exhibit relatively higher antioxidant activity than fermented ones and in the case of honeybush tea, this pattern is attributed to the decrease in xanthone and flavonoid content due to the fermentation processes involved (Joubert *et al*., 2003).

In some of the "*in vivo"* studies completed, honeybush tea along with rooibos tea, green and black teas, were given to male Fischer rats as a sole source of fluids for 10 weeks (Marnewick *et al*., 2004). These rats were also subjected to 2-AAF- and AFB-induced mutagenesis. Experimental rats exhibited no significant adverse effect on their body weight, relative liver weight, blood clinical changes and daily fluid intake. Both honeybush and rooibos tea stabilised the level of reduced glutathione (GSH) which resulted in increased antioxidant capacity in affected cells. The total daily flavonoid intake appeared to be significantly higher in rats fed with black, green and unprocessed honeybush teas. This suggested that the consumption of this tea, by inducing the different isoforms of cytochrome P450 (CYP450), was capable of directing metabolic processes away from the formation of active mutagenic metabolites (Marnewick *et al*., 2004).

Furthermore, a recent study has highlighted the antifungal effects of rooibos and honeybush tea extracts against *Botrytis cinerea* (Coetzee *et al.,* 2008). *Botrytis cinerea* is one of the microorganisms responsible for the development of the so-called "grey mould" on vegetables and fruits such as grapes. When not controlled it can lead to widespread damage of crops. It has been found that treatment of *Botrytis cinerea* spores with *Aspalathus linearis* or *Cyclopia genistoides* tea extract, has the propensity to reduce spore germination by approximately 36% and 19%, respectively. These effects have suggested the potential use of these extracts as antifungal agents given that some microorganisms within vineyard populations have developed fungicide-resistant strains (Coetzee *et al.,* 2008). However, the anti-microbial efficacy of these tea extracts may decrease over time because of either instability or oxidation of active compounds, thus raising the need to undertake further research in order to isolate, identify and stabilise the antimicrobial components involved (Coetzee *et al.,* 2008).

2.2.2.2 Development of honeybush into an agricultural crop

Although honeybush was gathered through wild harvesting during the 1800s, the transformation and development of this indigenous plant into an agricultural crop and viable agribusiness began only in the early 1990s (Joubert *et al.,* 2008). Supplies of the crop were initially limited by various factors, including scarcity of seedlings. This gap in the production chain was filled by Evelyn Thysse, a member of the Haarlem community, whose agribusiness operation was established successfully with the assistance of the non-governmental organisation, Agribusiness in Sustainable African Natural Plant Products (ASNAAP) (Neven *et al*., 2005). In 1999, a group of honeybush producers established the South African Honeybush Tea

Association (SAHTA) in order to coordinate activities within the industry, with assistance from the ARC (Neven *et al*., 2005; ARC, 2008). SAHTA has identified the following requirements for achieving growth in the sector:

- reliable supply of raw and processed product,
- reliable standards and consistent product quality,
- consumer education in the use of honeybush tea and
- integrated marketing campaign for honeybush tea.

*Source:* ARC (2008).

This organisation has evolved into an industry-wide organisation representing all stakeholders in South Africa's honeybush sub-sector (made of nurseries, producers, processors as well as packaging companies) (Neven *et al*., 2005). Due to a lack of adequate product standardisation, SAHTA is trying to develop industry-wide standards for taste, colour and quality assurance – a very important product attribute if honeybush tea is to succeed in specialised niche markets.

Over 250 hectares of land is currently allocated for the agricultural production of honeybush tea. Unlike rooibos tea, the production areas for honeybush tea are restricted to the wetter Eastern Cape mountains and then along the Langeberg and Swartberg mountains into the Western Cape (DA, 2005). Since 2001, approximately 20% of the commercial plantations are managed by small-scale emerging farmers of Ericaville, Groendal and Haarlem (Neven *et al*., 2005; ARC, 2008). As of 1998, the production of honeybush tea arising from the Langkloof area was estimated at approximately 20 tons annually (Du Toit *et al*., 1998).

#### 2.2.2.3 Markets for honeybush tea

When the formal honeybush tea agribusiness slowly unfolded during the late 1990s, it was mainly limited to traditional markets and was sold at road stalls and in health shops in the Southwestern and southern Cape (Du Toit *et al*., 1998). At that stage, the product was sold without an effective marketing strategy and consequently consumer awareness was limited to the Cape region only. However, around 2005, economic demand for honeybush tea began to increase rapidly as it exceeded its annual growth rate of 30% (Neven *et al*., 2005). This led to higher harvesting pressure on wild honeybush stocks and as a result, rising demand has opened new opportunities for increasing cultivated production yields. Inevitably, a number of large-, medium- and small-scale farmers have entered the industry (Neven *et al*., 2005).

Moreover, in an effort to develop a competitive advantage against other teas, almost all of the co-operatives involved in the production of honeybush tea have embraced the concept of organic production. Adopting such a production method means that they are committed to produce honeybush in an environmentally sustainable manner and without the application of fertilisers or chemicals – an aspect of growing marketing significance, especially relevant for export niches. However, the major constraint here is that organically produced honeybush has to be first certified by appropriate agencies such as the German-based Ecocert and this undertaking usually carries a high financial cost for small players (Nel *et al*., 2006). Consequently, certified organic honeybush tea production is rather small, constituting only 5-10% of the total output (Neven *et al*., 2005).

Exports of honeybush tea began during the past number of years (Figure 2.4) (ARC, 2008). Initially, there were only 19 tea brokers involved in the exporting of honeybush tea whilst three processors exported directly in bulk. Value-adding processors also play a role in exports (ARC, 2008). Other industry exports and investment processes are facilitated by Wesgrow and the Western Cape Department of Economic Affairs. Generally, honeybush tea exports have been increasing gradually since 1999 (Figure 2.4). Although these exports were as low as 50 tons in 1999, they have risen to 300 tons in 2005 – an increase of over 500% in a period of six years. However, this increase is small when compared to rooibos tea production trends, because it started from a very low base. The proportion of honeybush tea earmarked for international markets exceeds 80% of national production (ARC, 2008), meaning that if the exchange rates are favourable, this industry could be lucrative as more foreign earnings could be generated from sales in high-income countries such as Germany, Netherlands and the UK.

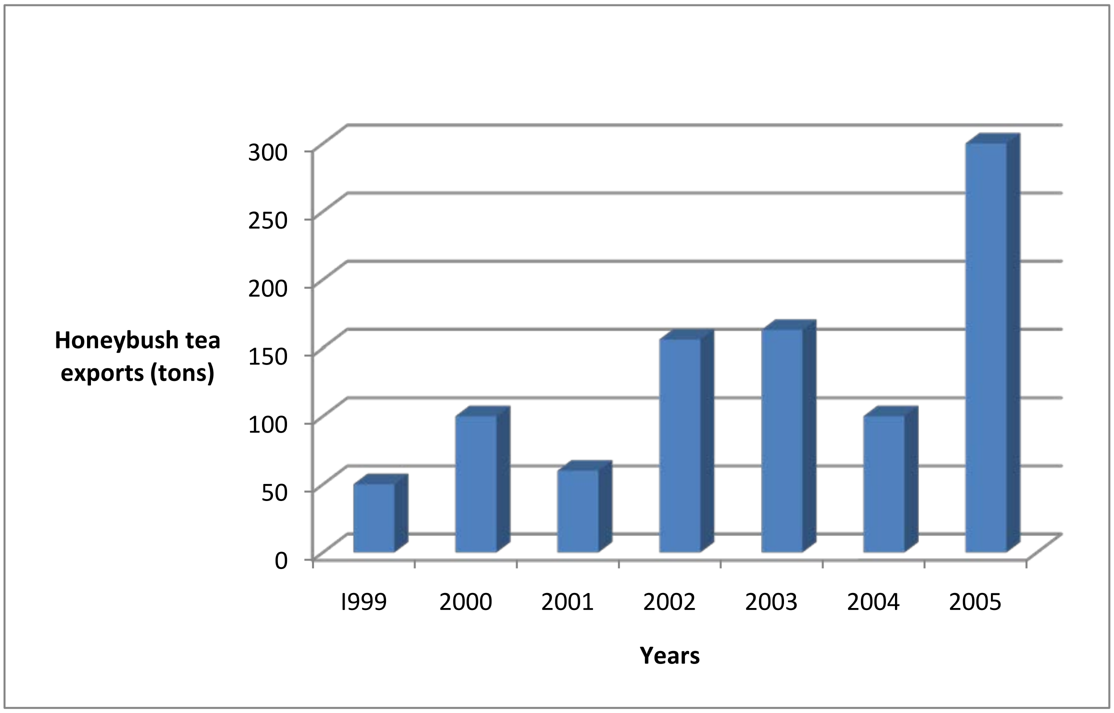



Figure 2.4: Exports of honeybush tea from 1999 until 2005.
*Source:* ARC (2008).

By 2004, the following countries (in descending order) constituted the main importing nations of honeybush tea from South Africa: Germany, USA, Netherlands, UK, Canada, Norway and Japan. The latter export destinations are illustrated in Figure 2.5. In 2004, Germany surpassed all other market destinations in terms of the percentages of these exports, accounting for between 64 -71% of total honeybush tea exports from South Africa (ARC, 2008).

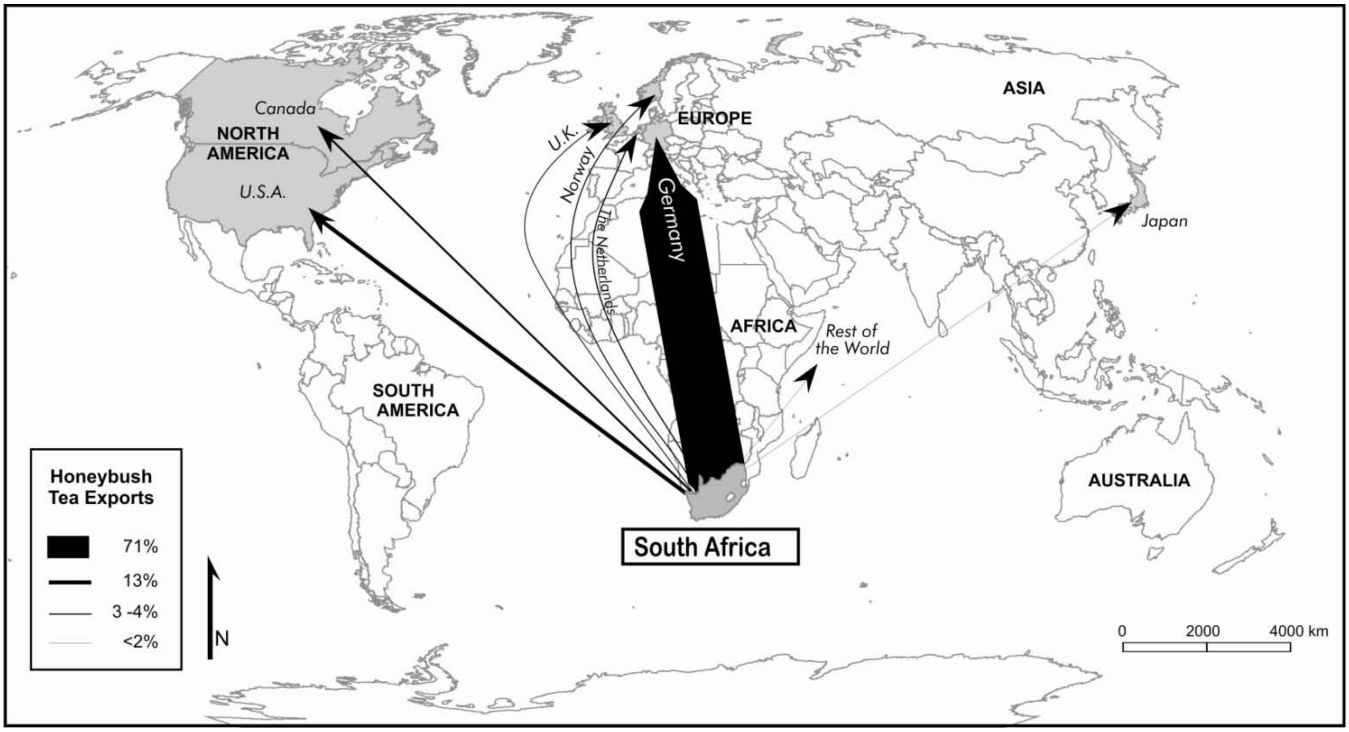



Figure 2.5: Honeybush tea exports sold into the different international markets for the year 2004.
*Source:* Adapted from data provided in the Export Directory (2004) and ARC (2008).

2.2.3 Bush tea, *Athrixia phylicoides*

2.2.3.1 Botanical and ethnobotanical aspects

*Athrixia phylicoides* has been used for many decades as a health tea and medicinal beverage by the peoples of South Africa. The genus *Athrixia* has 14 species distributed across southern Africa, tropical Africa and Madagascar. However, in South Africa the most common ones are *Athrixia angustissina, A. elata, A. gerardii, A. hererophylla* and *A. phylicoides* (Mudau *et al*., 2007). *Athrixia phylicoides* is traditionally known by various names such as "*mohlahlaisha"* (North-Sotho), bushman's tea (English), "*mubostee"* (Venda), "*boesmanstee"* (Afrikaans), *"icholocholo, itshelo, umtshanelo"* (Zulu) and "*ringana"* (Xitsonga) (Van Wyk and Gericke, 2003; Mudau *et al*., 2007; Olivier and Rampedi, 2008). This plant is an erect shrub which belongs to the Asteraceae (Daisy) family. It has silvery leaves and purple flower heads (Olivier, 2001).

2.2.3.2 Geographical distribution and harvesting practices

*Athrixia phylicoides* species has a wide geographical distribution and is capable of adapting well in open grasslands and thick forest margins of South Africa, particularly on the mountainous areas of the Limpopo, Mpumalanga, KwaZulu-Natal and Eastern Cape provinces (Olivier and

De Jager, 2005). It is harvested during early autumn and midwinter during flowering (Mudau *et al*., 2007). For the purpose of producing herbal tea, young shoots with heights ranging from 50 cm to 1 m are cut as low as possible from the ground and with more cutting the plant resprouts for future harvesting. Regular harvesting tends to provide better quality twigs and leaves because the stems are relatively softer (Mudau *et al*., 2007). *A. phylicoides* is also a multipurpose plant because harvested stems can be tied together in bundles to make traditional brooms (Olivier and De Jager, 2005).

These brooms are traded by hawkers in the Limpopo, Mpumalanga and KwaZulu-Natal provinces (Olivier and De Jager, 2005; Shackleton and Campbell, 2007). For instance, in the town of Giyani (Limpopo province), during 2006, close to 12 informal street traders were observed selling these brooms at prices ranging from R6.00 to R10.00 (Rampedi, 2006, *personal observations*). Moreover, Shackleton and Campbell (2007) have indicated that producers selling their brooms in Giyani sometimes build their stocks to nearly 400-1000 brooms during peak trading season. Similar brooms are also sold in areas such as Marabastad, Soweto and Mamelodi in the Gauteng province (Rampedi and Olivier, 2005). Unfortunately, this surge in demand for brooms has led to over-exploitation and human pressure in some of the ecological areas where this plant occurs. As a result, in areas such as the Wolkberg in the Limpopo province, near Haernetsburg, the locals complained about the unsustainable harvesting practices of “foreign pickers” (probably from the Gauteng province) who uproot the entire plant instead of carefully cutting the shoots in order to allow for regrowth (Rampedi and Olivier, 2005). Inevitably, the plant is becoming scarcer not only in the Wolkberg mountains but also in the Soutpansberg mountains in Venda, forcing many local harvesters to climb higher up on the mountain slopes to seek unexploited plants (Gundula, 2008, *personal communications*).

#### 2.2.3.3 Traditional medicinal uses and current research findings

*Athrixia phylicoides* has been used by many generations to produce herbal tea and a medicinal decoction in order to treat a wide range of ailments such as headaches, heart disease, vomiting, and skin disorders (Mudau *et al*., 2007). In the rural areas of provinces such as Limpopo, Mpumalanga and KwaZulu-Natal, communities use a decoction of the tea to deal with illnesses such as high blood pressure and diabetes (Olivier and Rampedi, 2008). It is also utilised to treat respiratory infections like sore throats, colds, coughs and loss of voice. Furthermore, it has blood cleansing and purification functions, given its mild laxative and diuretic properties. It can also be topically applied as leaf poultice to deal with skin irritations as well as swollen and tired feet and legs. Root decoctions have been reported to have stimulating and aphrodiasic properties (Mabogo, nd, *personal communications*, *cited* in Mudau *et al.,* 2007; Olivier and Rampedi, 2008). Apart from utilisation in rural areas, traditional medicinal practioners in urban areas such as Marabastad and Soweto (in the Gauteng province), still prescribe *A. phylicoides*-based medicines to their patients.

The last 10 years in South Africa have witnessed a surge of scientific interest in the ethnopharmacological and medicinal properties of bush tea (Olivier, 2001; Olivier *et al*., 2003; Araya *et al.,* 2005; Olivier and Rampedi, 2005; De Beer and Joubert, 2007; Mudau *et al*., 2007; Mogotlane *et al.,* 2006; McGaw *et al*., 2007a). Research has indicated a higher total phenolic content for *A. phylicoides* compared to rooibos tea. The processed leaves of *A. phylicoides* were found to contain a new flavonol derivative, 5-hydroxy-6,7,8,3,4,58-hexamethoxy flavon-3-ol (Mashimbye *et al*., 2006). Phenolic compounds are known to protect the human body against the harmful activity of free-radicals, carcinogens and mutagens. According to McGaw *et al*. (2007a), *A. phylicoides* extracts are superior free radical scavengers in the TEAC (Trolox Equivalent Antioxidant Capacity) antioxidant assay than *A. elata* extracts. In these tests, the TEAC value of bush tea was measured to be 0.269 whereas rooibos exhibited 0.259. Even the iron chelating ability of bush tea's dried extracts were found to be higher than those of commercial rooibos and honeybush tea (De Beer and Joubert, 2007). The concentration of total polyphenols in *A. phylicoides* has a definite seasonal variability as demonstrated by Mudau *et al*. (2007). Lowest concentrations (around 10.0 mg/g) were observed for March, April and September while the highest concentrations were recorded for June (35.5 mg/g) and July (35,9 mg/g), suggesting that the harvesting period should coincide with the latter two months.

Furthermore, infusions, decoctions, or extracts (aqueous and ethanol) of *Athrixia* species examined lacked caffeine and toxic pyrrolizidine alkaloids (PAs) (McGaw *et al*., 2007a). The absence of caffeine is a favourable attribute, given that caffeine has been implicated to have adverse physiological effects in humans. The fact that *A. phylicoides* has greater quantities of polyphenols and lacks caffeine, PAs and cytotoxic effects demonstrates its commercial development potential as a health beverage (Rampedi and Olivier, 2005; Joubert *et al.*, 2008). Consequently, there have been some scientific attempts to propagate it. Thus far, vegetative propagation trials have been carried out on apical cuttings with 2 to 3 leaves, with the application of 0.3% IBA (indole-3-butyric acid; Seradix No. 2 and 0.1% IBA (Seradix No.1). A higher survival rate was noticed on apical cuttings than on basal cuttings (Araya 2005, *cited* in

Mudau *et al*., 2007). Propagation trials by means of seeds have also been successful, with germination rates of up to 75% at 20-25$^{o}$C under continuous light (Mudau *et al*., 2007). To date, the tea has not been commercialised and attempts to achieve this are in progress (Olivier, 2010, *personal communications*).

## 2.3 ALCOHOLIC BEVERAGES

The consumption of traditional alcoholic beverages has a long history in Africa and South Africa. According to Platt (1955) there are five main categories of African alcoholic beverages, namely, fermented honey, fermented fruits and juices, fermented sap from various species of palm, drinks from milk and traditional beers. Platt (1955) further illustrates the early origins of these beverages in Africa, notably around the Nile Valley and Ethiopia. Some of the traditional alcoholic beverages known to be consumed in southern African are reviewed below.

### 2.3.1 African beers

African beers are brewed from various carbohydrate-rich materials such as sorghum, maize, millet and cereal-enriched cassava flour. Such beers perform numerous socio-cultural roles, including but not limited to the following:

- as leisure drink in social occasions,
- as a form of tribute to chiefs and leadership,
- as a source of income,
- as a method of payment for labour rendered and
- as offerings to spirits.

*Source:* Richards (1939, *cited* in Platt, 1955).

#### 2.3.1.1 Sorghum beer

Traditional beer brewed from the seeds of *Sorghum caffrorum* is known as "*umqombothi*" and "*bjalwa*" in African communities (Schwartz, 1956). Current production methods are based on traditional methods and basically involves: mashing, boiling, conversion, straining and alcoholic fermentation. However, modern equipment is currently utilised to improve the brewing process. Sorghum beer has notable cultural significance in the social settings of Africans throughout the continent. It is known to have a pleasantly sour taste and the consistency of a thin gruel. Given its nutritive properties imparted by the presence of vitamins of the B-group, some of the urban municipalities of the former Transvaal and Natal provinces in South Africa brewed it on an industrial scale for trade purposes. About 80% of the production was consumed by African people. As a result of their growing population size, its production increased markedly between the years 1946 and 1954 (Schwartz, 1956).

Currently, the sorghum beer market in South Africa produces 2.3 billion litres a year (Sikhakhane, 2008). Of this total, 600 million litres are produced by commercial breweries whilst 1.5 billion litres are produced by the informal liquor sector. The rest is made up of 200 million litres of dry-base or sorghum beer powder (Sikhakhane, 2008). However, with the growing popularity of European beers in South Africa, accelerated urbanisation and the adoption of Western lifestyles, the growth of the sorghum beer industry and its South African markets have been affected negatively.

Apart from the production and manufacturing of sorghum beer in South Africa, this beverage is also well known in many sub-Saharan African countries (Saul, 1981; Gadaga *et al*., 1999). In a study carried out in the Upper Volta, its popularity and local economic significance have been demonstrated (Saul, 1981). The beverage plays an important role in the livelihoods and financial transactions of African traditional farming communities. Invariably, it is brewed by women and the resulting product is a light, brownish-red liquid with alcohol contents that range from 3.5% v/v to 4% v/v (Saul, 1981). In the Upper Volta, it has been estimated that 23 million litres of sorghum beer were once consumed every year (Saul, 1981). The production of these amounts, required at least 4 300 tons of red sorghum, 43 000 cubic meters of water and 10 000 tons of fuelwood (Saul, 1981). However, sales of sorghum beer have declined in many African countries due to competition with European beers. Besides sorghum beer, a wide range of other traditional beers have been reported by Gadaga *et al*. (1999) and Van Wyk and Gericke (2003). However, no studies have been conducted to determine their commercial or industrial feasibility in any greater detail.

### 2.3.2 Indigenous spirits and wines

Unlike the traditional sorghum beer, which has an average alcohol content of approximately 3.75% v/v, indigenous alcoholic beverages, commonly classified as spirits and wines, tend to have a relatively higher alcohol content, ranging from 4% v/v up to 60% v/v (Platt, 1955; Scheidje, 2001). The manner in which the high alcohol content of potent indigenous spirits is achieved is succinctly described by Platt (1955: 122):

> "One way of increasing the potency of a brew practised in some areas is double fermentation. When the first fermentation is nearing completion the brew is heated and a further batch of readily fermentable material, e.g. honey, sugar or sugar-cane juice is added. One type of strong drink is

> prepared from Golden Syrup bought from the stores. A large quantity of tins of this harmless "missionary jam", as it is called in South Africa, imported into Johannesburg, is used not by missionaries but by the natives of the compounds, who brew a strong drink in large empty oil cans. Distillation has been introduced and many fermented preparations such as of cane juice, cassava, plantain, honey and various fruits, e.g. those of the so-called 'brandy bush', *Grewia flava,* have been used for making spirits".

Based on this information (Platt, 1955), it is clear that potent alcoholic beverages may be produced from a vast array of sources, as long as they have fermentable carbohydrates. In South Africa, such home-made distilled spirits are known by different names such as "*mampoer"* and "*witblits"* (Afrikaans), *"kgacha"* (North-Sotho) and *"mukumbi"* (Venda) (Van Wyk and Gericke, 2003; Gundula, 2008, *personal communications*). However, there are very few studies in South Africa which have examined their chemical and nutritional constituents, prompting the need for characterising these in the current research.

One notable exception is in respect of ilala wine. This beverage is produced from ilala palm (*Hyphaene natalensis*) and is believed to cure ailments such as gout and high blood pressure (Nash and Bornman, 1973; Scheijde, 2001). However, the downside of this beverage is that it is produced from pierced palm stems (Govender *et al*., 2005), thus unsustainable for exploitation from an environmental management perspective. Firstly, the stem is carefully cut open with a sharp instrument in order to initiate the flow of a whitish cell sap. The cell sap is then directed to collect inside a traditional container such as a calabash or clay container. Depending on the amounts (ranging from 3 up to 60 litres per stem) of cell sap available, tapping may continue for about five to seven weeks (Van Wyk and Gericke, 2003). The extracted juice is usually allowed to ferment in an undiluted or diluted form for approximately 36 hours, before being served. Usually, the fermentation process is carried out by natural yeasts. In northern KwaZulu-Natal, it is commonly known as "*bosulu"* wine and its consumption is of dietary and local economic significance. In fact, ilala wine has been found to be a significant source of iron, nitrogen, sugars and nicotinic acids (Nash and Bornman, 1973; Scheijde, 2001).

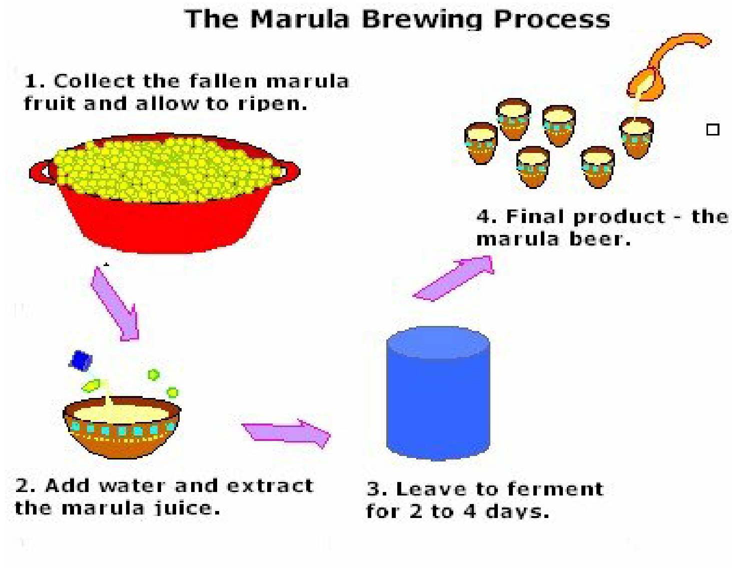
#### 2.3.2.1 The marula tree and its fruits

The marula tree has a wide geographical distribution (between 20$^o$N to 30$^o$S) and occurs in 29 countries in Africa (Nwonwu, 2006). In southern Africa it is restricted to the savanna biome located in subtropical areas (Van Wyk and Gericke, 2003). The marula (*Sclerocarya birrea*) species belong to the Anarcardiaceae or mango family, comprised of at least 80 native tree species. Several species in this family have alternate, imparipinnate leaves with a watery, rather than a milky latex (Van Wyk and Van Wyk, 1997; Leakey *et al*., 2005).

According to Palgrave (2002), marula trees are one of the most resourceful indigenous species. In fact, amongst all the trees that have been commercialised in South Africa, the marula tree has attracted most attention regarding domestication and commercialisation (Leakey *et al.,* 2005). The tree has separate sexes (dioecious) and is known to produce several thousands of fruits weighing a total of about 500 kg per season (Shackleton, 2004). However, a few trees have yielded more than that, about 1.5 tonnes of fruit mass per year (Leakey, 1999). Light greenish coloured fruits characteristically fall to the ground where they turn yellowish during ripening and are harvested during the January-March season. Together with the entire tree, the fruits have multiple socio-cultural and traditional uses. The nutrient composition of marula fruits have been found to differ widely depending upon genetic and environmental factors. However, most reports have documented a superior vitamin C content of 194 mg/100g of fruit mass at 85% moisture - nearly 2-3 times higher than the average of 49 mg/100g commonly associated with oranges (Leakey, 1999; Du Preez *et al.,* 2003).

#### 2.3.2.2 Local and small-scale production of marula beer

The marula tree plays an important role in the livelihoods of rural communities in the communal ecosystems where it occurs naturally (Shackleton, 2004; Nwonwu, 2006). This entail, amongst others, direct provisioning as edible fruits that may be utilised to produce marula beer, although to date no detailed nutritional analyses have been conducted on this beverage. This beer features highly in African socio-cultural gatherings such as marriages as well as burial ceremonies (Nwonwu, 2006). The practice is observed mostly in rural settings. The brewing process is very simple, as it involves the extraction of the juice from ripe fruits and allowing the juice to ferment and thus form an alcoholic beer over a few days. The brewing steps are indicated in Figure 2.6.




.

Figure 2.6: The marula brewing process.
*Source:* Goyvaerts (2003).

Initially, it was only produced at subsistence level but with rising poverty and unemployment levels in rural areas, many households have converted it into an income generating opportunity (Shackleton, 2004). Informal trade with marula beer generally involves some socio-economically disadvantaged households in the Limpopo and Mpumalanga provinces, whereby rural women regard it as a source of income (Shackleton, 2004). Indeed, between January and April, along the old R101 main road between Bela-Bela (former Warmbaths) and Polokwane (former Pietersburg) and other routes, women-manned roadside stalls may be seen selling home-brewed marula fruit beer to the public (Rampedi, 2006, *personal observations*). According to Shackleton (2004), there are nearly 300 households amongst the poorest sector of the Bushbuckridge community in the Limpopo province who sell marula beer. However, its production is only seasonal and on a small-scale. The beer also has limited shelf-life as it becomes unpalatable after a few days. Shackleton (2004) indicates the key features of marula beer trade in the Bushbuckridge area as follows:

- high seasonality lasting 2-3 months in mid-summer,
- very low entry barriers,
- intermediate value addition,
- abundant resource distribution,
- sales only in local markets and
- simple market chain.

*Source:* Shackleton (2004).

The beer is sold in two main units: 2-litre milk or soft drink containers and also in 740 ml "mayonnaise" jars. During any given selling season, close to 100 000 litres may be sold in the entire Bushbuckridge town, providing each seller with an average net income of approximately R 500 (as of 2004) (Shackleton, 2004). However, variations in net income (R 84.00 to R 2 299) have been observed, depending on the individual distances travelled by each trader to market the beverage and the number of weeks constituting the duration of sales (Shackleton, 2004).

#### 2.3.2.3 Other marula-based beverages and propagation initiatives

Since the mid-1980s, marula fruits harvested in the Limpopo province have been utilised by Distell (a beverage company based in Stellenbosch in the Western Cape province) to manufacture a highly sought-after alcoholic beverage, known and branded as Amarula cream liqueur (ACL). This liqueur is well positioned for the higher end of the liquor market and has penetrated several international markets successfully. Commercialisation successes such as these, have sparked widespread interest in the domestication and propagation of marula trees in southern Africa and abroad. For instance, vegetative propagation methods were first initiated by Holthauzen *et al*. (1990) at Pretoria University in South Africa. After careful selection of several thousand wild trees, marula cultivars with desired properties were developed by making use of grafting techniques. Another propagation initiative has occurred in Botswana and it is led by Veld Products Research (Taylor *et al*., 1996). The research collaboration which occurred in the 1980s between Botswana and Israel has led to indigenous plant exchanges between these countries. As a result, Israel received marula trees from Botswana whilst Botswana obtained date and pomegranate plant material from Israel (Sullivan *et al*., 2003). In fact, marula fruits in Israel are sold to the regional agricultural council, which manufactures and sell a distinct kosher liqueur named "Marula". These plant exchanges occurred along with negotiations between Israel, Namibia and Botswana on equitable benefit sharing provisions (Sullivan *et al*., 2003). Furthermore, the World Agroforestry Centre has established various partnerships (since 1995) with subsistence farmers in some of the sub-Saharan countries, the goal being to propagate marula trees for conservation and future utilisation purposes (Maghembe *et al*., 1995).

#### 2.3.2.4 Some commercial aspects of Amarula cream liqueur

Regarding the manufacturing of ACL, raw materials are supplied by a production plant based near Phalaborwa in the Limpopo province. The production plant is designed and managed as a joint venture between Distell (the Stellenbosch based drinks group) and local communities in and around Phalaborwa.

It is estimated that there are presently 6 000 collectors who harvest marula fruit for the manufacturing of ACL between January and March. Selling their harvested marula fruits has become an important source of domestic income for the improvement of their livelihoods (Amarula Report, 2008). Earnings are estimated at US $70 or R800 per tree harvested (New Agriculturist, 2008). In 2002 alone, Distell purchased marula fruits to the value of R 450 000 from local communities in the Limpopo province. A study conducted in 2003 has shown that when all costs, including all of the labour involved, are factored into the production equation, the financial benefits accruing to individual marula fruit collectors are highest if they sell their harvest directly to Distell, with the industrial chain generating significantly more for the whole community than any other commercial chain (Sullivan *et al.,* 2003). Moreover, if sales from the traditional marula beer are excluded, the formal Amarula industry has invested about R 2.2 million within the South African economy, with at least half of these revenues accruing to local community-based suppliers in 2001 (Sullivan *et al*., 2003).

***Markets for Amarula cream liqueur***

According to Distell, ACL has become one of the world's best selling beverage in its category (Distell Annual Report, 2005). By 2002, Distell estimated the annual production of Amarula to be in excess of 5.2 million litres. Out of this total production, about 1.7 million litres are sold locally. In view of these production trends, the Limpopo provincial government has expressed its intention to distribute approximately 5 million marula trees for planting at homesteads as part of a reforestation project in Phalaborwa and adjacent areas in order to respond effectively to the demand (New Agriculturist, 2008).

On the international front, Amarula cream liqueur is widely regarded as the world's second most popular cream liqueur, surpassed only by Baileys Irish Cream liqueur. Amarula cream liqueur is exported to nearly 150 countries (Amarula Report, 2008) and Distell has been able to achieve a volume increase of 12.1% for the 2005-2006 financial year (Distell Annual Report, 2005). Since 2006, growth rates have maintained double digit increases in all key international markets. The most important key market niches are Brazil, Canada, Germany, Britain and USA. Around 2002, the beverage was the market leader in Brazil whilst in Germany it was the fastest growing cream liqueur (Watson, 2002). In Germany, sales levels have increased by more than 20% between 2007 and 2008 and this growth is ascribed to very focused marketing campaigns undertaken through local television advertisements (Amarula Report, 2008). However, the export market with greater opportunities is the USA (in view of its size) and recently strategic partnerships between Distell and American distributors have been established. As a result, ACL is distributed in seven USA states in order to build brand awareness (Watson, 2002; Distell Annual Report, 2005).


Figure 2.7: Amarula cream liqueur promoted in gift tins known as the “Magnificent Seven Series”.
*Source:* www.giftworld.co.za/IMAGES/Amatin.jpg (2010).

In keeping with Distell’s international growth strategy, ACL is also exported to new markets such as Eastern Europe and the Scandinavian countries (Amarula Report, 2008). Other new growth opportunities are pursued in higher-end market niches such as the lucrative travel retail channels at major international airports. To this end, ACL has recently acquired World Duty

Free status at London's Heathrow Airport – a new promotional strategy geared to increase sales in niche sectors (Amarula Report, 2008). The ACL brand is also marketed via the design and articulation of a carefully integrated African theme and image, closely interwoven with the continent's natural environment and people. For instance, the cream may be uniquely bottled in the so-called "Magnificent Seven Collectors Series" – comprised of individual gift tubes dedicated to a legendary African elephant. This series (Figure 2.7) has been launched successfully in South Africa, Canada and Germany. The series is named after the seven elephants or tuskers, that are collectively known as the "Magnificent Seven" in the Kruger National Park, one of the world's best known game reserve (Amarula Report, 2008).

## 2.4 BRIEF SUMMARY OF LITERATURE REVIEWED

### 2.4.1 Indigenous teas

The main teas which have been commercialised successfully in South Africa include rooibos and honeybush. They have a background of ethnobotanical history behind their utilisation, highlighting the role that indigenous knowledge may play in providing leads to new product development. However, indigenous knowledge systems alone did not translate into successful commercialisation as there were constraints in transforming them into agricultural crops. Harvesting material from the wild is problematical because of variations between species and the potential to affect the ecological integrity of natural populations negatively. Due to challenges experienced in the commercialisation pathway, it took considerable time (over 80 years) for rooibos to be produced successfully as an agricultural crop and marketable product. The propagation initiatives that were introduced required detailed scientific knowledge, indicating the important role that modern science councils and universities can play in this regard. Some of the constraints and challenges experienced in the commercialisation pipeline of both rooibos and honeybush tea may be summarised as follows:

- propagation challenges,
- impact of adverse economic cycles,
- need for detailed scientific research before market development,
- identification of key markets (local, niche and export markets),
- establishment of effective industry associations and cooperatives and
- product standardisation and quality control.

Having noted these challenges, the commercialisation trajectory of bush tea and others does not have to be more than eight decades long as important lessons can be learned from the problems which delayed the market development of rooibos. Moreover, some of the key scientific information on bush tea is now available in the literature to assist with decisions toward market development and promotion of health products derived from bush tea.

### 2.4.2 Alcoholic beverages

Two types of beverages are produced in this category. These include beverages prepared at subsistence level and those that are manufactured for the formal commercial sector. Production at subsistence level is necessitated not only by socio-cultural factors but also by the needs of poor households in predominantly rural settings to generate income. The manufacturing of ACL demonstrates how the commercialisation of a natural product can benefit most of the stakeholders involved and even contribute towards local economic development and international growth of export markets. However, in the literature reviewed there is little information based on the nutrients found in these beverages although such information is usually displayed on commercial product labels. There is also no evidence of other beverages derived from wild indigenous fruits, except those derived from marula (*Sclerocarya birrea*).

# CHAPTER 3

# DESCRIPTION OF STUDY AREA AND RESEARCH METHODOLOGY

## 3.1 INTRODUCTION

Chapter 3 provides a brief background on the Limpopo province as well as a description of the study areas, followed by an elucidation of data collection methods and techniques. The study was multidisciplinary in nature and employed both quantitative and qualitative research approaches, dependent on the research objective being addressed. An indication is also provided as to how the collected data were analysed.

## 3.2 BRIEF BACKGROUND ON THE LIMPOPO PROVINCE AND STUDY AREAS

### 3.2.1 Geographical and biophysical background

The Limpopo province covers an area of 123910 $km^2$ and is located in the northernmost part of South Africa (SA Year Book, 2008/09). A major part of the province lie within mountainous areas such as the Soutpansberg and the mountains constituting the eastern escarpment of the country (Olivier and Rautenbach, 2002). The province is located in a region with a summer rainfall pattern with the western side and far northern areas being semi-arid and susceptible to frequent droughts while the eastern side is mainly sub-tropical. Mean annual rainfall ranges from 300 mm to 500 mm, although it is relatively higher for the southwestern and Lowveld areas (LSOER, 2004). Due to prevailing climatic conditions, the province has limited surface and groundwater resources. However, given its biogeographical attributes and varied topography and landscapes, the province has a rich plant biodiversity. Natural vegetation belongs to the savanna (bushveld) biome, with 15 different natural vegetation types and three centres (Drakensberg Escarpment, Sekhukhuneland and Soutpansberg) of endemism (LSOER, 2004). However, increasing deforestation is contributing to loss of plant diversity, especially in Sekhukhune and Vhembe Districts (LSOER, 2004).

### 3.2.2 Socio-economic background

In terms of human aspects, the province “has a culturally mixed population of about 5, 27 million people, which is 12% of the South African population” (LSOER), 2004). It is regarded as one of the poorest areas of South Africa with an economy marked by a small and concentrated production base and a large consumer population, with limited means in terms of income (SA Year Book, 2008/09). Unemployment rates have decreased only gradually, from 35.6% in 2006 to 27.6% in 2007 (SA Year Book, 2008/09). Despite increasing urbanisation rates in South

Africa, most of the inhabitants of the Limpopo province are still confined to localities that are predominantly rural, with the majority of settlements located in former homeland areas such as Venda, Gazankulu and Lebowa. Households in such former homelands are for the most part poor and in certain areas people depend on the extraction of wild plant resources, rearing of traditional livestock as well as subsistence crop production and poverty-relief grants for satisfying their livelihood needs (Dovie *et al*., 2008). Access to educational opportunities in the province remains a huge challenge, with 22% of people aged 5-24 years not attending any educational institution. Only 7% of adults have attained a higher education level while the proportion of those who completed primary education is 5% (Table 3.1) (LSOER, 2004).

Table 3.1: Level of education attained by adults in Limpopo province.

| Level of education of adults in Limpopo province | Percentages |
|---|---|
| Higher education schooling | 7% |
| Some secondary schooling | 27% |
| No schooling | 33% |
| Grade 12 | 14% |
| Some primary schooling | 14% |
| Complete primary schooling | 5% |

*Source:* LSOER (2004).

Surveys by means of questionnaires were conducted in selected areas of the Limpopo province in order to document existing indigenous knowledge on beverage-making plant species growing in the wild. The surveys were conducted in three different study areas based on predominant indigenous cultures and languages spoken by the inhabitants. As a result, three categories of study areas whose language is mainly Venda, Tsonga and North-Sotho, respectively, were selected and demarcated for the study (Figure 3.1).

### 3.2.3 Venda-speaking study area

In the Venda-speaking study area (Figure 3.1), 10 rural communities were surveyed. Relatively more villages were surveyed in this study area because that is where pilot studies started and there were also more respondent referrals than elsewhere in the province. The villages comprised Luheni (22$^{o}$48’00.02”S; 30$^{o}$22’00.04”E), Dzanani (22$^{o}$52’59.17”S; 30$^{o}$10’08.09”E), Tshixwadza (22$^{o}$46’23.45’’S; 30$^{o}$21’00.09’’E), Ha-Mavunga (22$^{o}$55’54.92"S; 30$^{o}$07'18.63"E), and Muswodi (22$^{0}$44’06.24”S; 30$^{o}$28'16.42"E). Others were Mapuloni and Sheshe, northwest of the famous Lake Fundudzi (22$^{o}$50’00.12”E; 30$^{o}$17’38.20”S) as well as Makonde (22$^{o}$48’28.54”S;

30°35’31.06”E) and Ha-Phaswana (22°49’08.25’’S; 30°38’21.09’’E). Most of these villages are located within the moist Afromontane bushveld vegetation type along the mistbelt of the Soutpansberg mountains and have exceptionally high levels of species diversity (Institute of Conservation and Natural History of the Soutpansberg (ICONS), 2002). This high level of species diversity is attested to by the Tree List of the Soutpansberg area, which has over 600 different types of plant species, grouped in 98 different plant families (ICONS, 2002). By contrast, the village of Ha-Tshikonelo (22°53’00.12”S; 30°44’04.84”E), located off the main road to the Punda Maria Gate of the Kruger National Park has sour mixed bushveld vegetation type.

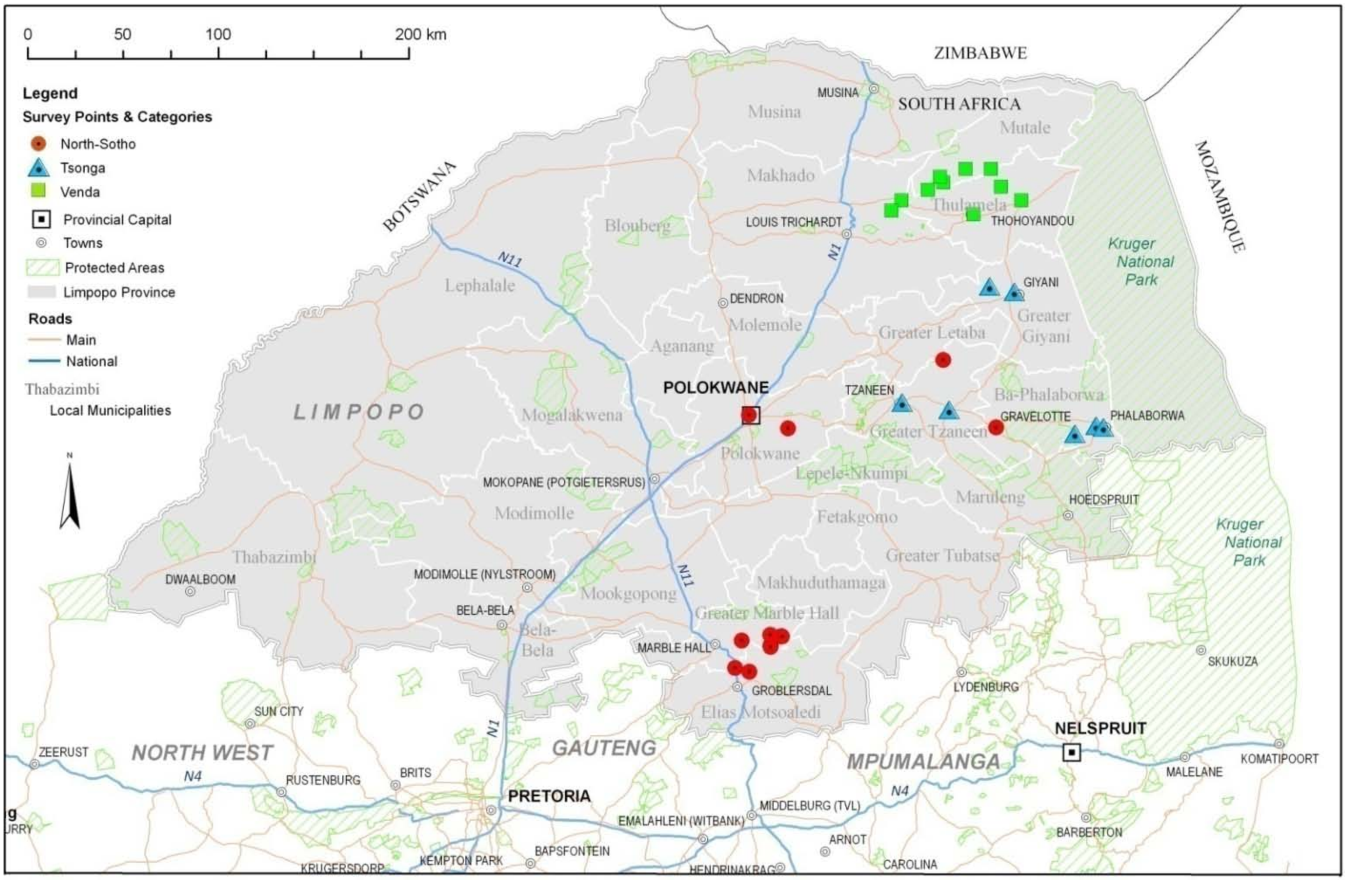



Figure 3.1: Location of rural communities (survey points) surveyed in the Limpopo province. *Source:* Booysen (2009).

Rainfall and temperature patterns (1961-1990) at Punda Maria weather station are depicted in Figure 3.2 and Figure 3.3 (Venter *et al*., 2003). About 80% of the rainfall occurs between October and April (Institute of Soil, Climate and Water (ISCW), 2009). The mean monthly maximum and minimum temperatures for the 1998-2001 period were 26°C and 13°C during winter season and 31°C and 20°C during summer season, respectively (ISCW, 2009).

Given the subtropical climate and the rainfall pattern in most parts of the Venda region, most of the communal ecosystems in and around homesteads have many kinds of indigenous fruit types and other plants that have served as a diet for the local people over many generations (Tshikudu, 2005). People in many of these villages also rear livestock (goats and cattle).

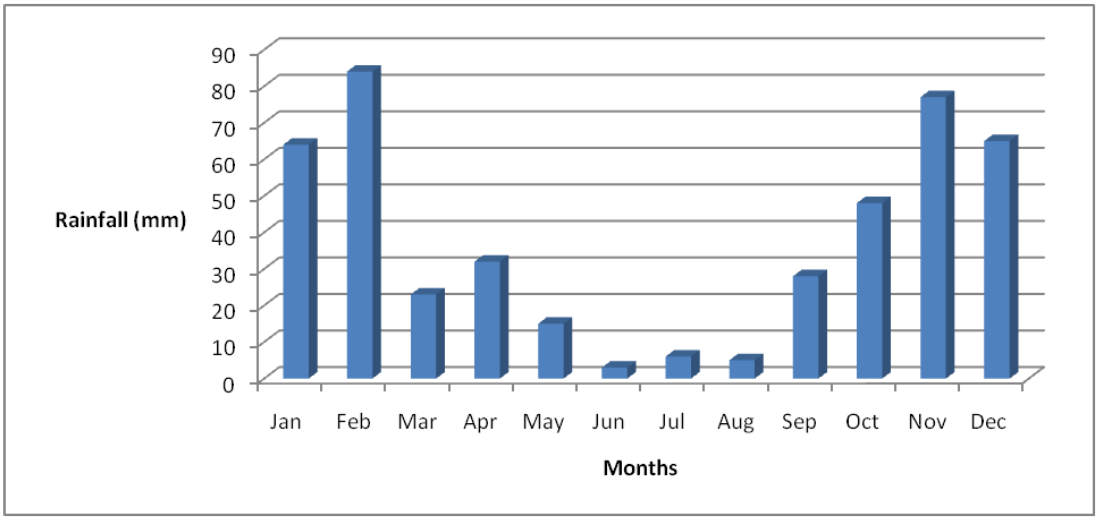



Figure 3.2: Long term mean rainfall pattern at Punda Maria weather station (altitude ~462 m), in the Vhembe District of the Limpopo province, recorded during 1961-1990.
*Source:* Venter *et al*. (2003).

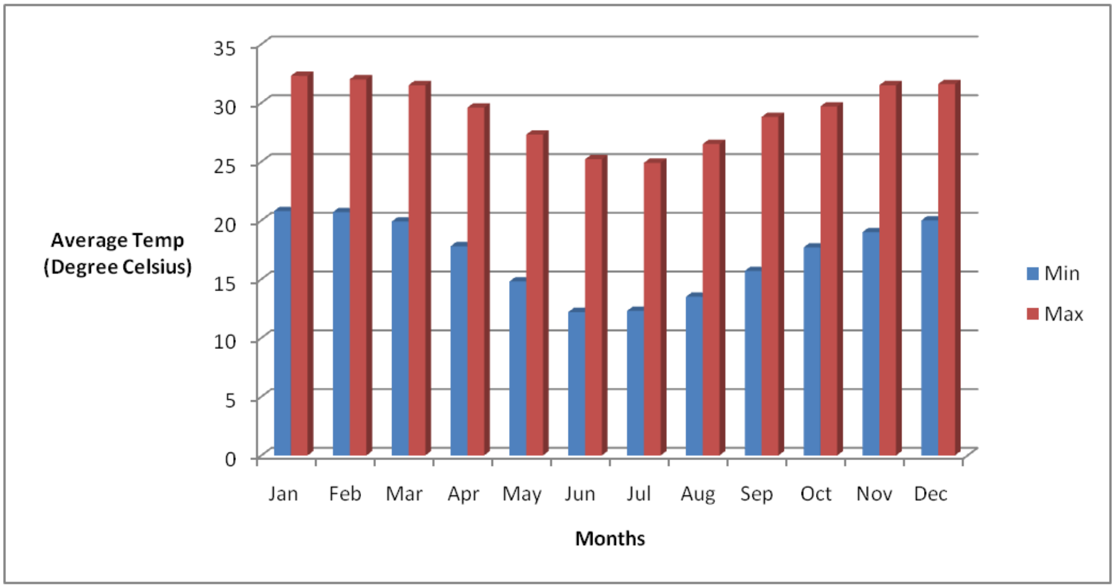



Figure 3.3: Mean minimum and maximums temperatures ($^0$C) associated with the Punda Maria (22$^o$68'S; 31$^o$01'E; altitude 462 m) weather station in the Vhembe District of the Limpopo province, recorded during 1961-1990.
*Source:* Venter *et al*. (2003).

### 3.2.4 Tsonga-speaking study area

The communities (Figure 3.1) surveyed in the mainly Tsonga-speaking study areas included the following villages: Hlaneki (23°17'13.00"S; 30°34'44.62"E), Ngobe (23°21'51.04"S, 30°43'29.90" E) and Malamulele (25°00'52.83"S; 30°42'31.35"E) around the town of Giyani in the Limpopo province. The cultural site known as Tsonga Kraal (23°58'51.27"S; 30°58'57.50"E), located near the Hans Merensky Nature Reserve, was also surveyed.

The mean rainfall and long-term minimum and maximum temperature patterns (1972-1984) at the Giyani weather station are shown in Figure 3.4 and Figure 3.5, respectively. Most (87%) of the rainfall occurs during the summer rainfall season between November and March. The mean monthly minimum and maximum temperatures for the 1998-1999 period were: 9°C and 25°C during the winter season and 19°C and 31°C during the summer season, respectively (ISCW, 2009).

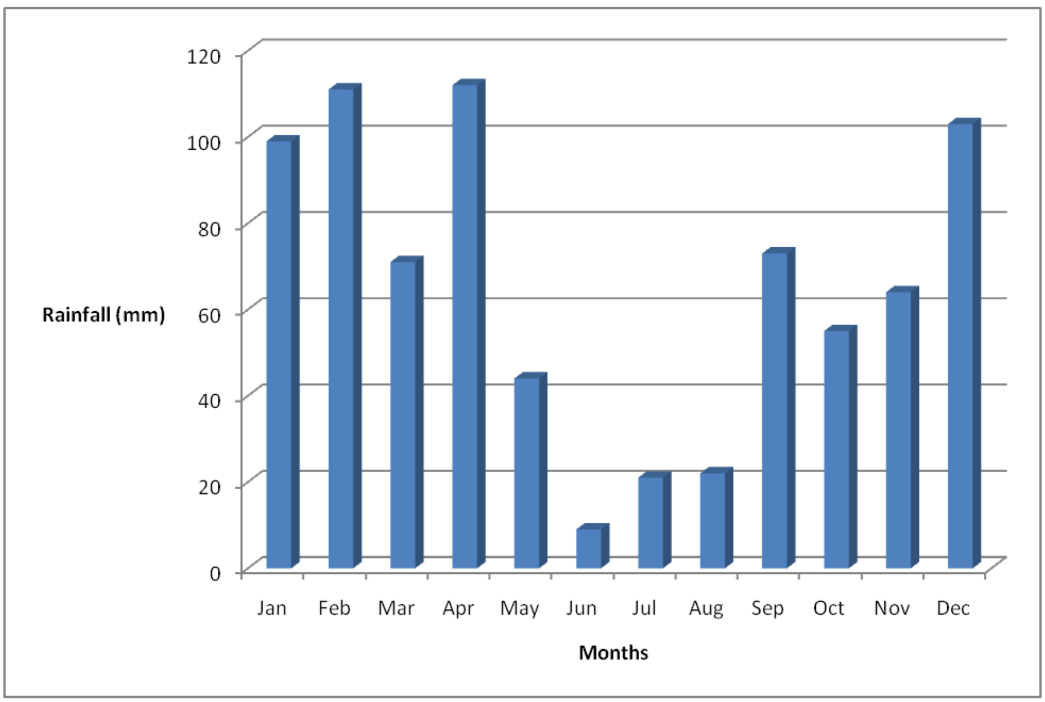



Figure 3.4: The mean rainfall (mm) pattern at Giyani (altitude ~450 m) weather station for 1972-1984.
*Source:* South African Weather Bureau (SAWB) (1986).

These areas have a distinctly semi-arid climate and are located within the Mopane bushveld vegetation type, with open patches of grasslands. The mopane bushveld has a distinct fairly dense growth of indigenous natural vegetation such as *Colophospermum mopane* species in association with other trees and shrubs such as *Adansonia digitata,* Combretum *apiculatum*, *Sclerocarya birrea* and *Acacia*, *Grewia* as well as *Commiphora* species (Acocks, 1988). However, most of the homesteads in these areas lack the diversity of indigenous and exotic fruit trees commonly observed in Venda although they still cultivate staple crops at subsistence level. Likewise, livestock reared are mainly cattle and goats.

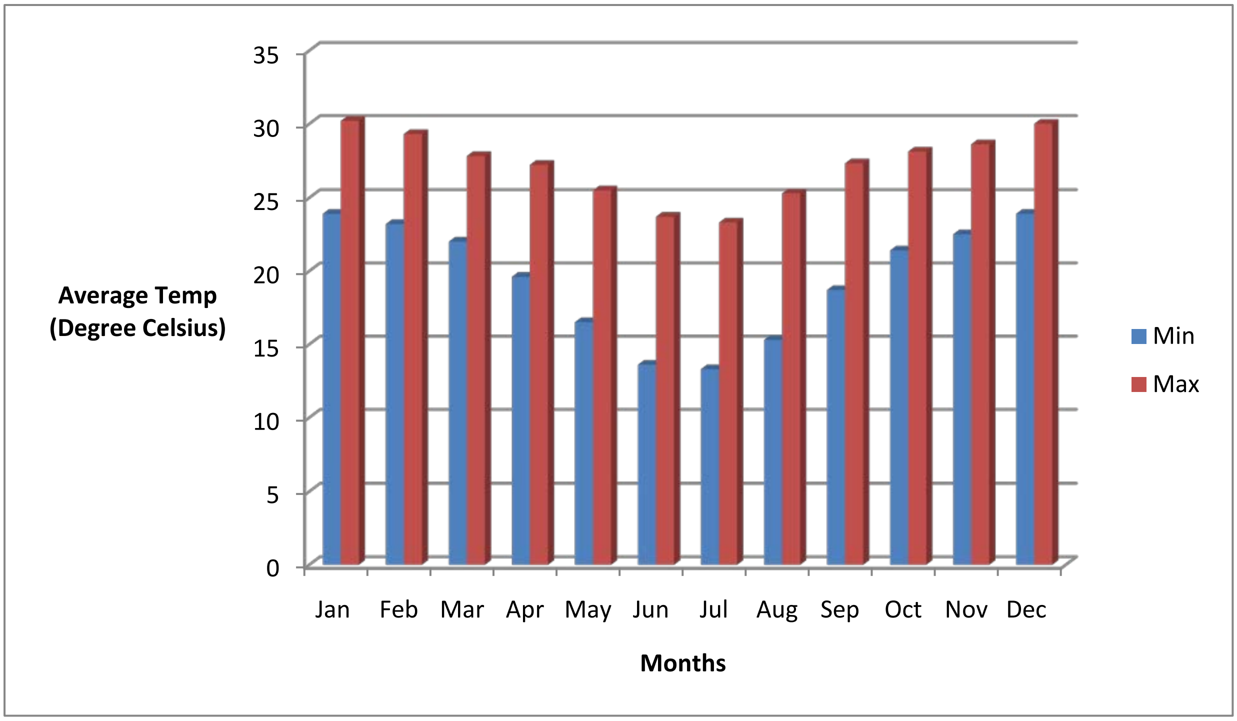



Figure 3.5: Long term mean temperature minimums and maximums at the Giyani (22$^o$53'S; 14$^o$26'E) weather station (altitude ~450 m) in the Limpopo province, recorded during 1972-1984. *Source*: SAWB (1986).

### 3.2.5 North-Sotho speaking study area

In the North-Sotho-speaking parts of the Limpopo province, the majority of villages surveyed are located in the Nebo region occupying most of Sekhukhuneland. This region is characterised by a landscape with marked variations in relief, climate and natural vegetation (Tapela, 2002). The undulating plains of the Highveld are grass-covered and are dotted with scattered trees and bushes (such as for instance, *Acacia nigrescens, Lannea discolor, Sclerocarya birrea, Grewia* spp, *Kirkii wilmsii, Schotia brachypetala, Strychnos* spp, *Ximenia americana*, *X. caffra* and *Ziziphus mucronata*) of a mixed bushveld vegetation type (Acocks, 1988). Villages surveyed included Mabitsi (24$^o$56'00.06"S; 29$^o$35'59.91"E), Ga-Matlala (Vaalbank) (24$^o$56'27.82"S; 29$^o$36'17.82"E), Puleng (24$^o$55'36.10"S; 29$^o$33'01.00"E), Ngwalemong (24$^o$58'34.94"S;

29°33’03.97”E), Legolaneng (24°59’00.12”S; 29°38’.00.17”E) and Moganyaka (24°57’12.48”S; 29°24’55.49”E). These villages are situated about 20-30 km from the towns of Marble Hall and Groblersdal. Additional villages included in the survey were Ga-Mashashane (28°57'20.23"S; 29°11'15.27"E) (near Polokwane), Ga–Modjadji (near the town of Modjadjiskloof) and others around Gravelotte (23°57’08.22”S; 30°36’43.76”E).

Figure 3.6 and Figure 3.7 indicates rainfall and temperature patterns associated with Sekhukhuneland (SAWB, 1986; ISCW, 2009), where most of the villages surveyed for the study are located. The total annual rainfall for the 2006–2009 period was 594.50 mm, of which 74% occurred during the rainy season between November and March (ISCW, 2009). The mean monthly minimum and maximum temperatures for the 1936-1946 period were: 7°C and 24°C during winter, 18°C and 28°C during summer, respectively (SAWB, 1986). Like in the other regions surveyed, rainfall is largely seasonal and occurs mostly between November and April, while the winters are generally cool and dry (SAWB, 1986; ISCW, 2009).

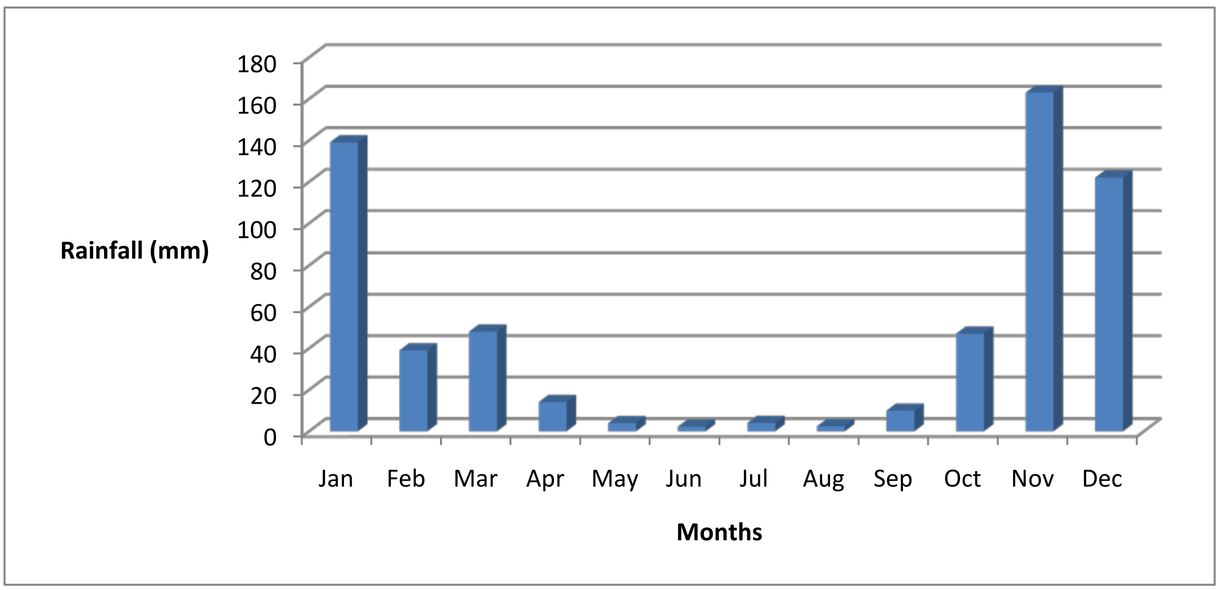



Figure 3.6: The mean rainfall pattern at the Tompi Seleka weather station (altitude ~879 m), near Marble Hall in the Sekhukhune region of the Limpopo province, for 2006–2009.
*Source*: ISCW (2009).

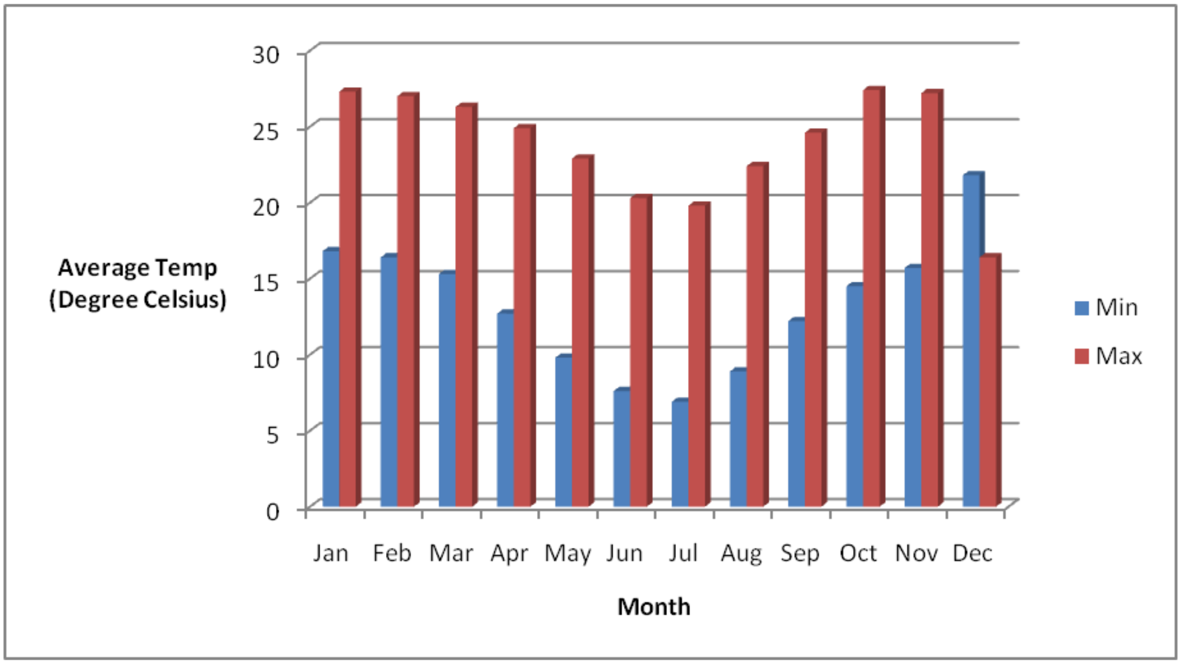



Figure 3.7: Average temperature minimums and maximums associated with Sekhukhuneland (24°45'S; 30°01'E) in the Limpopo province, during 1936-1946.
*Source:* SAWB (1986).

## 3.3 RESEARCH DESIGN, DATA COLLECTION METHODS AND ANALYSES

In order to achieve the outcomes of the three research objectives stated in Chapter 1, several research designs were adopted for the study. A descriptive and quantitative research design was selected to address research objective 1 (i.e. identifying and documenting beverage-making plants) while an experimental (or analytical) research design was followed for research objective 2 (nutritional characterisation and evaluation). Research objective 3 (assessment of market potential for selected beverages) was addressed by means of a descriptive, experimental as well as a quantitative approach. In particular, the latter research design required (i) sensory analyses and (ii) estimation of market potential for selected beverages, which were undertaken concurrently. In the sections below, each research design is outlined.

### 3.3.1 Survey design and data collection methods

The study design for research objective 1 was by means of research surveys, which involved data collection from deliberately selected "information-rich" respondents. The data received from willing respondents or participants were collected by means of questionnaires and then summarised, where appropriate, with percentages and frequencies, in order to draw deductions and conclusions.

Given the scarcity of people with sufficient local knowledge on certain indigenous plants that are utilised to prepare traditional beverages, even in predominantly rural settings in South Africa, a snowball sampling approach was followed. According to Browne (2005), snowball sampling is frequently used where the populations under scrutiny are "hidden" either due to the low numbers of potential respondents or the sensitive nature of the topic under investigation. Moreover, such "hidden" populations may have strong incentives to hide their identities and activities from outsiders, thus making it difficult to reach them through conventional sampling frameworks (Wright and Stein, 2005).

These constraints were particularly relevant for the current study because indigenous knowledge is gradually being eroded by the adoption of modern lifestyles, accelerated urbanisation as well as increasing access to Western education and health-care (Van Wyk and Gericke, 2003). In addition, the preparation of certain traditional drinks, especially alcoholic varieties at household level, is not legally acceptable in South Africa. Thus, with snowball sampling, which takes advantage of existing interpersonal relations and societal networks between people (Browne, 2005), a few villagers, traditional healers, herdsmen and local experts in the Limpopo province provided initial contacts on key individuals thought to be knowledgeable on the domain of interest (i.e. beverage-making plants growing in the wild) and who were willing to participate in the study. This means that the interviewer would begin by identifying someone who meets the criteria for inclusion in the study. After completing the interview with that respondent, he or she was requested to suggest others who also meet the same criteria (Research Centre Knowledge Base (RCKB), 2009). In the current study, the criteria adopted involved anyone with indigenous insights and local knowledge about sought-after beverage-making plants in the Limpopo province and the traditional methods to prepare the beverages.

#### 3.3.1.1 First phase of data collection

Questionnaires were compiled in order to acquire data and information on indigenous plants as well as beverages derived from them. The questionnaires had three sections, comprising the (i) biographical aspects of respondents, (ii) local knowledge indicators (mainly ecological aspects of sought-after plants, their ethnobotanical background and local uses, plant parts used, gender roles if any, harvesting methods and seasons as well as related issues) of useful beverage-making indigenous plant species, and (iii) beverage preparation methods.

Before visiting any village for the surveys, permission to conduct the study was acquired from the Research Committee in the College of Agriculture and Environmental Sciences at the University of South Africa and then the local traditional chieftaincies and relevant community leadership structures in the Limpopo province were contacted for prior informed consent. Local data collectors were selected and recruited into the study and comprised of literate individuals who were able to speak the three indigenous languages of the province - North-Sotho, Tsonga and Venda - as well as English, fluently. Nearly 65% of data collectors were women and had completed at least a post-matriculation qualification in botany, nature conservation or environmental science and thus were knowledgeable about some of the sought-after indigenous beverage-making plants. However, they also received training on how to reach respondents, making use of snowball sampling methods and the completion of questionnaires during interviews. The brief period of training was followed by structured and semi-structured pilot interviews in the Venda region of the Limpopo province during the months of December 2005 and January 2006. In this manner, a total of 25 individuals, of which 13 (or 52%) were women, were interviewed in villages such as Luheni, Mapuloni and Tshixwadza.

Following pilot surveys, the questionnaires were fine-tuned by careful formatting and coding in order to ease data capture and statistical analysis before the main survey began. The remaining surveys were undertaken between 2006 and 2008 because the harvesting of certain indigenous plants, especially fruit-bearing species and a number of tea-making plants, was season dependent and therefore placed constraints on the data collection phase. All the collected research data was stored in Microsoft Excel 2007 before descriptive statistical analyses were conducted.

As with other surveys, it was not possible to remove certain sources of bias entirely. Prior existence of social networks amongst the respondents meant that the respondents interviewed may not have been representative of the population required for the study. However, this source of bias was reduced because the villages surveyed were sometimes far apart, thus partially preventing the flow of similar data amongst respondents. Furthermore, nearly 60% of all respondents for the study were women. This was unavoidable given the information leads and snowball referrals arising from the interviews conducted. Additionally, during the actual data collection phase, some controls were placed to regulate the chain of snowball referrals. This means that whenever interviews with further respondents were yielding no new insights and information, data collection in that area would cease, thus preventing unnecessary collection and documentation of similar information. Regardless of the various sources of bias and possible constraints, the data collected was essential to this study because the respondents encountered were from local populations who appeared to possess sought-after indigenous knowledge on beverage-making plants.

3.3.1.2 Second phase of data collection and analyses

The second phase of data collection was conducted during the various seasons of 2008 and 2009. Various periods were pre-selected because they coincided with the time frame when certain indigenous plants are harvested for their fruits as well as other non-timber products. Voucher specimens were collected from nearby ecosystems and woodlands with the assistance of participating respondents. The plant specimens were kept at the Department of Environmental Sciences at the University of South Africa, before being identified and verified at the South African Institute of Biodiversity (SANBI) Herbarium by trained taxonomists. Thereafter, each plant was provided with a Genspec Number and Latin name, in addition to the local indigenous name provided by respondents. These plants are listed and discussed in Chapter 4.

***The selection of plants identified in the surveys for further study***

All the plants cited by respondents were recorded in the appropriate section of the questionnaires, although it was only a few (about 18%) of them which were selected for a detailed literature review in Chapter 5. Three criteria were used for their selection and involved their (i) percent nominations by participating respondents as well as the (ii) nature of harvesting methods used. The third criterion (iii) was based on whether or not they were classified in South Africa as alien and invasive species according to the Conservation of Agricultural Resources Act (CARA) (1983) and the National Environmental Management Biodiversity Act (NEMBA) (2004). Each of these criteria is explained below.

The first selection criterion was based on percent nominations for each species cited by respondents. These nominations were derived from existing methods for obtaining local use value (UV) of any plant species of interest (as in, for instance, Trotter and Logan, 1986; Hudaib *et al*., 2008 and Al-Quran, 2009). The local use value is calculated as follows:

$$UV=TU/n$$

where TU is the number of citations by respondents for a given use while $n$ is the average number of respondents (Hudaib *et al*., 2008; Al-Quran, 2009). In the current study, the local use value of each species was multiplied by 100 (based on Mashela and Mollel, 2001), in order to calculate percent nominations for every plant highlighted by respondents. According to Hudaib *et al.* (2008: 64), local use value of species may be regarded as “helpful in determining the plants with the highest use”, implying species most frequently cited during surveys while Al-Quran (2009) maintains that the local use value is an important quantitative method that illustrates the relative importance of locally known species.

The second criterion was based on the sustainability of the harvesting methods followed by respondents. Plants which are harvested by destructive means such as removing their roots and bark, piercing their stems in order to obtain cell sap or uprooting their shoots are not suitable for the commercial production of beverages in the Limpopo province, even if samples of beverages derived from them were analysed in this study.

Lastly, the third criterion was based on the alien and invasive nature of the plant species identified by the local respondents. Only indigenous species may be considered for the commercial feasibility of producing beverages because the legal provisions in the Conservation of Agricultural Resources Act (CARA) (1983) and the National Environmental Management Biodiversity Act (NEMBA) (2004) restrict trade based on the propagation and cultivation of so-called declared weeds and invasives in South Africa. It is argued that invasive and alien species pose constraints on local ecosystems integrity and the national hydrological budget. As a result, those plants which are alien and invasive in nature were noted in this study and did not receive any detailed literature review except for nutrient characterisation and evaluation of some of the beverages derived from them.

In summary, with the application of the three criteria explained above, it was possible to determine a sustainability or suitability index for each plant species involved. It was decided that only plants which were cited in the surveys by at least 15% of the participating respondents and had a final sustainability index of 1 (and not 0) were suitable for beverage production and hence were subjected to a literature review in chapter 5. A sustainability index of 1 implies that there are no adverse environmental threats associated with the use of any plant species under consideration while 0 denotes the existence of environmental pressures and constraints which may militate negatively against possible commercialisation.

3.3.1.3 Experimental and analytical methods

Depending on the availability of indigenous plants during the study, especially their ripe fruits and other plant parts, fresh samples of non-alcoholic and alcoholic beverages, including traditional teas, fruit juices and beers were prepared by participating respondents. All beverage samples prepared by participating respondents in the Limpopo province were kept under low temperatures (4-6$^{o}$C) "*en route*" before laboratory analyses. The preparation methods used were recorded in a specific section of the questionnaire. One of the problems associated with the nutritional analyses of these samples was that in certain cases, not all analytical tests could be undertaken on them due to limited quantities supplied by participating respondents. Moreover, with fruit juices, this constraint was compounded by their seasonal availability and scarcity of quality specimens as well as microbiological deterioration because no preservatives were used. Also, preparing samples of tea from *Monsonia angustifolia* and *Cymbopogon citratus* plant species presented a number of challenges for laboratory analyses because it was not possible to obtain sufficient plant material.

Nevertheless, a number of beverages were analysed in keeping with research objective 2, including those prepared from non-indigenous plant species for comparative purposes. Table 3.2 depicts some of the analytical methods followed. The pH value of fruit juices was determined by means of an electronic pH meter (T0319-5.4-02 L SABS). Total protein, fat and dietary fibre as well as moisture and ash were analysed by the methods described in the Association of Official Analytical Chemists (AOAC) International (1990; 2000). Protein was determined by the Kjeldahl method, whereby total protein was multiplied by 6.25. Fat was determined by the Soxhlet extraction method (TO319-5.4-02 SABS). With respect to dietary fibre determination, an AOAC enzymatic−gravimetric method was used (TO319-5.402H SABS). Moisture was determined by using the oven drying method and ash content was estimated by incineration of a sample (weighing 4 g) in a muffle furnace at 600$^{o}$C for 6 h until the colour turned white. Available carbohydrates were determined by using the difference formula: [100 – (sum of protein + fat + moisture + ash + dietary fibre)]. The total non-structural carbohydrates as well as tannins in teas were determined by the Agricultural Research Council (ARC Analytical Section) (ASM 073 method) at Irene, near Pretoria. The energy value of the beverages analysed was calculated by adding the following parameters as follows: [(Carbohydrates x 16) + (Protein x 17) + (Fat x 37)] (South African Bureau of Standards (SABS), 2007).

Table 3.2: List of analytical methods and techniques used.

| Test performed | Analytical method |
|---|---|
| Moisture | Oven dry weighing |
| pH | Electronic pH meter |
| Total dietary fibre | Enzymatic method |
| Protein | Kjeldahl method |
| Fat | Ether extraction, Soxhlet method |
| Ash | Incineration in muffle furnace |
| Vit $B_3$, $B_{6;}$ & $B_{12}$ | Microbiological method |
| Niacin; Biotin | Microbiological method |
| Vitamin C | HPLC[1] |
| Detailed sugar analyses | HPLC[1] |
| Alcohol content | GC[2] with flame ionization detector |
| Mineral analyses | ICP-OES[3] |

[1]High performance liquid chromatography; [2]Gas chromatography;
[3]Inductively coupled plasma optical emission spectrometry.
*Source*: SABS (2007).

Vitamin C, fructose, glucose and sucrose concentrations were determined by means of HPLC by the South African Bureau of Standards (SABS). All the B vitamins estimated (for instance, Vit $B_3$, $B_6$, $B_9$ ,and $B_{12}$) were determined microbiologically as described by the South African Bureau of Standards (SABS) methods (specified as T0269 Man 5.49 C; T0269 Man 5.49D and 5447/E149F). The alcohol content in alcoholic beverages was determined by means of Gas Chromatography (GC). Mineral analyses were performed for (i) teas as well as (ii) selected fruit juices by means of inductively coupled plasma optical emission spectrometry (ICP-OES) by the Agricultural Research Council Analytical Section. Mineral elements were measured at an appropriate emission wavelength selected for high sensitivity and lack of spectral interferences. The following Tables: 3.3, 3.4, 3.5, 3.6 and 3.7 provide information on which beverages were analysed. In addition to the beverages analysed for the study, further nutrient-related data were obtained from the food labels of a few commercial beverages. For instance, fresh commercial beverages - such as wild berry fruit juice, orange fruit juice and a blend of gojiberry, peach and granadilla - were purchased from local supermarkets in order to facilitate nutritional comparisons. Additional nutritional information on commercial beverages was obtained from existing scientific literature. With respect to the nutritional composition of some of the traditional beers analysed, one imported (Nigerian palm) beer, sold in Sandton (in the Gauteng province) was also analysed for the study in order to make comparisons.

Table 3.3: Tests performed on traditionally and locally prepared fruit juices from specified plant species.

| Plant species | Protein | Vitamin C | Total dietary fibre | Carbohydrates |
|---|---|---|---|---|
| African mangosteen* | x | x | x | x |
| Blue sourplum* | x | x | x | |
| Brown ivory* | x | | x | |
| Forest num num* | x | x | x | x |
| Marula* | x | x | | |
| Mobola plum* | x | x | x | x |
| Sand apricot vine* | x | x | x | x |

*Indigenous plant species.

Table 3.4: Tests performed on two types of juices derived from mobola plum.

| Type of test performed | Mobola juice* | Mobola juice** |
|---|---|---|
| Carbohydrates | x | x |
| Total dietary fibre | x | x |
| Energy levels | x | x |
| Vitamin C | x | x |
| Minerals | x | x |

*Prepared by traditional local methods; **Prepared by non-traditional methods.

Table 3.5: Tests performed on selected samples of beer.

| Plant species | Protein | Carbohydrates | Total dietary fibre | Energy |
|---|---|---|---|---|
| Blue sourplum* | x | x | x | x |
| Ilala palm* | x | x | x | x |
| Mobola plum* | x | x | x | x |
| Mountain karee* | x | x | x | x |
| Nigerian palm** | x | x | x | x |

*Traditional beer derived from indigenous species making use of local methods in the rural communities

**Imported Nigerian palm beer.

Table 3.6: Tests performed on tea samples analysed for the study.

| Plant species | TNC | Caffeine | Tannins | Vitamins |
|---|---|---|---|---|
| Large-leave raisin* | x | x | x | |
| Bush tea* | x | x | x | X |
| Wild tea* | x | | | |
| Lemon grass** | x | | | |
| Mopane tea* | x | x | x | X |

*Indigenous plant species; **Exotic plant species.

Table 3.7: Mineral analyses performed on three South African indigenous teas.

| Plant species | Calcium | Magnesium | Phosphorus | Potassium | Sulphur | Sodium |
|---|---|---|---|---|---|---|
| Bush tea* | x | x | x | x | x | x |
| Honeybush* tea | x | x | x | x | x | x |
| Rooibos* tea | x | x | x | x | x | x |

*Indigenous plant species.

The recommended dietary reference intakes (DRIs) as well as recommended dietary daily intakes suggested by the US National Academy of Sciences (2008) and by Rolfes, *et al*. (2009) were used to evaluate the minimum nutrient contribution noted for some of the beverages under investigation. However, it is also worthwhile to recognise that many beverages (such as, for instance, soft drinks and alcoholic drinks) are consumed not necessarily for being key dietary sources of nutrients but rather as convenience foodstuffs for fluid intake, pleasure and relaxation. On the other hand, there is a rapidly growing health and commercial trend associated with the manufacturing of functional beverages such as *functional* fruit juices, *functional* wines (Stasko *et al*., 2006; Barreiro-Hurle *et al*., 2008) and *functional* teas (Wu and Wei, 2002; Vanisree *et al*., 2008) able to deliver not only a nutrient benefit to the consumer but also an added physiological benefit (Hasler, 2002). While it is fully recognised that random and indiscriminate consumption of alcoholic beverages such as beer is injurious to health and not socially accepted across many cultures, there is mounting scientific evidence to suggest that moderate drinking of beer (made from hops and barley) could be a beneficial component of diet (Bamforth, 2002 and 2009; Gerhauser, 2005). Hence, some (nutritional) comparisons amongst alcoholic beverages were also made in this study, where relevant.

3.3.1.4 Sensory analyses and estimation of market potential

Seven beverages were selected for sensory analyses and limited market surveys. However, only one beverage made from the indigenous tea (*Athrixia phylicoides*) species was analysed for sensory characterisation because insufficient material of other wild teas was not available in the Limpopo province. Market trends in the (commercially available) tea sector were gleaned from product inspections during a limited survey carried out in some of the leading supermarkets and health shops in the Gauteng province. Given the limited shelf-life and perishability of fruit juices, only one indigenous fruit (made from mobola plum or *Parinari curatellifolia*) juice was profiled for sensory description and market potential analyses. A traditional beer made from the same (mobola plum) fruit species was also analysed. Apart from these traditional beverages, value-added and custom-made beverages in the form of fruit liqueurs were evaluated. These liqueurs were produced from the fruits of the sand paper raisin (*Grewia flavescens*), African mangosteen (*Garcinia livingstonei*), Kei apple (*Doyvalis caffra*) and stem fruit (*Englerophytum magalismontanum*), in association with the Institute of Subtropical and Tropical Crops (ISTC) at Nelspruit in the Mpumalanga province (De Jager and Du Preez, 2008, *personal communications*).

3.3.1.5 Sensory analytical techniques

The significance of sensory analysis lie in assisting food product developers to determine consumer insights, perceptions, preferences and acceptance as well as potential commercial success (Tuorilla and Monteleon, 2009). Sensory analysis may also assist in the creation of product concepts and the development of sensory attributes that guide consumer acceptability (Moskowits, 1999; Resano *et al*., 2009). To achieve these goals, different groups of sensory panellists were involved in the evaluation of selected beverages. The first group was made of 13 skilled sensory panellists who worked for specialist laboratories (in Woodmead and Irene, in the Gauteng province). This group provided data on the sensory descriptors of the tea made from *Athrixia phylicoides* as well as a traditional fruit juice and a beer derived from mobola plum (*Parinari curatellifolia*).

The experimental procedures followed by these laboratories were as follows. Experienced and trained panellists were selected for the project, based on their participation in previous descriptive sensory panels, taste and smell acuity, interest and ability to discriminate between the four basic tastes. Reference samples such as fresh and dried herbs, bark from pine trees and commercially available beverages (for instance, herbal teas and fruit juices) were used to guide the panel during the development of the sensory lexicon. Thereafter, panellists were exposed to the samples to be evaluated, in order to be able to develop the relevant sensory vocabulary. They were trained to increase their sensitivity and ability to discriminate between the sensory attributes of each concept product (namely, the *Athrixia phylicoides* tea and the traditional fruit juice and beer made from *Parinari curatellifolia*). Panellists were expected to provide a detailed description of the aroma, flavour and after-taste attributes of the sample under consideration. In order to ensure that panellists were not in any way influenced by extraneous factors they were not allowed to use perfumed cosmetics (2 hours prior to evaluations) and were required to avoid exposure to foods and fragrances at least 30 minutes before evaluation sessions. Carrot rings and water at room temperature were served as palate cleansers in between evaluation sessions. In this manner, a clear sensory evaluation of each product was made.

Other than trained sensory panellists, there untrained sensory panellists who were available for the study and represented potential consumers in the marketplace. The first group of such panellists consisted of 15 staff members from the College of Agriculture and Environmental Sciences at UNISA. These panellists were recruited to assist in determining the sensory attributes and market potential of selected beverages. The second group of panellists was constituted by delegates and plant specialists (21 participating volunteers) who attended the Indigenous Plant Use Forum (IPUF) Conference at Graaff Reinet, in the Eastern Cape province (7-10 July 2008). The third group of sensory evaluators consisted of 35 shoppers chosen randomly for participation in the study, at the Liquor Section of the Centurion Branch of Makro Store in Pretoria. Prior to conducting the sensory evaluation, permission to conduct the study was granted by Makro Head Office by means of a letter. The most crucial aspect in these evaluation processes was the selection of appropriate terms for descriptive purposes as well as designing a measurement instrument for the determination of product acceptability and willingness to make purchases.

In order to ensure this, all these panellists were provided with a list of descriptive terms describing the aroma (odour) and flavour notes of beverages in general, as illustrated in Tables 3.8 and 3.9. These sensory terms served only as guidelines,which means panellists were allowed to suggest other sensory descriptors that best described the beverages under investigation. To gather all these data systematically, panellists were provided with a structured questionnaire.

Table 3.8: Odour elements selected for profiling selected beverages.

| Sensory element | Main sensory notes | Shadows |
|---|---|---|
| Odour / Smell | Alcoholic | Spicy; alcohol-like |
| | Aromatic | Pleasant aromatic odour-<br>Woody odour |
| | Fruity | Fruity shadow-apple, strawberry |
| | Floral | Flower-based fragrance |
| | Cereal | Grainy<br>Malty |
| | Resinous | Woody |
| | Nutty | Nutty |
| | Green | Green apples |
| | Grassy | Green grass |
| | Roasted caramel | Caramel<br>Molasses<br>Licorice |
| | Rancid | Rancid |
| | Soapy | Oily |
| | Fatty | Butter-like |
| | Sulphury | Yeasty<br>Cooked vegetables<br>Eggs<br>Rubber |

*Sources:* Adapted from sensory descriptors used in Piggot *et al*. (1990); Luckow and Delahunty (2004) as well as Carbonell *et al.* (2008).

Table 3.9: Flavour elements utilised as guidelines for the sensory characterisation of selected beverages.

| Sensory element | Flavour note | Shadows and themes |
|---|---|---|
| Flavoue/Mouthfeel | Mouthfeel | Warming sensation of alcohol<br>Astringence-dry rough feeling<br>Creamy<br>Smooth<br>Powdery |
| | Bitterness | Harsh<br>Too dry |
| | Fruity flavour | Watermelon<br>Guava<br>Citrus |
| | Acidic | Sourness<br>Sourmilk<br>Vinegar<br>Acidic |
| | Sweetness | Syrup-like |
| | Oxidised/stale | Papery<br>Leathery<br>Mouldy |

*Sources*: Adapted from sensory descriptors used in Piggot *et al*. (1990); Luckow and Delahunty (2004) and Carbonell *et al.* (2008).

Table 3.10: A 9-point (Hedonic) acceptability scale showing measures of increasing consumer preference.

| Unit | Definition of acceptability and likeness |
|---|---|
| 9 | Like extremely |
| 8 | Like very much |
| 7 | Like moderately |
| 6 | Like slightly |
| 5 | Neither like nor dislike |
| 4 | Dislike slightly |
| 3 | Dislike moderately |
| 2 | Dislike very much |
| 1 | Dislike extremely |

*Source:* Adapted from Meilgaard *et al*. (1999).

The first part of the questionnaire was based on the description and evaluation of sensory notes such as odour, flavour, mouthfeel and colour. The second part measured product acceptability and ratings on a likeness scale (hedonic scale), ranging from 1 to 9 (as shown on Table 3.10). Indications on the part of panellists regarding their willingness to make purchases or recommend the concept product to someone they know, were also captured. The third part of the questionnaire dealt with prices the various panellists were willing to pay for the beverages being assessed. All the quantitative descriptive data obtained from all evaluations undertaken were captured in a spreadsheet using Microsoft Excel 2007, in order to enable and facilitate statistical analyses. In total, the following samples were selected for sensory analyses: tea prepared from bush tea (*Athrixia phylicoides*), fruit juice and beer made from mobola plum (*Parinari curatellifolia*), liqueurs flavoured with the fruits of sand paper raisins (*Grewia flavescens*), Kei apple (*Doyvalis caffra*), African mangosteen (*Garcinia livingstonei*) and stem fruit (*Englerophytum magalismontanum*). All the research findings stemming from this study are discussed in the next three chapters.

# CHAPTER 4

## RESEARCH FINDINGS AND DISCUSSION: INDIGENOUS KNOWLEDGE ON BEVERAGE MAKING PLANTS

### 4.1 INTRODUCTION

This chapter provides a presentation and a discussion of research findings based on the data analysed from the questionnaires designed for the study. Research findings from specific study areas are discussed in sections 4.2, 4.3 and 4.4. These sections are followed by a summary in section 4.5.

### 4.2 INDIGENOUS KNOWLEDGE ON BEVERAGE-MAKING PLANTS IN THE VENDA-SPEAKING REGION

#### 4.2.1 Profiles of respondent's in selected rural communities

Of the 79 respondents interviewed in the study area, 60% were women. The largest number (39) of respondents was in the 60-69 age category, constituting 49% of this sample (Figure 4.1). Female respondents dominated the 60-69 age range, accounting for 64% of all respondents in this category.

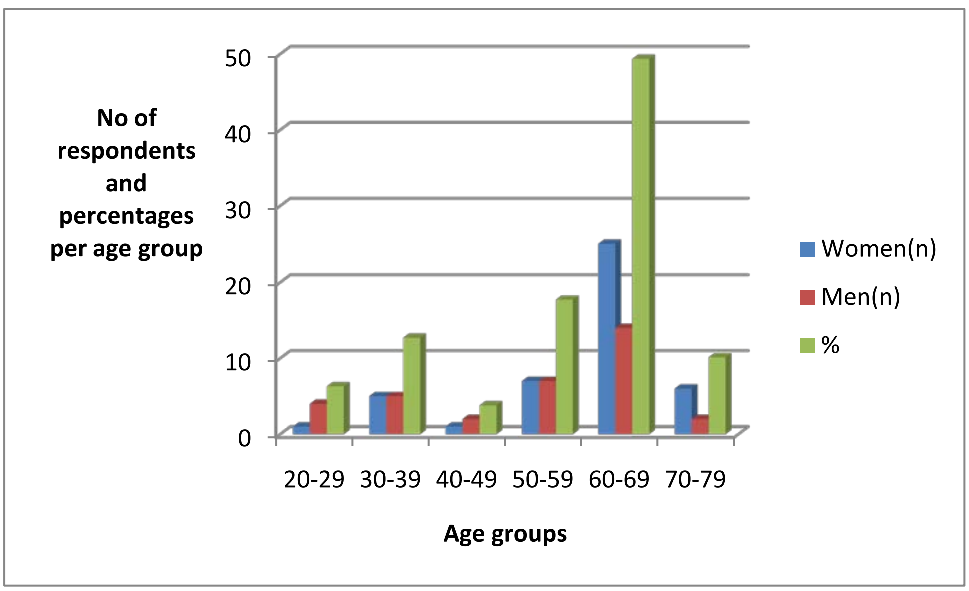



Figure 4.1: Number and percentages of respondents per age group and gender.

The 60-69 age category was followed by the 50-59 age group which comprised an equal gender number of seven. The latter age range included 18% of all respondents interviewed and was followed by the 30-39 age category (13%), 70-79 age category (10%) and the 20-29 age category (6%). The smallest category was the 40-49 age group, comprising only 4% of all respondents interviewed in this study area.

In terms of occupations, 63% of respondents were pensioners (i.e. over 65 years of age) and were thus not involved in the formal employment sector. The total proportion of unemployed respondents was 68%, possibly accentuated by the higher number of pensioners in the survey. Approximately 13% of respondents were employed in semi-skilled occupations such as the production of handcrafted curios, traditional equipment, clothes and the subsistence cultivation of agricultural crops. Nineteen percent of respondents owned informal micro-enterprises, such as home-based informal shops (called *spazas),* food vendors, home-based liquor shops (called *shebeens*) and repair services.

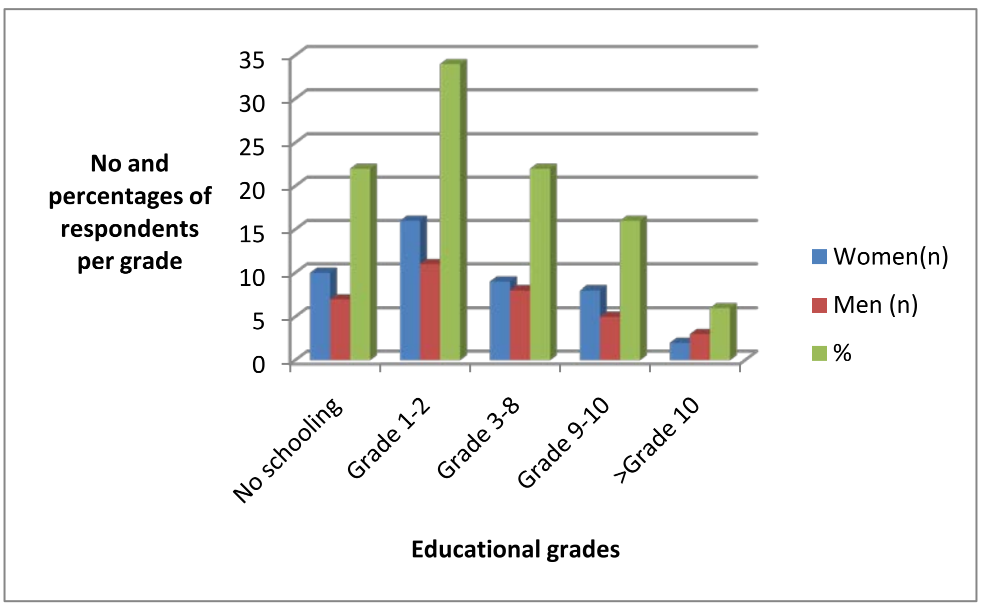



Figure 4.2: Educational profile of respondents in the study area.

Figure 4.2 illustrates the different educational achievements of respondents. Generally, the respondents interviewed had a poor educational background. The proportion without formal schooling and those who had achieved only Grades 1 and 2, constituted 22% and 32%, respectively. Twenty four percent had Grades 3 to 8 as their highest level of formal education. Only 16% passed Grades 9 and 10. The total number of respondents who attained post-matriculation qualifications was five, representing 6% of the sample. As shown on Figure 4.2, these patterns prevailed regardless of gender.

Further analyses of respondent's linguistic abilities revealed that 92% were able to speak the local (Venda) language fluently. Those who were able to speak other ethnic languages in the province, in addition to the Venda language, accounted for only 8% of the total number interviewed. This tendency may be ascribed to the fact that over 75% of the respondents have lived in these rural areas for 45 years or more.

### 4.2.2 Indigenous knowledge of beverage-making plants

The Venda-speaking respondents listed an assortment of indigenous plants utilised for the traditional brewing of different types of beverages. Both male and female respondents claimed that their knowledge of sought-after indigenous plants had been acquired from their parents and grandparents through a long-term process of cultural transmission and learning. The average number of beverage-making indigenous plant species mentioned by an individual respondent, regardless of educational background was four, reflecting the existence of a knowledge system regarding sought-after plants.

Figure 4.3 indicates the number of beverage-making plants mentioned by the different classes of respondents. As shown on this Figure, the maximum number of beverage-making plants mentioned by a respondent in this region during the survey was 13 and the minimum number 1**.** Figure 4.3 further indicates that 27% of all respondents interviewed knew at least one type of a beverage-making plant whilst 25% could identify three.

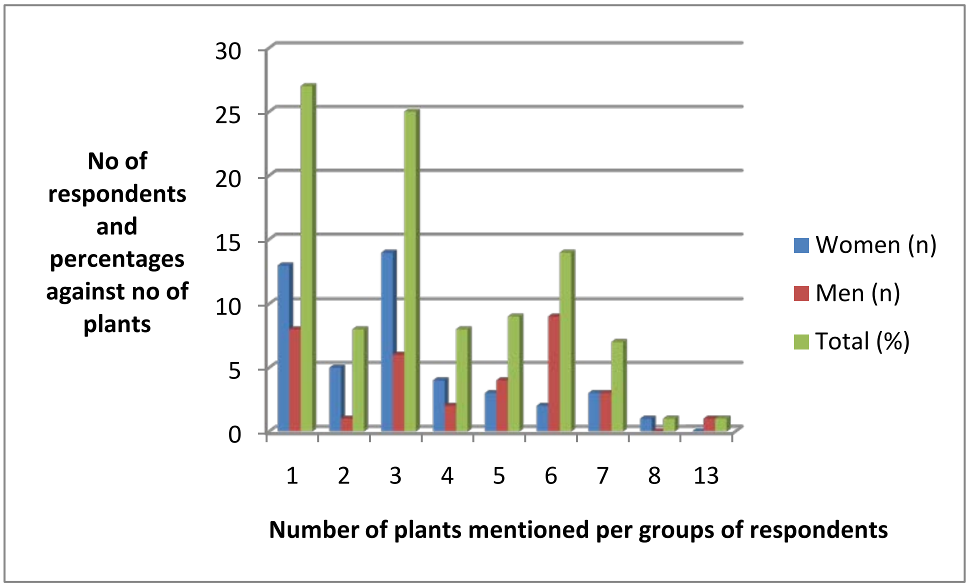



Figure 4.3: Number and percentages of plants mentioned by respondents in the Venda-speaking areas.

Those who could identify four or more plants constituted 51% of the entire sample. Only a relatively small (<20%) number of respondents were able to point out six or more plants. For instance, there was only one respondent in the 50-59 age category who identified 13 different plants from the savanna woodlands in and around the Makonde rural community, located near the Soutpansberg mountains. This particular respondent has lived in the study area for over 55 years and was actively involved in some of the indigenous plant development projects in partnership with the Institute for Tropical and Subtropical Crops (ITSC) at the Agricultural Research Council (Nelspruit). Lastly, in five of the nine classes of respondents (Figure 4.3), female respondents invariably mentioned more plant species than their male counterparts, reflecting some local gender discrepancies in indigenous knowledge.

### 4.2.3 Diversity of beverage-making plant species

During the interviews, respondents cited a total of 56 beverage-making plants in this study area. Many of these plants were only known by their vernacular names and could not be collected for the current research because they have become extremely scarce due to increasing human encroachment into their natural habitats. Beverage-making plant species collected in the surrounding ecosystems with the assistance of participating respondents are listed in Table 4.1. The species collected were 41 in number and represented 29 plant families. The most represented plant families were the Apocynaceae (19%) and Ebenaceae (10%) while other families such as Rhamnaceae (6%), Olacaceae (6%), Araliaceae (3%) and Vitaceae (3%) were relatively smaller in representation. Not all of plant species specified in Table 4.1 are indigenous to South Africa. Hence, other plants cited by respondents during interviews (and subsequently collected) were non-native species such as *Cymbopogon citratus* (lemon grass), *Opuntia ficus indica* (sweet prickly pear), *Physalis peruviana (marungudane* or Cape gooseberry*), Zyzigium cumini* (water berry) and *Rubus rigidus* (wild bramble). Although these species have naturalised successfully in South Africa, respondents were not aware of this point. Species such as the sweet prickly pear are classified within Category 1 as weeds and invader plants in the Conservation of Agricultural Resources Act (CARA) (1983) and the National Environmental Management: Biodiversity Act (NEMBA) (2004). According to these laws, invasive species of Category 1 need to be eradicated from the environment (land or inland water surface) and, consequently, no permits for their propagation are issued by regulatory Departments in South Africa (Meyer, 2010).

Although respondents used only one vernacular name for each specimen identified in the wild, in certain instances, there were interspecies variations amongst the plants collected. Such variations were noted in the genera *Berchemia, Diospyros* and *Ximenia*. However, the greatest interspecies variation occurred in the *Carissa* genera as it was represented by three different plant species (i.e. *Carissa bispinosa, C. edulis* and *C. tetramera*). These closely-related species are distinguished by the position of their leaves, spines, degree of branching, colour of flowers as well as microhabitats (Palgrave, 2002). In terms of growth form, 61% of the species collected are trees, 34% are shrubs whilst 5% are climbers. In fact, 95% of the species in Table 4.1 are fruit-bearing trees and shrubs, pointing to the popularity of these fruits among the local inhabitants.

Table 4.1: Beverage-making plants identified and collected in the Venda study area.

| Vernacular name | English common name | Confirmed* species name | Family | Plant type |
|---|---|---|---|---|
| Muvhuyu | Baobab | *Adansonia digitata* | Araliaceae | Tree |
| Mubostee | Bush tea/ Zulu tea | *Arthrixia phylicoides* | Asteraceae | Shrub |
| Muembe | Wild custard apple | *Annona senegalensis* | Annonaceae | Tree |
| Munie | Brown ivory | *Berchemia discolor* | Rhamnaceae | Tree |
| Munie | Red ivory | *Berchemia zeyheri* | Rhamnaceae | Tree |
| Munombelo | Stem fruit | *E. magalismontanum*[1] | Sapotaceae | Tree |
| Thungulu | Forest num num | *Carissa bispinosa* | Apocynaceae | Shrub |
| Thungulu | Spined num num | *Carissa edulis* | Apocynaceae | Shrub |
| Thungulu | Sand forest num num | *Carissa tetramera* | Apocynaceae | Shrub |
| Mutee | Bushmans tea | *Catha edulis* | Apocynaceae | Tree |
| Mupani | Mopane | *Colophospermum mopane* | Caesalpiniaceae | Tree |
| Mutee | Lemon grass tea | *Cymbopogon citratus* | Poaceae | Shrub |
| Musuma | Blue bush | *Diospyros lycioides* | Ebenaceae | Tree |
| Musuma | Jackal berry | *Diospyros mespiliformis* | Ebenaceae | Tree |
| Tshiluvhari | Common wild pear | *Dombeya rotundifolia* | Sterculiaceae | Tree |
| Mutunu | Kei apple | *Doyvalis caffra* | Flacourtiaceae | Tree |
| Mure | Puzzle bush | *Ehretia rigida* | Boraginaceae | Tree |
| Mutangule | Magic quarry | *Euclea divinorum* | Ebenaceae | Tree |
| Mutamvu/muumuu | Wild fig | *Ficus thonningii* | Moraceae | Tree |
| Mutangahuma | Whiteberry bush | *Flueggia virosa* | Euphorbiaceae | Shrub |
| Muphiphi/muhimbi | African mangosteen | *Garcinia livingstonei* | Apocynaceae | Tree |
| Mutshevho | Ilala palm | *Hyphaene coriacea* | Arecaceae | Tree |
| Mupimbi | Spiny gardenia | *Hyperacanthus amoenus* | Rubiaceae | Shrub |
| Mavhungo | Sand apricot vine | *Landophia kirkii* | Apocynaceae | Climber |
| Musudzungwane | Fever tea | *Lippia javanica* | Lamiaceae | Shrub |
| Mububulu | Red milkwood | *Mimusops zeyheri* | Sapotaceae | Tree |
| Mudoro | Sweet prickly pear | *Opuntia ficus indica* | Cactaceae | Shrub |
| Muvhula | Mobola plum | *Parinari curatellifolia* | Chrysobalanaceae | Tree |
| Mumbe | Jacket plum | *Pappea capensis* | Sapindaceae | Tree |
| Marungudane | Cape gooseberry | *Physalis peruviana* | Solanaceae | Shrub |
| Murumbulashedo | Common forest grape | *Rhoicissus tomentosa* | Vitaceae | Climber |
| Tshidzimba | Hard-leaved currant | *Rhus tumilicola* | Anacardiaceae | Shrub |
| Munambala | Wild bramble | *Rubus rigidus* | Rosaceae | Shrub |
| Maramba | Green monkey orange | *Strychnos spinosa* | Loganiaceae | Tree |
| Mufula | Marula | *Sclerocarya birrea* | Anacardiaceae | Tree |
| Mutuu | Water berry | *Syzigium cumini* | Myrtaceae | Tree |
| Mutshikili | Natal mahogany | *Trichilia emetica* | Meliaceae | Tree |
| Mazwilo | Wild medlar | *Vanguira infausta* | Rubiaceae | Tree |
| Thandzwa | Blue sourplum | *Ximenia americana* | Olacaceae | Shrub |
| Thandzwa | Large sourplum | *Ximenia caffra* | Olacacea | Shrub |
| Mutwari | Purple pod cluster leaf | *Terminalia prunioides* | Combretaceae | Tree |

*Species names have been confirmed by trained taxonomists at SANBI. [1]*Englerophytum magalismontanum.*

#### 4.2.3.1 Local uses of plant species

With the exception of *Athrixia phylicoides* (bush tea), *Catha edulis* (bushmans tea), *Colophospermum mopane* (mopane), *Cymbopogon citratus* (lemon grass), *Dombeya rotundifolia* (common wild pear), *Ehretia rigida* (puzzlebush), *Lippia javanica* (fever tea) and *Terminalia prunioides* (purple-pod cluster-leaf) that are mostly used for brewing traditional and medicinal teas, 78% of the plants listed in Table 4.1 are utilised for the traditional production of different types of non-alcoholic fruit-based beverages as well as alcoholic beverages. Fifty four percent of the plants listed in Table 4.1 have some degree of ethno-medicinal importance that has been scientifically researched – the most notable being *Annona senegalensis* (wild custard apple), *Athrixia phylicoides* (bush tea), *Catha edulis* (bushman's tea), *Euclea divinorum* (magic guarri), *Landolphia kirkii* (sand apricot vine), *Pappea capensis (*jacket plum), *Parinari curatellifolia* (mobola plum), *Rhoicissus tomentosa* (common forest grape) and *Trichilia emetica (Natal mahogany)* (Palgrave, 2002; Van Wyk and Gericke, 2003; McGaw and Eloff, 2005; Shange *et al*., 2006; Komane *et al*., 2008; Olivier *et al*., 2008). However, when used for medicinal purposes, the plant parts utilised are mainly roots, bark and leaves, rather than fruits (Palgrave, 2002).

4.2.3.2 Frequencies associated with plant species

Further analyses examined the frequencies with which the plants listed in Table 4.1 were mentioned by the various respondents. These frequencies are illustrated in Figures 4.4 (tea-making plants) and Figure 4.5 (juices and alcoholic beverages) and may be construed as reflecting their relative ethnobotanical importance in the traditional making of beverages.

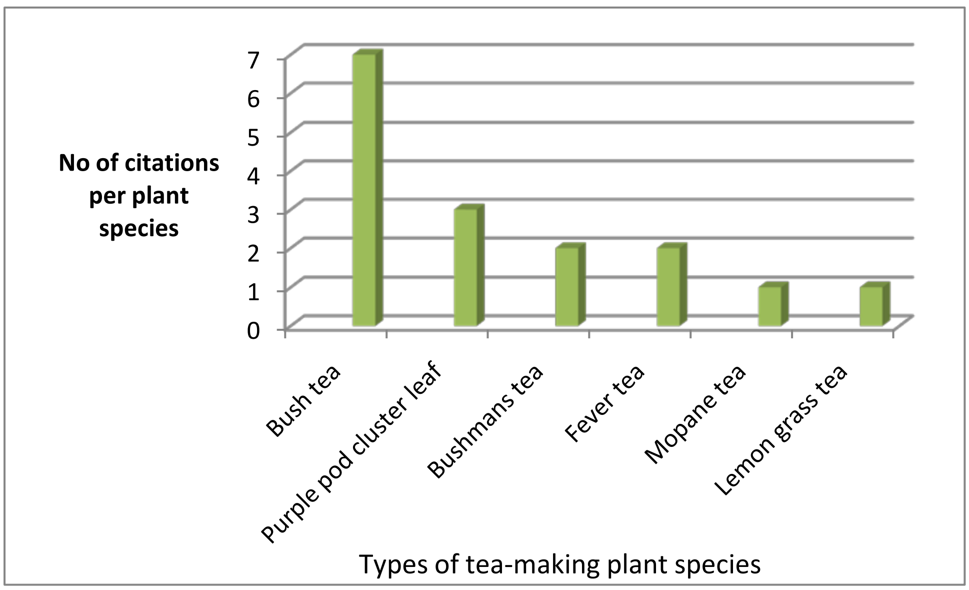



Figure 4.4: Number of citations per plant species (frequencies) associated with the different tea-making plants in study area.

Regarding tea-making plants, the most frequently mentioned species was *Athrixia phylicoides* (7x) (as shown in Figure 4.4), followed in descending order by *Terminalia prunioides* (3x), *Catha edulis, Lippia javanica)* (2x) and *Colophospermum mopane* (1x). Based on these trends, it can be seen that *Athrixia phylicoides* is the most important tea-making indigenous plant species (Figure 4.4) in the Venda study area. Other studies have indicated that the latter tea plant species is well known in the rural areas of provinces such as Mpumalanga, KwaZulu-Natal and the Eastern Cape (Olivier and De Jager, 2005; Olivier and Rampedi, 2008).

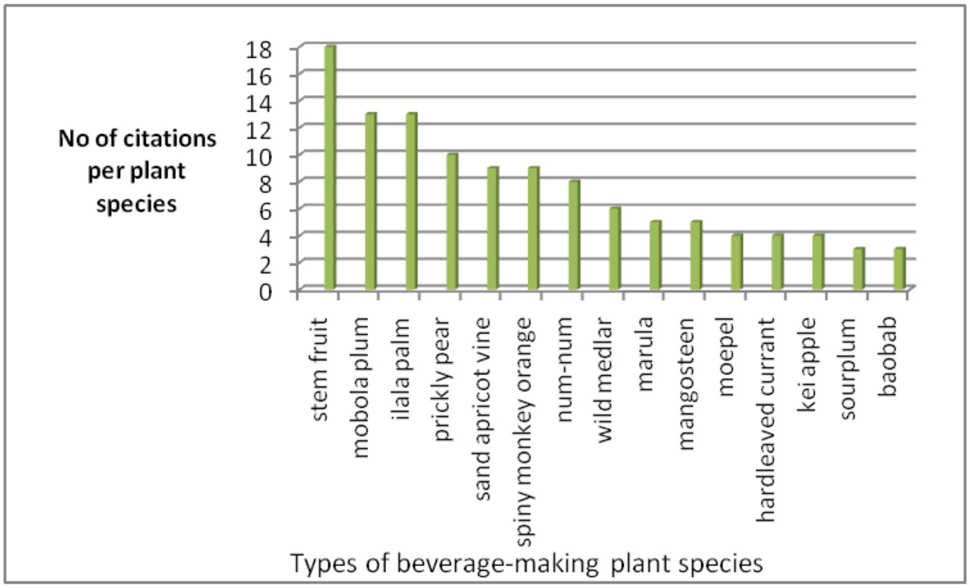



Figure 4.5: The most frequently mentioned beverage-making species in the Venda study area.

Amongst the juice- and alcoholic beverage-making plant species mentioned by respondents, the stem fruit (*Englerophytum magalismontanum*) was known by most respondents. Eighteen of the respondents identified this indigenous plant (Figure 4.5). The next important beverage-making plant was the mobola plum (*Parinari curatellifolia*) which was mentioned by 13 respondents. Similarly, the ilala palm (*Hyphaene coriacea*), was also mentioned 13 times. These plants were followed in descending order by species such as the sweet prickly pear (*Opuntia ficus indica*) (10), sand apricot vine (*Landolphia kirkii)* (9), spiny monkey orange (*Strychnos spinosa)* (9) and the forest num num (*Carissa bispinosa*) (8). These plants were followed by the wild medlar (*Vanguira infausta)*, cited six times by respondents in the study area. Both the marula (*Sclerocarya birrea)* and the African mangosteen (*Garcinia livingstonei*) were cited five (5) times. Plant species mentioned by four respondents included the (Transvaal) red milkwood or "*moepel*" (*Mimusops zeyheri*), hard-leaved currant (*Rhus tumulicola*) and the Kei apple (*Doyvalis caffra*). Others such as the large sourplum (*Ximenia caffra*) and the baobab (*Adansonia digitata*) were mentioned only three times. Some of the fruit-bearing species mentioned by less than three individual respondents included the following plants: the common forest grape (*Rhoicissus tomentosa)*, Natal mahogany (*Trichilia emetica)*, wild bramble (*Rubus rigidus*) and the water berry (*Syzigium cumini***)**. In all cases, except for the ilala palm, the plant part used to make beverages is the fruit. By contrast, in the case of ilala palms, an alcoholic beverage is brewed from their cellsap.

The higher frequencies noted in the survey may be ascribed to the popularity of selected species, based on the size, taste, availability and the role their fruits play in the diets and livelihoods of the local populations. As a result some of them are propagated on a small-scale, notably the sweet prickly pear, despite its Category 1 status as an invasive. Infact, in the Gauteng province the sweet prickly pear is aready sold in fruit and vegetable stores.

#### 4.2.3.3 The seasonal availability of plant species

Table 4.2 indicates the seasonal availability of the fruit species represented in Table 4.1, based on information obtained from respondents and verified with existing literature (Van Wyk and Van Wyk, 1997; Palgrave, 2002; Van Wyk and Gericke, 2003). The spring season months (August, September and October) are usually dry, but this is also the period during the year when atmospheric temperature begins to increase. The spring period is characterised by the development of plant leaves as well as flowers. In addition, it is the time when certain fruits begin to ripen and thus marks the beginning of the harvesting period. About 75% of the fruit species depicted in Table 4.2 begin to ripen in spring and can be harvested during August-Oct period. When the rainfall period intensifies during the summer months (November, December and January), it heralds the ripening of more than 70% of the fruit types listed in Table 4.2. The proportion of fruits which ripen during the autumn months (February, March and April) is very low, comprising only 13% of the plants in Table 4.2. Only *Ficus thonningii* species bears fruits throughout the year, although some variations in yield can be expected depending on prevailing climatic factors. During the winter period (May-July), when most areas do not receive rainfall, only three fruit types (*Englerophytum magalismontanum*, *Euclea divinorum* and *Ficus thonningii*) can be harvested in this study area.

Table 4.2: Beverage-making fruits[1] and their seasons of availability in the Venda study area.

| English common name | Confirmed* name | Winter | Spring | Summer | Autumn |
|---|---|---|---|---|---|
| Baobab | *Adansonia digitata* | | | | |
| Wild custard apple | *Annona senegalensis* | | | | |
| Brown ivory | *Berchemia discolor* | | | | |
| Red ivory | *Berchemia zeyheri* | | | | |
| Stem fruit | *E. magalismontanum* | | | | |
| Forest num num | *Carissa bispinosa* | | | | |
| Spined num num | *Carissa edulis* | | | | |
| Sand forest num num | *Carissa tetramera* | | | | |
| Blue bush | *Diospyros lycioides* | | | | |
| Jackal berry | *Diospyros mespiliformis* | | | | |
| Kei apple | *Doyvalis caffra* | | | | |
| Puzzle bush | *Ehretia rigida* | | | | |
| Magic quarry | *Euclea divinorum* | | | | |
| Wild fig | *Ficus thonningii* | | | | |
| Whiteberry bush | *Flueggia virosa* | | | | |
| African mangosteen | *Garcinia livingstonei* | | | | |
| Spiny gardenia | *Hyperacanthus amoenus* | | | | |
| Sand apricot vine | *Landophia kirkii* | | | | |
| Red milkwood | *Mimusops zeyheri* | | | | |
| Sweet prickly pear | *Opuntia ficus indica* | | | | |
| Mobola plum | *Parinari curatellifolia* | | | | |
| Jacket plum | *Pappea capensis* | | | | |
| Common forest grape | *Rhoicissus tomentosa* | | | | |
| Hard-leaved currant | *Rhus tumilicola* | | | | |
| Wild bramble | *Rubus rigidus* | | | | |
| Green monkey orange | *Strychnos spinosa* | | | | |
| Marula | *Sclerocarya birrea* | | | | |
| Water berry | *Syzigium cumini* | | | | |
| Natal mahogany | *Trichilia emetica* | | | | |
| Wild medlar | *Vanguira infausta* | | | | |
| Blue sourplum | *Ximenia americana* | | | | |
| Large sourplum | *Ximenia caffra* | | | | |

[1] The number of fruits compared is 32. The shaded zones denote the time when ripe fruits are available for harvesting.

*Confirmed and verified by trained taxonomists at the South African Institute of Biodiversity (SANBI).

In terms of the duration and the length of the harvesting period regarding the fruit types listed in Table 4.2, some patterns have been observed. There are 19 fruit species which have a relatively longer harvesting period, lasting for six months. These fruit types represent 59% of species listed in Table 4.2. Only *Ficus thonningii*, representing 3% of species indicated in Table 4.2, may be harvested throughout the year. Fruit types such as the Kei apple (*Doyvalis caffra*), jackal berry (*Diospyros mespiliformis*) and the wild bramble (*Rubus rigida*) have a very restricted harvesting season, lasting only three to four months within the year.

4.2.3.4 Accessibility aspects and harvesting constraints

Fruit harvesting is generally accessible to all members of the rural communities surveyed, except for fruit trees growing in individual homesteads and cultivated lands. Most of the fruits depicted in Table 4.2 are hand-picked and collected in tins, buckets and plastic bags (Figure 4.6).


Figure 4.6: The collection of marula fruits in a plastic bag.

Often these fruits are collected by young women during fuel-wood collection trips in and around nearby savanna woodlands. In addition, men who herd livestock and collect medicinal plant parts and other ecosystem goods also harvest these fruits. However, there are some constraints regarding the harvesting of sought-after wild fruits. One of these constraints stems from the size and height of some of these trees above the ground, notably for species such as *Adansonia digitata*, *Berchemia discolor*, *Strychnos spinosa* and *Parinari curatellifolia*. These species may grow up to 15-20 m above the ground, thus rendering a certain proportion of their fruits inaccessible, particularly those occurring in the higher branches of the tree canopy.

According to the respondents interviewed in the study area, other constraints limiting the amounts of fruits harvested are the result of competition not only among humans but also between humans and wildlife. For instance, wild fruits such as *Annona senegalensis, Englerophytum magalismontanum*, *Mimusops zeyheri and Syzigium cumini* and others are also consumed by birds and monkeys and are subsequently damaged before human harvesting occurs. Given these limitations, some fruits such as *Landolphia kirkki* and *Strychnos spinosa* are collected by harvesters very early in the season, even before their actual ripening stage. Once collected in this manner, they are taken home and buried in the sand to accelerate the ripening process before being consumed.

4.2.3.5 Harvesting methods and some aspects of sustainability

The ilala palms (*Hyphaene coriacea* and *H. petersiana*) are harvested rather differently from the other species listed on Table 4.2. It is not the fruits that are targeted by the locals but rather the cell sap tapped from their stem. To harvest this sap, the stem is first pierced with a sharp instrument. Once the stem is pierced (and definitely damaged by this harvesting method), the sap begins to flow and is carefully channelled for collection in a dish or bucket before being utilised to brew an alcoholic beverage. From an environmental sustainability point of view, this harvesting method is not suitable for beverage preparation purposes because most of the affected plants usually die (Govender *et al*., 2005).

Brewing traditional tea from the mopane tree (*Colophospernum mopane*) requires the removal of the bark by means of an equally unsustainable harvesting method. Stripping the bark away from the tree trunk invariably harm plants, especially as the locals currently lack the know-how for restoring damaged stems. In the case of harvesting *Athrixia phylicoides* species for tea-preparation purposes, the branches of the plant are carefully cut as close to the ground as possible but without damaging plant stems.

## 4.3 INDIGENOUS KNOWLEDGE ON BEVERAGE-MAKING PLANTS IN THE TSONGA-SPEAKING REGION

### 4.3.1 Profile of respondent's in selected Tsonga-speaking rural communities

The total number of respondents interviewed in this region was 55. Seventy three percent were women. Figure 4.7 depicts the number of respondents based on age and gender. It can be seen that the highest number of respondents were in the 40-49 and 50-59 age categories, representing 33% and 36%, respectively. These categories were followed by the 60-69, 30-39 and 70-79 classes, in the proportions of 15%, 9% and 7%, respectively. Furthermore, women respondents dominated three of the six classes (Figure 4.7).

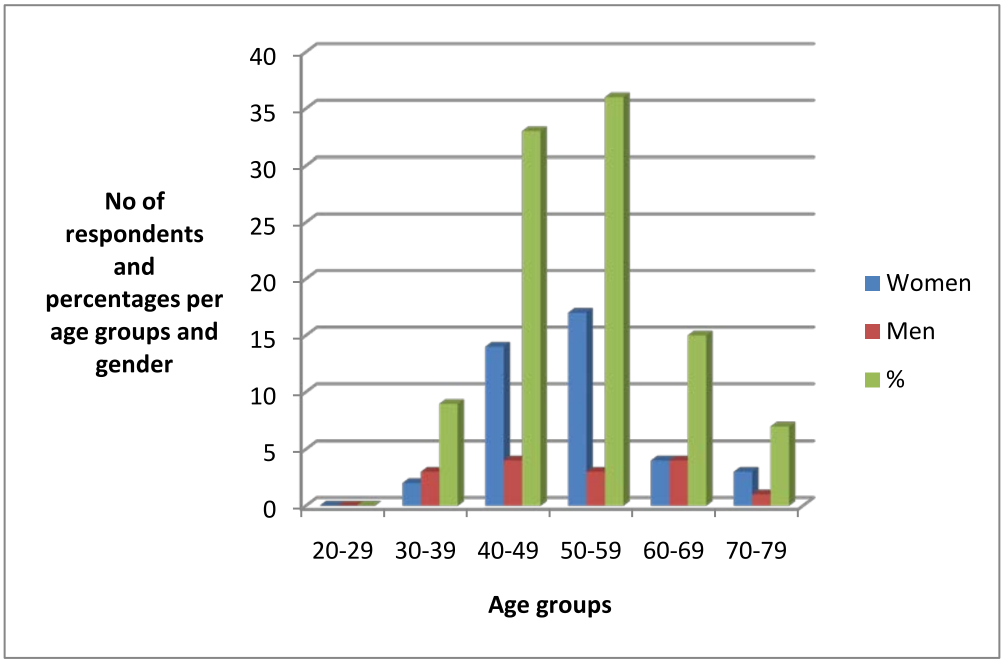



Figure 4.7: Number and percentages of respondents per age group and gender.

Regarding occupational profiles, 22% of respondents were pensioners whilst 40% were unemployed. The respondents involved in semi-skilled occupations represented 25% of the subsample while those who earned an income through privately-owned small businesses were only 13%.

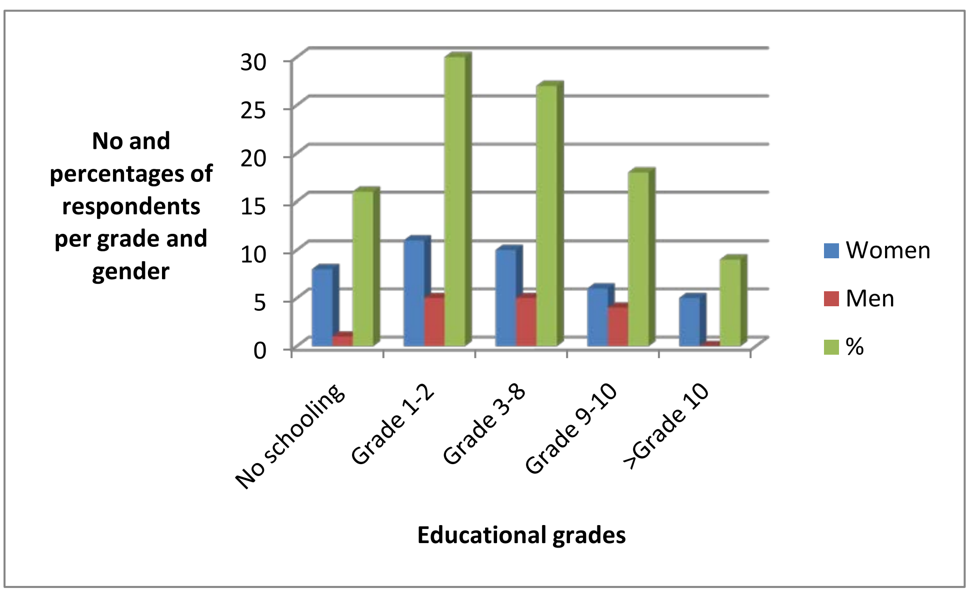



Figure 4.8: Educational profile of respondents in the Tsonga-speaking study area.

Figure 4.8 indicates the educational levels attained by respondents interviewed in this region. Although there are variations within each educational class between men and women, the bulk of respondents achieved Grades 1 to 2 and Grades 3 to 8 levels, representing 30% and 27% of the subtotal, respectively. Sixteen percent of respondents have had no formal schooling and only 18% had obtained a Grade 9-10 education. However, the proportion of respondents with post-matriculation educational achievement was 9%. Regarding use of language, over 90% of respondents spoke Tsonga fluently and about 20% were able to understand other African languages such as North-Sotho, Venda and Zulu. Furthermore, 64% of them have spent an average of 34 years in the areas where the surveys were conducted.

### 4.3.2 Indigenous knowledge of beverage-making plants

The information gathered from the Tsonga-speaking respondents revealed an array of beverage-making plant species. The respondents ascribed their existing knowledge of these plants to cultural learning derived from their parents and grandparents regarding human-environment relationships. Figure 4.9 shows the number of beverage-making plant species mentioned by the different classes of respondents. The maximum number of plants mentioned by a single respondent during the present surveys was five. Three respondents (collectively constituting 5% of this sample) mentioned four different types of sought-after plants while five respondents (9%) cited three plant species. Notably, 73% of respondents in this sample highlighted only one plant species during the survey. This tendency may be a result of relatively less plant diversity in the surrounding woodlands coupled with respondents' close proximity to towns such as Giyani and Tzaneen, where commercialised beverages are conveniently sold in modern restaurents and supermarkets.

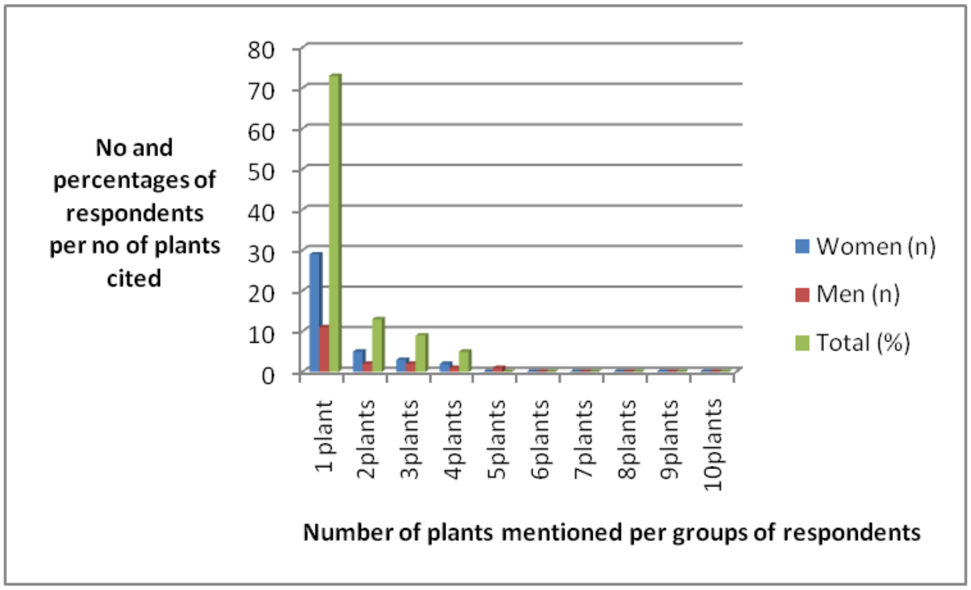



Figure 4.9: Number and percentages of plants mentioned by respondents in the study area.

### 4.3.3 Diversity of beverage-making plant species

The ethnobotanical survey conducted in this study area documented 36 different plants, including two wild species which could not be found in their natural habitats due to increasing scarcity in the surrounding ecosystems as a result of mounting anthropogenic impacts and environmental change. Those listed in Table 4.3 were identified in the wild. Of these species, 35% are shrubs while trees and climbers contributed 59% and 6%, respectively. The major plant families represented were Tiliaceae and Rhamnaceae, which accounted for 12% and 9% of the species collected, respectively. In contrast, families such as Apocynaceae, Ebenaceae, Flacourticeae and Olacaceae featured less as they individually contributed only 6% each. In addition, 44% of the plants listed in Table 4.3 have some ethnomedicinal significance.

Table 4.3: The beverage-making plant species* identified in the Tsonga-speaking (Mopani District) study area of the Limpopo province.

| Vernacular name | English common name | Confirmed* name | Family | Plant type |
|---|---|---|---|---|
| Nkanyi | Baobab | *Adansonia digitata* | Bombacaceae | Tree |
| Mhlonyana | Bush tea/ Zulu tea | *Arthrixia phylicoides* | Astereaceae | Shrub |
| Ntinta | Large hook-berry | *Artabotrys brachypetalus* | Annonaceae | Tree |
| Nyiri | Brown ivory | *Berchemia discolor* | Rhamnaceae | Tree |
| Nyirani | Red ivory | *Berchemia zeyheri* | Rhamnaceae | Tree |
| Nchuguru | Climbing num num | *Carissa edulis* | Apocynaceae | Shrub |
| Khalavatla | Wild watermelon | *Citrillus lanatus* | Cucurbitaceae | Shrub |
| Ntoma | Jackal berry | *Diospyros mespiliformis* | Dipterocarpaceae | Tree |
| Nvisangani | Kei apple | *Doyvalis caffra* | Flacourtiaceae | Tree |
| Nvisangani | Wild apricot | *Doyvalis zeyheri* | Flacourticeae | Tree |
| Mpongwane | Puzzle bush | *Ehretia rigida* | Boraginaceae | Shrub |
| Nhlangula | Magic quarry | *Euclea crispa* | Ebenaceae | Tree |
| Nhlangula | Magic quarry | *Euclea divinorum* | Ebenaceae | Tree |
| Makwa | Wild fig | *Ficus thonningii.* | Moraceae | Tree |
| Mihimbi | African mangosteen | *Garcinia livingstonei* | Clusiaceae | Tree |
| Nsihani | Sand paper raisin | *Grewia flavescens* | Tiliaceae | Shrub |
| Nsihani | Velvet raisin | *Grewia flava* | Tiliaceae | Shrub |
| Nsihani | Grey raisin | *Grewia monticola* | Tiliaceae | Shrub |
| Nsihani | Large-leaved raisin | *Grewia inequilateria* | Tiliaceae | Shrub |
| Mahodinga | Shakama plum | *Hexalobus monopetalus* | Annonaceae | Shrub |
| Mavungwa | Sand apricot vine | *Landolphia kirkii* | Apocynaceae | Climber |
| Xidzingulani | Jacket plum | *Pappea capensis* | Sapindaceae | Tree |
| Mbulwa | Mobola plum | *Parinari curatellifolia* | Chrysobalanaceae | Tree |
| Ncindzu | Wild date palm | *Phoenix reclinata* | Arecaceae | Tree |
| Mbhezani | Common forest grape | *Rhoicissus tomentosa* | Vitaceae | Climber |
| Chochela mandleni | Weeping boer-bean | *Schotia brachypetala* | Caesalpiniaceae | Shrub |
| Nkanyi | Marula | *Sclerocarya birrea* | Anacardiaceae | Tree |
| Nkwakwa | Corky monkey orange | *Strychnos cocculoides* | Loganiaceae | Tree |
| Nkwakwa | Black monkey orange | *Strych. madagascariensis* | Loganiaceae | Tree |
| Nkuhlu | Natal mahogany | *Trichilia emetica* | Meliaceae | Tree |
| Ntswila | Wild medlar | *Vanguira infausta* | Rubiaceae | Tree |
| Ntsengele | Blue sourplum | *Ximenia americana* | Olacaceae | Shrub |
| Ntsengele | Large sourplum | *Ximenia caffra* | Olacaceae | Shrub |
| Nceseni | Buffalo thorn | *Ziziphus mucronata* | Rhamnaceae | Tree |

*The common names and Latin names of these species (34) were verified and confirmed by taxonomists at SANBI.

Some interspecies variations occurred, particularly amongst the genera *Berchemia (Berchemia discolor; B. zeyheri); Doyvalis (Doyvalis caffra; D. zeyheri*) and *Euclea* (*Euclea crispa; E. divinorum*). However, the largest interspecies variation was noted amongst *Grewia* species, which were represented by *Grewia flava, G. flavescens, G. inequilateria* and *G. monticola*.

#### 4.3.3.1 Local uses and frequencies associated with individual plant species

Apart from direct consumption by locals, the fruits of some of the species collected in the wild are utilised for the traditional production of different types of drinks. Whereas the berries of the velvet raisin bush (*Grewia flava*) are used for brewing beer by other traditional groups (Van Wyk and Gericke, 2003), the Tsonga-speaking respondents mentioned how a unique ethno-medicinal tea can be made from the raisins of *Grewia inequilateria*. Judging from the information provided, it appears this traditional "fruit" tea was once very popular although this practice has declined considerably due to the adoption of modern lifestyles and the successful commercialisation of conventional tea derived from the Chinese tea plant, *Camellia sinensis*. Furthermore, the traditional tea-making plants amongst the Tsonga-speaking respondents included bush tea (*Athrixia phylicoides*) and the weeping boer-bean (*Schotia brachypetala*). Although the leaves, twigs as well as the flowers of *Athrixia phylicoides* are boiled in water to brew traditional tea, with respect to the traditional use of the weeping boer bean, large amounts of bark are stripped away for the same purpose.

An analysis of the number of citations per plant species revealed that in respect of indigenous tea-producing plants, only two of them are of ethnobotanical significance in this study area. These plants were the bush tea (*Athrixia phylicoides*) and the large-leaved yellow raisin (*Grewia inquilateria*), each with a frequency of 4. Figure 4.10 illustrates the number of times respondents mentioned fruit-bearing indigenous plant species.

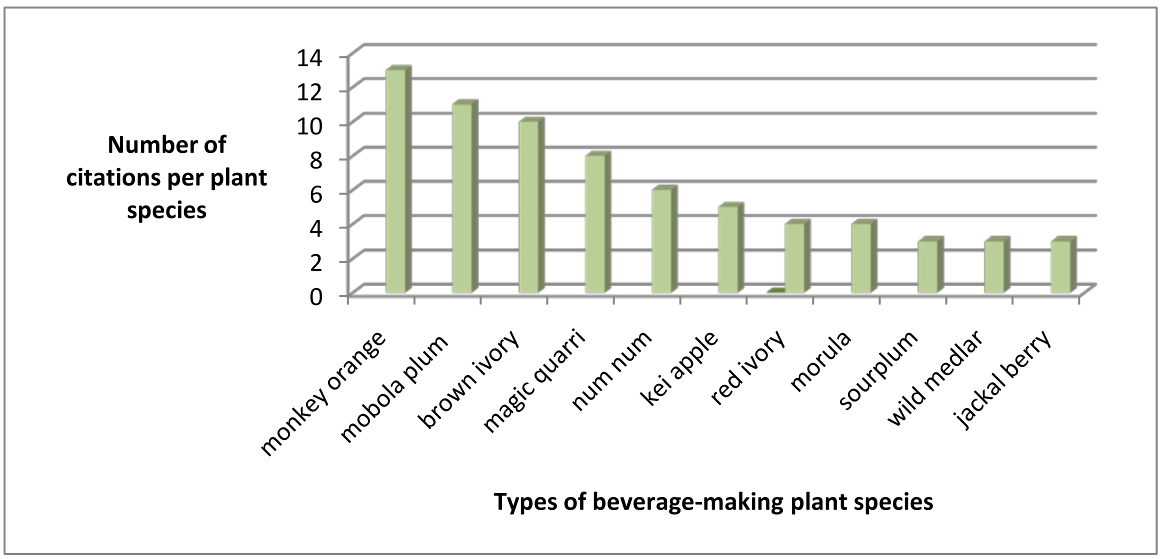



Figure 4.10: Number of citations per plant species (frequencies) associated with the different plant species in the Tsonga-speaking study area.

The corky monkey orange (*Strychnos cocculoides*) species appeared to be the most frequently cited indigenous plant for brewing non-alcoholic fruit juices and alcoholic beverages. This species was mentioned by 13 respondents. This relatively higher frequency may be attributed to its widespread distribution, pleasant taste, bigger size of the fruit and greater interspecies variation (notably *Strychnos cocculoides; S. pungens* and *S. spinosa*). After the monkey orange, in descending order, the most well-known species in this study area, included the mobola plum (*Parinari curatellifolia*) (11), brown ivory (*Berchemia discolor*) (10), magic quarri (*Euclea crispa)* (8) and the climbing num-num (*Carissa edulis)* (6). Species with relatively lower number of citations were the sourplum (*Ximenia caffra*), wild medlar (*Vanguira infausta*) and the jackal berry (*Diospyros mespiliformis*)*,* as shown in Figure 4.10.

4.3.3.2 The seasonal availability of plant species and harvesting patterns

The seasonal availability of the indigenous fruits identified in the Tsonga-speaking study areas is summarised in Table 4.4. Based on Table 4.4, there are 31 different indigenous species exist whose fruits may be harvested by locals.

Table 4.4: Beverage-making fruits[1] and their seasons of availability in the Tsonga-speaking study area.

| English common name | Confirmed* species name | Winter | Spring | Summer | Autumn |
|---|---|---|---|---|---|
| Baobab | *Adansonia digitata* | | ■ | ■ | |
| Large hook-berry | *Artabotrys brachypetalus* | | | ■ | ■ |
| Brown ivory | *Berchemia discolor* | | ■ | ■ | |
| Red ivory | *Berchemia zeyheri* | | ■ | ■ | |
| Spined num num | *Carissa edulis* | | ■ | ■ | |
| Wild watermelon | *Citrillus lanatus* | ■ | | | |
| Jackal berry | *Diospyros mespiliformis* | | ■ | | |
| Kei apple | *Doyvalis caffra* | | | ■ | |
| Wild apricot | *Doyvalis zeyheri* | | ■ | | |
| Puzzle bush | *Ehretia rigida* | | ■ | ■ | |
| Magic quarri | *Euclea crispa* | | ■ | ■ | |
| Blue quarri | *Euclea divinorum* | ■ | | ■ | |
| Wild fig | *Ficus thonningii* | ■ | ■ | ■ | ■ |
| African mangosteen | *Garcinia livingstonei* | | ■ | | |
| Sand paper raisin | *Grewia flavescens* | | | ■ | ■ |
| Velvet raisin | *Grewia flava* | | ■ | ■ | |
| Silver raisin | *Grewia monticola* | | ■ | ■ | |
| Large-leaved raisin | *Grewia inequilateria* | ■ | | ■ | ■ |
| Shakama plum | *Hexalobus monopetalus* | | | ■ | ■ |
| Sand apricot vine | *Landolphia kirkii* | | | ■ | |
| Jacket plum | *Pappea capensis* | | | ■ | ■ |
| Mobola plum | *Parinari curatellifolia* | | ■ | ■ | |
| Forest grape | *Rhoicissus tomentosa* | | ■ | ■ | |
| Marula | *Sclerocarya birrea* | | | ■ | |
| Corky monkey orange | *Strychnos cocculoides* | | ■ | | |
| Black monkey orange | *Strychnos madagascariensis* | | ■ | | |
| Natal mahogany | *Trichilia emetica* | | ■ | | |
| Wild medlar | *Vanguira infausta* | | ■ | | |
| Blue sourplum | *Ximenia americana* | | ■ | | |
| Large sourplum | *Ximenia caffra* | | ■ | | |
| Buffalo thorn | *Ziziphus mucronata* | | | ■ | |

[1] The number of fruits compared is 31. The shaded zones denote the time when ripe fruits are available for harvesting.

*Confirmed and verified by trained taxonomists at the South African Institute of Biodiversity (SANBI).

The winter season (May, June and July) has three (only 10% of the total available) wild fruit types which typically ripen during this period. These fruits are the wild watermelon (*Citrillus lanatus*), magic quarri (*Euclea divinorum*) and the large-leaved yellow raisin (*Grewia inequilateria*). When temperature begins to increase in spring (August, September and October), 61% of the wild fruits (Table 4.4) ripen and are ready to be harvested. This trend continues during the summer months (November, December and January) with rising humidity, when 68% of wild fruits are ready for harvesting. By contrast, seven wild fruits ripen during autumn months, constituting only 23% of the wild species collected during the survey (Table 4.4). The fruits of the wild fig (*Ficus thonningii*) are available in all seasons across the Tsonga-speaking areas surveyed.

The overall pattern observed is that most indigenous fruits occurring in this study area are harvested mainly during spring and summer months. In addition, the proportion of fruits harvested during these two seasons is nearly equal – with spring fruits and summer fruits constituting 65% and 68% of the total, respectively. The remainder of collected fruits in the Tsonga-speaking areas are harvested in winter (13%) and autumn (16%). However, of the 31 indigenous fruit types specified in Table 4.4, 13 of them can be harvested in two consecutive seasons, lasting for a period of 5 to 6 months. The proportion of fruits classified in this category is approximately 42%.

All the indigenous fruit species cited by respondents thus far may be harvested by any member of the rural communities surveyed as there are no restrictions in this study area, except for those growing on private lands. Generally, the fruits are harvested by the locals who undertake trips in the surrounding woodlands to obtain other ecosystem goods, although there are some constraints regarding quantities harvested.

#### 4.3.3.3 Some harvesting constraints

Many of the fruits harvested by locals are also preferred by wild animals such as monkeys, baboons and birds. Figure 4.10 indicates some of the damaged fruits found on the ground below the water berry (*Syzigium cumini*) tree canopy. These fruits have fallen down on the ground due to the damage caused by wild birds. Besides competition with wildlife, some of the fruits may be damaged by maggots or infested with different types of mould, thus affecting the quantity and quality of the harvest.

Figure 4.11:  Damaged fruits (*Syzigium cumini*) on the grass, after falling from the tree.

Other constraints relate to the morphological and structural aspects of the plants and fruits being harvested.  For instance, the harvesting of extremely small fruits such as those of the sand paper raisin (*Grewia flavescens*) is extremely labour-intensive and requires considerable time and patience on the part of the locals.  *Grewia flavescens* is a multi-stemmed shrub with berries (Figure 4.12) that are often inaccessible by hand picking.  Apart from the inaccessibility of the berries, the plant itself is usually closely located to plants such as those which bear spikes or thorns (Figure 4.13).  This problem is illustrated in Figure 4.12.  According to respondents interviewed in this study area, failure to reach the berries by hand is often resolved by cutting off their branches and carrying them home in order to lessen harvesting time.

Figure 4.12: Ripe berries on a multi-stemmed sand paper raisin (*Grewia flavescens*) shrub.

Figure 4.13: Several sand paper raisin (*Grewia flavescens)* shrubs occurring in close proximity to a thorn (appearing in white colour to the right) bearing *Acacia* spp.

Apart from fruit-bearing species, other plants harvested for the traditional production of beverages involve species such as the bush tea (*Athrixia phylicoides*). As in the Wolkberg mountains of the Limpopo province (Rampedi and Olivier, 2005), harvesting constraints may arise when the whole plant is uprooted for the purpose of making traditional brooms. Another aspect of unsustainable harvesting pertains to the traditional use of the weeping boer-bean (*Schotia brachypetala*) plant, whose bark is stripped away by locals if the goal is to brew medicinal tea.

## 4.4 INDIGENOUS KNOWLEDGE ON BEVERAGE-MAKING PLANTS IN THE NORTH SOTHO-SPEAKING REGION

### 4.4.1 Profiles of respondent's in selected rural communities

The total number of respondents interviewed was 31, comprising nearly equal proportions of men (52%) and women (48%). Figure 4.14 depicts the number of respondents based on age and gender. There were no respondents in the 20-29 age category whilst respondents in the 30-39 and 40-49 categories amounted to 13% and 16%, respectively. The majority of the respondents were in the 50-59 age category as they constituted 29% of the entire sample. The latter class was followed in descending order by the 60-69 and 70-79 age categories, at 23% and 19%, respectively. Even though no marked differences existed in terms of gender proportions in this sample, Figure 4.14 shows that the number of women respondents exceeded that of their male counterparts in three of the age classes represented.

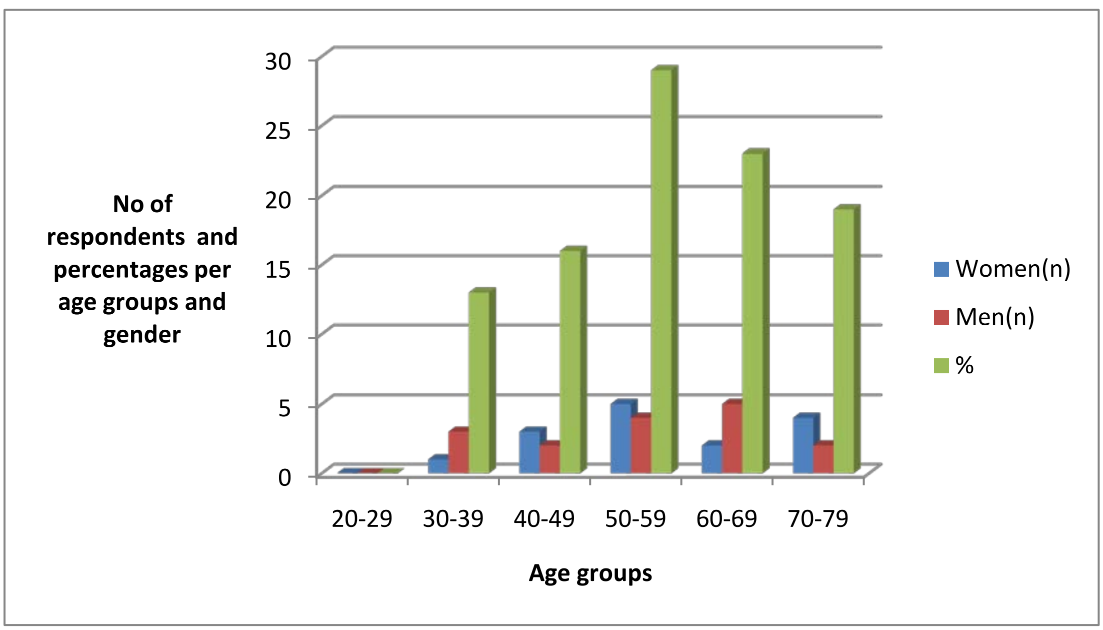



Figure 4.14: Number and percentages of respondents per age group and gender.

Regarding occupations, 35% of respondents were in the pension-earning category whilst 30% were unemployed. Those involved in semi-skilled occupations such as farm labour, shoe-repairs and auto-repairs amounted to 28%. The proportion of respondents involved in informal micro-enterprises such as home-based informal stores *(spazas)* and the selling of live chickens, food and beverages was 7%.

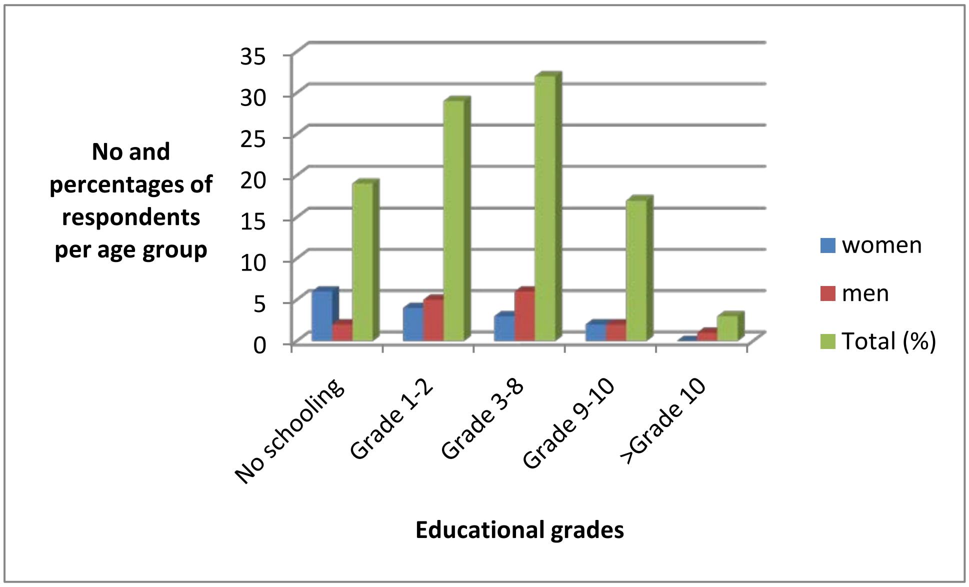



Figure 4.15: Educational profile of respondents in the North-Sotho speaking areas.

The respondent's educational profiles are illustrated in Figure 4.15. Nineteen percent of respondents have received no formal schooling whilst 29% have received Grades 1 to 2 education. The proportion of respondents who completed Grades 3 to 8 was 32%. Only few respondents had completed Grades (9-10) and >Grade 10. For the North-Sotho speaking areas, the proportions of the latter classes were 17% and 3%, respectively. In terms of language usage, 87% of respondents communicated fluently in North-Sotho. However, only a small proportion (3%) could speak other African languages such as Venda or Tsonga with the exception of the Ndebele language (13%). Furthermore, over 90% of respondents have lived in this region for over 40 years.

### 4.4.2 Indigenous knowledge of beverage-making plants

Respondents in this region stated that they acquired knowledge of beverage-making plants from their parents and grandparents as they have depended on edible wild plants for meeting some of their livelihood needs. Figure 4.16 indicates the number of beverage-making plants mentioned by the various respondents interviewed and the actual proportions represented for each category.

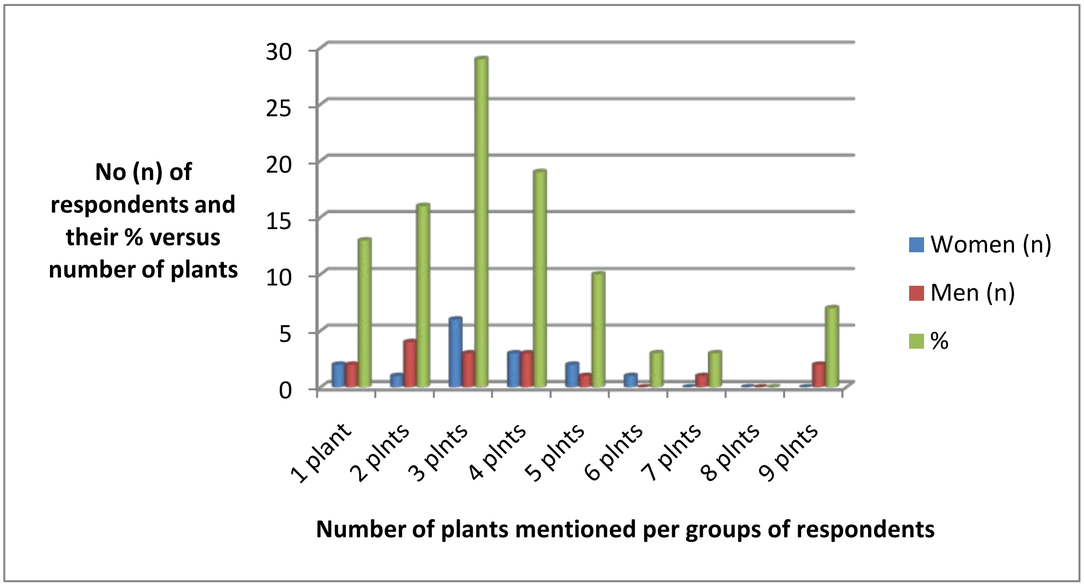



Figure 4.16: Number and percentages of plants mentioned by respondents in the North-Sotho speaking areas.

On average, each respondent was able to list at least three different indigenous plants. Figure 4.16 shows that such respondents comprised 29% of the sample. Other proportions are also reflected in Figure 4.16. Nineteen per cent of respondents were able to list four different beverage-making plant species. However, only three respondents, who constituted 10% of this sample, cited five different beverage-making plants while the respondents who mentioned seven or nine different plants represented only 3% or 7% of the sample, respectively. The latter percentages may be attributed to lesser diversity of plant species mainly due to the semi-arid climate and restricted rainfall ssociated with the study area.

### 4.4.3 Diversity of beverage-making plant species

In the North-Sotho speaking areas, respondents cited 29 different beverage-making plants during the surveys. However, during fieldwork it was possible to collect only 27 of these plants in the wild since others have become increasingly scarce due to anthropogenic impacts and environmental change. The collected species, grouped in 17 different plant families, are listed in Table 4.5. In terms of growth form, 50% of species (Table 4.5) are classified as shrubs while trees constituted 46%. Climbers comprised 4% of the species collected in this study area. The plant family most represented was Tiliaceae, as it constituted 15% of all species collected during the survey. This family was followed by Anacardiaceae, Euphorbiaceae, Loganiaceae, Olacaceae and Sapotaceae, each representing about 8%. Some of the plants collected were found to be non-native, particularly the sweet prickly pear (*Opuntia ficus indica*) and lemon grass (*Cymbopogon nardus*). Table 4.5 also shows that there are 22 different genera represented, the most common ones being *Grewia, Strychnos* and *Ximenia*. However, the degree of interspecies variation observed was greatest in the genus *Grewia* (Table 4.5).

Table 4.5: Beverage-making plant species collected and identified in the North-Sotho speaking study area of the Limpopo province.

| Vernacular name | Common name | Confirmed* species name | Family | Plant type |
|---|---|---|---|---|
| Mohlahlaila | Bush tea | *Arthrixia phylicoides* | Astereaceae | Shrub |
| Mohlopi | Sherperd's tree | *Boscia albitrunca* | Capparaceae | Tree |
| Moswane | Velvet sweetberry | *Bridelia mollis* | Euphorbiaceae | Shrub |
| Teye ya naga | Lemon grass | *Cymbopogon nardus* | Poaceae | Shrub |
| Mahlatswa | Stem fruit | *E.magalismontanum*** | Sapotaceae | Tree |
| Tee ya naga | Bushmans tea | *Catha transvaalensis* | Celastraceae | Tree |
| Mogodiri | Dune myrtle | *Euclea natalensis* | Ebenaceae | Shrub |
| Mohlakaume | White-berry bush | *Flueggia virosa* | Euphorbiaceae | Shrub |
| Mogwane | Yellow raisin | *Grewia inequilateria* | Tiliaceae | Shrub |
| Mogwane | White raisin | *Grewia bicolor* | Tiliaceae | Shrub |
| Mogwane | Velvet raisin | *Grewia flava* | Tiliaceae | Shrub |
| Mopharolatshwene | Sand paper raisin | *Grewia flavescens* | Tiliaceae | Shrub |
| Morotodi | Live-long | *Lannea discolor* | Anacardiaceae | Tree |
| Musunkwane | Fever tea | *Lippia javanica* | Verbanaceae | Shrub |
| Mmupudu | Red milkwood | *Mimusops zeyheri* | Sapotaceae | Tree |
| Teye ya naga | Wild tea | *Monsonia angustifolia* | Geraniaceae | Shrub |
| Torofeiye | Prickly pear | *Opuntia ficus indica* | Cactaceae | Shrub |
| Dipola | Mobola plum | *Parinari curatellifolia* | Chrysobalanacea | Tree |
| Terebe | Forest grape | *Rhoicissus tomentosa* | Vitaceae | Climber |
| Mosohlo | Mountain karee | *Rhus lancea* | Anacardiaceae | Tree |
| Morula | Marula | *Sclerocarya birrea* | Anacardiaceae | Tree |
| Morelerele | Monkey orange | *Strychnos cocculoides* | Loganiaceae | Tree |
| Magogwane | Monkey orange | *Strychnos pungens* | Loganiaceae | Tree |
| Mabilo | Wild medlar | *Vanguira infausta* | Rubiaceae | Tree |
| Dichidi | Blue sourplum | *Ximenia americana* | Olacaceae | Shrub |
| Dichidi | Large sourplum | *Ximenia caffra* | Olacaceae | Shrub |
| Mokgalo | Buffalo thorn | *Ziziphus mucronata* | Rhamnaceae | Tree |

*These plant species (27 in number) were verified and confirmed by trained taxonomists at SANBI.
***Englerophytum magalismontanum.*

4.4.3.1 Local uses of plant species

Amongst the plant species specified in Table 4.5, five of them (19%) (i.e. *Athrixia phylicoides; Lannea discolor; Lippia javanica*; *Monsonia angustifolia* and *Sclerocarya birrea*) have local ethnomedicinal importance. It has been observed that North-Sotho speaking respondents use at least two different vernacular names to distinguish between certain *Grewia* species. On the one hand, the traditional name "*mopharolatshwene"* is reserved for the sand paper raisin (*Grewia flavescens*) species. According to the respondents interviewed, this indigenous name (*mopharolatshwene)* derives from the direct relationship between excessive consumption of sand paper raisins and colon-related stiffness, usually accompanied by the release of extremely dry and hard stools. Consequently, the berries of the sand paper raisin bush should not be consumed in large quantities, although the fruit pulp has a pleasantly crunchy texture in the mouth and a very sweet taste. On the other hand, the vernacular name "*mowane"* is restricted predominantly to the *Grewia flava* species but also to related species such as *G. inequilateria* and *G. bicolor* whose consumption is not linked to any colon-related discomfort. Similarly, local distinction is also drawn between *Strychnos cocculoides* (corky monkey orange) and *S. pungens (*spine-leaved monkey orange*)* species. Hence, the native name "*morelerele"* is traditionally assigned for the corky monkey orange, mainly because it has the most delicious fruit pulp compared with related species in the same genus. Furthermore, when the fruit pulp is in the mouth, the pips of the fruit are very slippery and, therefore, care must be exercised as they should not be swallowed because they are feared to be poisonous. The local name "*magogwane"* is reserved for the spine-leaved monkey orange (*S. pungens*) species whose ripe fruit-pulp is distinctively yellow in colour and not as sweet-tasting as the corky monkey orange species (*S. cocculoides*). Similarly, the pips of these fruit species are not to be swallowed.

A variety of fruit juices and alcoholic beverages can be produced from these fruits. The North-Sotho-speaking respondents do not brew traditional tea from the berries of *Grewia* species. The only traditional use reserved for these berries is food and alcoholic beverages. In addition, certain fruits in the North-Sotho region may be combined with other ingredients to produce refreshing foodstuffs. For instance, the fruit pulp of the wild medlar (*Vanguira infausta*) may be mixed with ordinary milk to make a traditional yoghurt-like drink. The milk is added because the fruit pulp of the wild medlar is extremely dry. The traditional yoghurt-like drink brewed from the fruits of the wild medlar is popular amongst men who herd livestock in the wild because they sometimes find themselves in areas that are remote from their homes, thus compelling them to prepare alternative foodstuffs.

#### 4.4.3.2 Frequencies associated with individual plant species

The most cited plant species for the traditional brewing of teas in the North-Sotho speaking study area were found to be bush tea (*Athrixia phylicoides*) and fever tea (*Lippia javanica*) species. Bush tea was mentioned by five respondents while fever tea was cited by three respondents. The leaves and twigs of these plants may be boiled in water as a decoction, and then served as medicinal tea. In addition to these tea-making plants, species such as Sekhukhune Bushman's tea *(Catha transvaalensis*), lemon tea (*Cymbopogon nardus)* and another wild tea (*Monsonia angustifolia*) are utilised to brew medicinal teas but due to increasing scarcity they are no longer utilised to any greater extent.

Figure 4.17 indicates the various frequencies (number of citations) (of at least >2) associated with the number of respondents who mentioned each fruit-bearing species in this study area. The corky monkey orange (*Strychnos cocculoides)* with a frequency of 12, appears to be the most important fruit-juice making plant in the study area. This tendency may be attributed to the large size of the fruits as well as their pleasant taste and the fact that it is possible to harvest and store them early in the season before their natural ripening. In addition, the fruits of the corky monkey orange can also be used for the production of traditional beer as well as distilled spirits. Other uses of the fruits involve the production of a sweet jam. The next most important species amongst North-Sotho respondents were the sand paper raisin (*Grewia flavescens*) and the stem fruit (*Englerophytum magalismontanum*). The sand paper raisin was cited by nine respondents while the stem fruit was mentioned by ten respondents. The latter plants were followed in descending order by species such as the large sourplum (*Ximenia caffra*), marula (*Sclerocarya birrea*), (Transvaal) red milkwood (*Mimusops zeyheri*) and the buffalo thorn (*Ziziphus mucronata*) with response frequencies of 8, 7, 7 and 5, respectively.

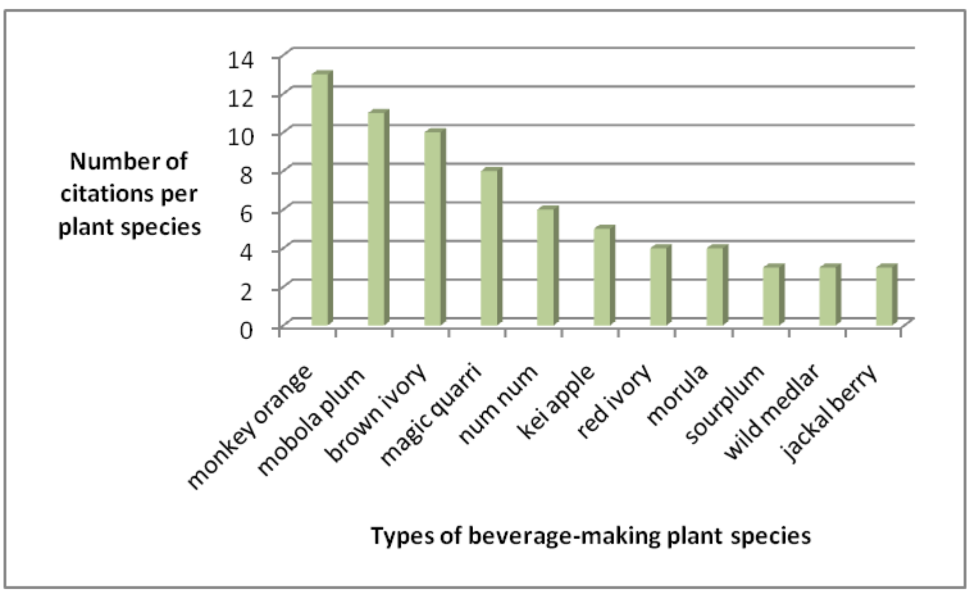



Figure 4.17: Number of citations per plant species (frequencies) associated with the different plant species in the North-Sotho-speaking study area.

#### 4.4.3.3 The seasonal availability of plant species and their harvesting

The seasonal availability of fruits derived from the different plant species identified in the North-Sotho-speaking areas is summarised in Table 4.6. The number of species which can be harvested in this study area is 23, as shown in Table 4.6. Of these fruit species, only 17% and 13% can be harvested during the winter (May-July) and autumn (Feb-April) seasons, respectively. However, the onset of spring months (August, September and October) heralds the ripening and harvesting of about 17 different fruit types (Table 4.6). This means that approximately 74% of the fruits in Table 4.6 can be harvested during the months of spring. However, this proportion of ripening fruits declines during the summer months to about 50%.

Table 4.6: Beverage-producing fruits[1] and their seasons of availability in the North-Sotho-speaking study area of the Limpopo province.

| Common name | Confirmed* species name | Winter | Spring | Summer | Autumn |
|---|---|---|---|---|---|
| Sherperd's tree | *Boscia albitrunca* | | ■ | | |
| Velvet sweetberry | *Bridelia mollis* | | | ■ | |
| Stem fruit | *E.magalismontanum*** | ■ | ■ | | |
| Kei apple | *Doyvalis cafra* | | | ■ | |
| Natal quarry | *Euclea natalensis* | | ■ | ■ | |
| Wild fig | *Ficus thonningii* | ■ | ■ | ■ | ■ |
| Large-leaved raisin | *Grewia inequilateria* | ■ | | ■ | ■ |
| White raisin | *Grewia bicolor* | | ■ | ■ | |
| Velvet raisin | *Grewia flava* | | ■ | ■ | |
| Sand paper raisin | *Grewia flavescens* | | | ■ | ■ |
| Live-long | *Lannea discolor* | | ■ | | |
| Red milkwood | *Mimusops zeyheri* | | ■ | ■ | |
| Sweet prickly pear | *Opuntia ficus indica* | | ■ | | |
| Mobola plum | *Parinari curatellifolia* | | ■ | | |
| Forest grape | *Rhoicissus tomentosa* | | ■ | ■ | |
| Mountain karee | *Rhus lancea* | ■ | ■ | | |
| Marula | *Sclerocarya birrea* | | | ■ | |
| Corkey monkey orange | *Strychnos cocculoides* | | ■ | | |
| Spined monkey orange | *Strychnos pungens* | | ■ | | |
| Wild medlar | *Vanguira infausta* | | ■ | | |
| Blue sourplum | *Ximenia americana* | | ■ | | |
| Large sourplum | *Ximenia caffra* | | ■ | | |
| Buffalo thorn | *Ziziphus mucronata* | | | ■ | |

[1] The number of fruits compared is 23. The shaded zones denote the time when ripe fruits are available for harvesting. *Confirmed and verified by trained taxonomists at the South African Institute of Biodiversity (SANBI).
** *Englerophytum magalismontanum.*

#### 4.4.3.4 Harvesting constraints

The respondents interviewed mentioned some constraints regarding the harvesting of sought-after wild fruits. The most important constraints involved the smaller populations of sought-after species as well as the structural damage caused by pests and wildlife. In addition, fruit species such as the velvet sweetberry (*Bridelia mollis*), Kei apple (*Doyvalis caffra*), mobola plum (*Parinari curatellifolia*), marula (*Sclerocarya birrea*), corky monkey orange (*Strychnos cocculoides*), spined monkey orange (*Strychnos pungens*), sourplums (*Ximenia americana* and

*X. caffra*) and the buffalo thorn (*Ziziphus mucronata*) have a very restricted harvesting period, lasting only three to four months during the year. Furthermore, species such as *Englerophytum magalismontanum, Euclea natalensis, Grewia inequilateria, Mimusops zeyheri*, *Rhoicissus tomentosa* and *Rhus lancea* can be harvested for about five to six months while most *Ficus* species bear fruits throughout the year.

## 4.5 SUMMARY OF RESEARCH FINDINGS

### 4.5.1 Respondents' profile

The biographical profiles of respondents in the different study areas surveyed have been discussed in the various sections outlined above. Although the groups of respondents in the different areas were not similar in terms of sample size, ethnicity and the number of villages surveyed, pertinent patterns for each study area have been highlighted. The Venda region exhibited the highest number (79) of respondents, followed by the Tsonga-speaking and North-Sotho-speaking regions, with 55 and 31 respondents, respectively. It is not surprising that the greatest proportion (48%) of respondents were encountered in the Venda region, because that is where pilot studies for the research project were conducted. In addition, the local biodiversity is exceptionally rich with plant species, coupled with the fact that most Venda people in the Limpopo province have retained much of their cultural and traditional background, unlike other ethnic groups in South Africa (L'abbe *et al*., 2008).

When the data on the age and gender characteristics of all respondents interviewed for the whole study is taken into account (Figure 4.18), it can be deduced that the general trends emerging are not markedly different from those observed earlier in the specific study areas. For instance, the majority of respondents were in the 50-59 and 60-69 age ranges and represented 26% and 33% of the total number of respondents who participated in the whole study. Moreover, these categories collectively constitute approximately 60% of all respondents interviewed. Another important category of respondents belonged to the 70-79 age class. These three classes (i.e. 50-59; 60-69 and 70-79) were the most important in terms of the overall knowledge of beverage-making plants in any area surveyed for the current research. Similar findings have been observed in some of the ethnobotanical studies conducted, leading researchers such as Cavalli-Sforza and Feldman (1981, *cited* in Reyes-Garcia *et al.,* 2009); Dovie *et al.* (2008) and Reyes-Garcia *et al*. (2010) to maintain that the transmission and acquisition of local traditional knowledge, technology and language require a long-term process of cultural learning.

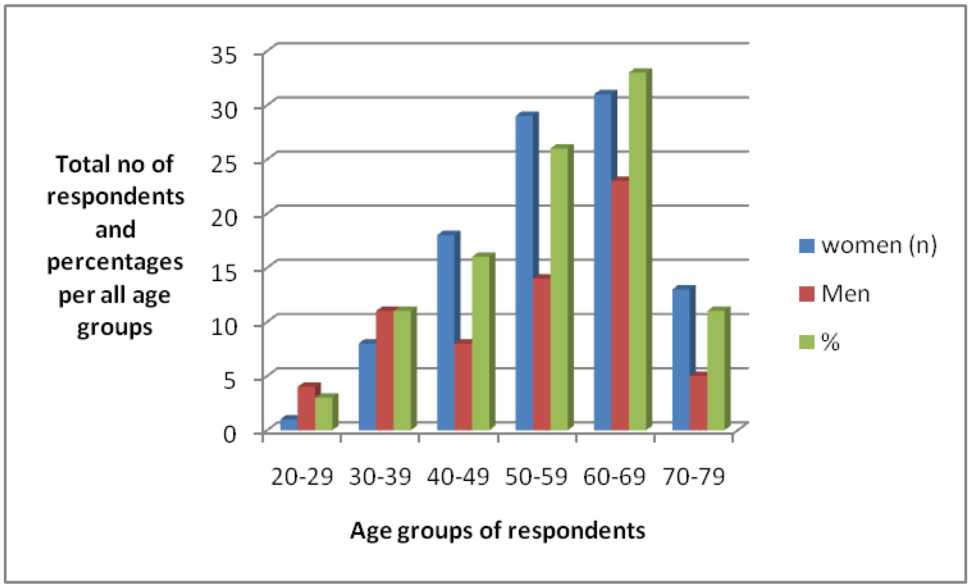



Figure 4.18: Summary of the age- and gender-related aspects of all respondents interviewed for the study.

Another dimension observed is that most snowball referrals (~60%) were directed to women respondents, suggesting the importance of their traditional role in the knowledge of valuable plant species, including the brewing methods of beverages being examined for the research. This point has been raised in many livelihoods studies, indicating that rural women in surveyed sites are not only an important source of knowledge on the use of wild food plants (Hudaib *et al*., 2008) but are also often responsible for the collection of wild edible plant species as well as their preparation prior to consumption as food (Frances and Mohammed, 2003; Shackleton, 2004).

In all areas surveyed, approximately 60% of all respondents were either pensioners or unemployed or a combination of both classes, leaving only a small fraction involved in the formal and informal employment sector. In addition, the educational profile of respondents in all areas surveyed displayed a common general trend (Figure 4.19), whereby the majority of individuals lacked both Grades 9 to 10 or a higher educational qualification. In fact, the proportions of individuals with Grades 9 to 10 or >Grade 10 for the whole study constituted only 16% and 6%, respectively.

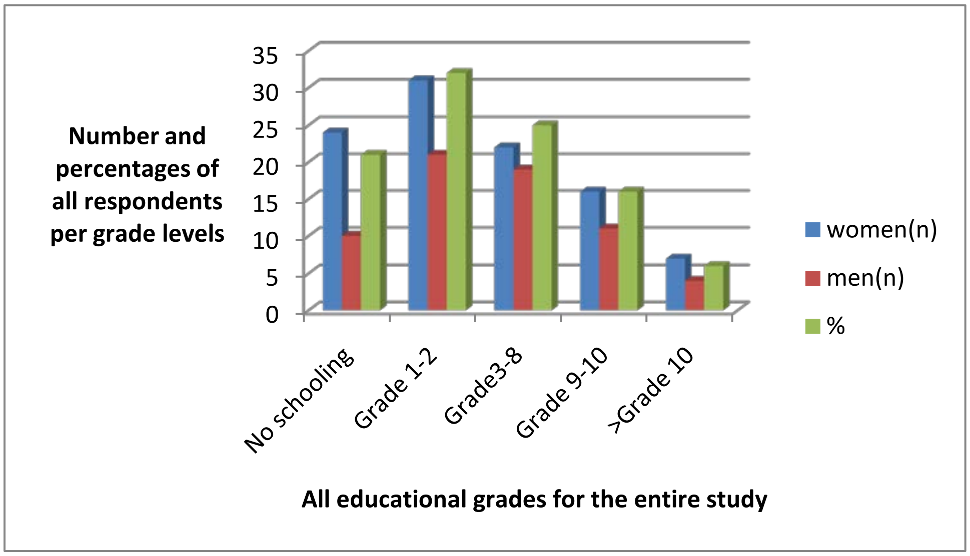



Figure 4.19: Generalised province-wide educational profile of all respondents interviewed for the study.

### 4.5.2 Knowledge of beverage-making plants in the different areas of the Limpopo province

Figure 4.20 indicates a generalised province-wide pattern depicting the maximum number of sought-after species cited per respondent during the survey. For the whole study, nearly 40% of all the respondents interviewed cited only 1 beverage-making plant species, followed by the class of respondents (20%) who mentioned 3 sought-after species. Based on Figure 4.20, it can be deduced that more than 50% of all respondents interviewed were not able to list more than 2 different sought-after plant species. By contrast, there were a few respondents who could cite more than 5 plant species, amounting to less than 10% of all respondents interviewed for the study.

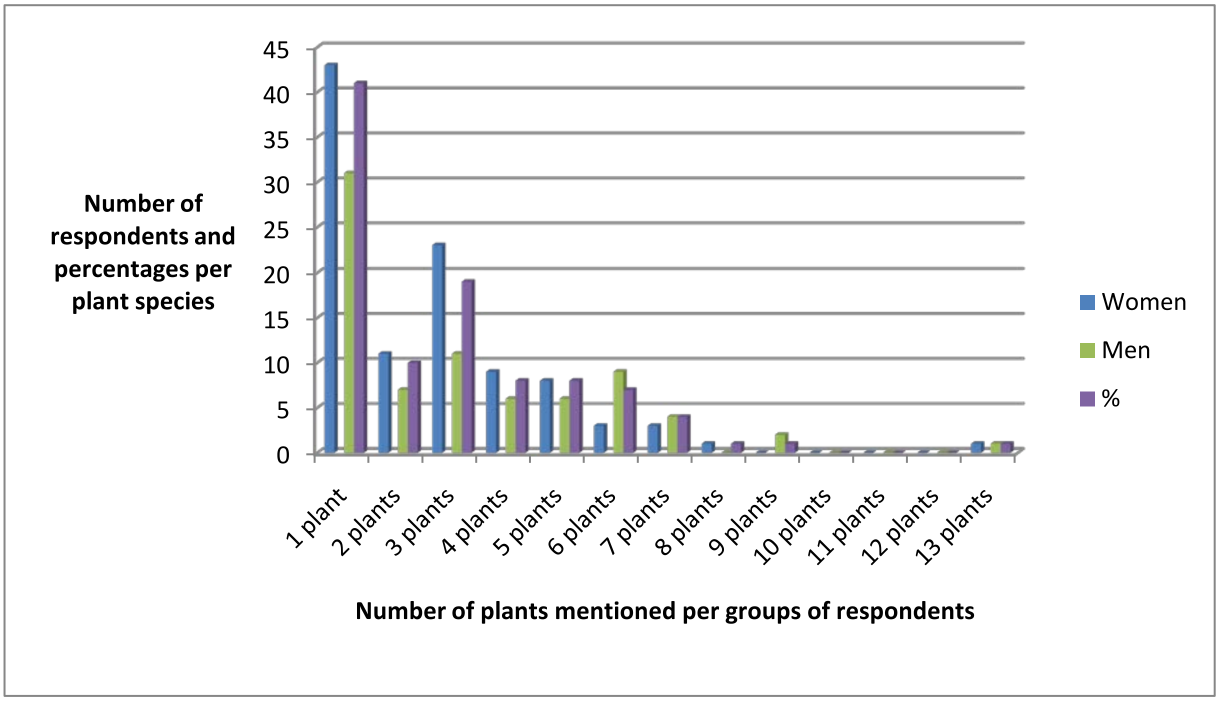



Figure 4.20: Total number and percentages of plants mentioned by respondents in all study areas surveyed.

Furthermore, although women comprised the majority of respondents interviewed, when all the data gathered for the survey is synthesised they were not always the most knowledgeable about beverage-making plant species. In some cases they were slightly overshadowed by male respondents, who mentioned relatively higher numbers of species. This trend is clearly illustrated in at least four classes of male respondents who mentioned as many as five plants, six plants, seven plants and nine plants (Figure 4.20), respectively.

Table 4.7 provides a complete inventory for all beverage-making plants indicated by the respondents during surveys and field trips around nearby woodlands in all study areas. In total, 63 plant species were collected and identified. These plant species belong to 36 different plant families, the most notable being Ebenaceae (8%), Tiliaceae (7%), Apocynaceae (7%), Annonaceae (5%) and Rhamnaceae (5%) as well as Anacardiaceae (5%). In addition, these plants are classified into 29 different genera, of which the most represented included *Grewia* (4 spp.), *Strychnos* (4 spp.), *Carissa* (3 spp.) and *Euclea* (3 spp.). It is also worth noting that over 80% of the plants included in Table 4.7 are fruit-bearing trees, shrubs and climbers known to the locals.

Table 4.7: A list of all plant species (63 in total) identified and collected in the study areas during surveys in the Limpopo province.

| Common name | Species name | Plant part used | Family | Plant type |
|---|---|---|---|---|
| Baobab | *Adansonia digitata* | Fruit | Bombacaceae | Tree |
| Bush tea | *Athrixia phylicoides* | Leaves, twigs | Asteraceae | Shrub |
| Wild custard apple | *Annona senegalensis* | Fruit | Annonaceae | Tree |
| Large hook-berry | *Artabotrys brachypetalus* | Fruit | Annonaceae | Tree |
| Brown ivory | *Berchemia discolor* | Fruit | Rhamnaceae | Tree |
| Red ivory | *Berchemia zeyheri* | Fruit | Rhamnaceae | Tree |
| Sherperd's tree | *Boscia albitrunca* | Roots | Capparaceae | Tree |
| Velvet sweetberry | *Bridelia mollis* | Fruit | Euphorbiaceae | Shrub |
| Forest num num | *Carissa bispinosa* | Fruit | Apocynaceae | Shrub |
| Spined num num | *Carissa edulis* | Fruit | Apocynaceae | Shrub |
| Sand forest num num | *Carissa tetramera* | Fruit | Apocynaceae | Shrub |
| Bushman's tea | *Catha edulis* | Fruit | Celestraceae | Tree |
| Sekhuhune bushman's tea | *Catha transvaalensis* | Leaves | Celastraceae | Tree |
| Mopane | *Colophospermum mopane* | Bark | Caesalpiniaceae | Tree |
| Lemon grass tea | *Cymbopogon citratus* | Leaves | Poaceae | Shrub |
| Lemon grass tea | *Cymbopogon nardus* | Leaves | Poaceae | Shrub |
| Wild watermelon | *Citrillus lanatus* | Fruit | Cucurbitaceae | Shrub |
| Blue bush | *Diospyros lycioides* | Fruit | Ebenaceae | Tree |
| Jackal berry | *Diospyros mespiliformis* | Fruit | Ebenaceae | Tree |
| Common wild pear | *Dombeya rotundifolia* | Leaves | Sterculiaceae | Tree |
| Kei apple | *Doyvalis caffra* | Fruit | Flacourtiaceae | Tree |
| Wild apricot | *Doyvalis zeyheri* | Fruit | Flacourtiaceae | Tree |
| Puzzle bush | *Ehretia rigida* | Fruit | Boraginaceae | Tree |
| Stem fruit | *E, magalismontanum** | Fruit | Sapotaceae | Tree |
| Magic quarry | *Euclea crispa* | Fruit | Ebenaceae | Tree |
| Blue quarry | *Euclea divinorum* | Fruit | Ebenaceae | Tree |
| Natal quarry | *Euclea natalensis* | Fruit | Ebenaceae | Shrub |
| Common wild fig | *Ficus thonningii* | Fruit | Moraceae | Tree |
| White-berry bush | *Flueggia virosa* | Fruit | Euphorbiaceae | Tree |
| African mangosteen | *Garcinia livingstonei* | Fruit | Clusiaceae | Tree |
| Sand paper raisin | *Grewia flavescens* | Fruit | Tiliaceae | Shrub |
| Velvet raisin | *Grewia flava* | Fruit | Tiliaceae | Shrub |
| Grey raisin | *Grewia monticola* | Fruit | Tiliaceae | Shrub |
| Large-leaved raisin | *Grewia inequilateria* | Fruit | Tiliaceae | Shrub |
| Shakama plum | *Hexalobus monopetalus* | Fruit | Annonaceae | Shrub |
| Lala palm | *Hyphaene coriacea* | Stem cell sap | Arecaceae | Tree |
| Thorny gardenia | *Hyperacanthus amoenus* | Fruit | Rubiaceae | Shrub |
| Sand apricot vine | *Landolphia kirkii* | Fruit | Apocynaceae | Climber |
| Live-long | *Lannea discolor* | Fruit | Anacardiaceae | Tree |
| Fever tea | *Lippia javanica* | Leaves | Verbanaceae | Shrub |
| Wild tea | *Monsonia angustifolia* | Leaves and twigs | Geraniaceae | Shrub |
| Red milkwood | *Mimusops zeyheri* | Fruit | Sapotaceae | Tree |
| Sweet prickly pear | *Opuntia ficus indica* | Fruit | Cactaceae | Shrub |
| Mobola plum | *Parinari curatellifolia* | Fruit | Chrysobalanaceae | Tree |
| Jacket plum | *Pappea capensis* | Fruit | Sapindaceae | Tree |
| Cape gooseberry | *Physalis peruviana* | Fruit | Solanaceae | Shrub |
| Wild date palm | *Phoenix reclinata* | Fruit | Arecaceae | Tree |
| Common forest grape | *Rhoicissus tomentosa* | Fruit | Vitaceae | Climber |
| Hard-leaved currant | *Rhus tumilicola* | Fruit | Anacardiaceae | Shrub |
| Wild bramble | *Rubus rigidus* | Fruit | Rosaceae | Shrub |
| Weeping boer-bean | *Schotia brachypetala* | Bark | Caesalpiniaceae | Tree |
| Corky monkey orange | *Strychnos cocculoides* | Fruit | Loganiaceae | Tree |
| Black monkey orange | *Strychnos madagascariensis* | fruit | Loganiaceae | Tree |
| Spine-leaved monkey orange | *Strychnos pungens* | Fruit | Loganiaceae | Tree |
| Green monkey orange | *Strychnos spinosa* | Fruit | Loganiaceae | Tree |
| Marula | *Sclerocarya birrea* | Fruit | Anacardiaceae | Tree |
| Water berry | *Syzigium cumini* | Fruit | Myrtaceae | Tree |
| Natal mahogany | *Trichilia emetica* | Fruit | Meliaceae | Tree |
| Wild medlar | *Vanguira infausta* | Fruit | Rubuiaceae | Tree |
| Blue sourplum | *Ximenia americana* | fruit | Olacaceae | Shrub |
| Large sourplum | *Ximenia caffra* | Fruit | Olacaceae | Shrub |
| Purple pod cluster leaf | *Terminalia prunioides* | Leaves and twigs | Combretaceae | Tree |
| Buffalo thorn | *Ziziphus mucronata* | Fruit | Rhamnaceae | Tree |

As mentioned earlier, the majority of these plants are of ethnobotanical importance in the traditional production of fruit-juices and alcoholic beverages. Four of the indigenous plant species (*Adansonia digitata, Boscia albitrunca, Catha edulis and Sclerocarya birrea*) listed in

Table 4.7, are featured in the Category of the 47 Protected Tree Species in South Africa (DWAF, 2007). This implies that these species are officially classified as some of the endangered plants in South Africa, which means their traditional uses and commercial exploitation should proceed with caution in order not to harm and deplete their natural populations.

Apart from the latter plants, some of the respondents have revealed that there are other plant species that are becoming scarcer in certain parts of the Limpopo province. These species include, for instance, the bush tea (*Athrixia phylicoides*) and Sekhukhune bushman's tea (*Catha transvaalensis*) and others which could not be accessed in their local ecological habitats. However, *Athrixia phylicoides* and *Catha transvaalensis* are not listed anywhere as endangered species, despite the fact that they are facing increasing anthropogenic pressure in some of their natural habitats. This finding suggests the important role that existing indigenous knowledge systems can play in local and regional plant biodiversity conservation as well as management.

In terms of differences between the regions surveyed, the Venda-speaking respondents have mentioned more plant species than any other ethnic group in this study. Venda-speaking respondents cited about 56 different plant species during the survey, greater than that of the other groups who mentioned only 36 (Tsonga-speaking group) and 29 (North-Sotho-speaking group) plant species, respectively. The higher degree of plant diversity cited in the Venda-speaking areas may be ascribed to a number of factors. First, the present survey attracted 79 respondents in Venda, higher than in the other two study areas. Second, Venda-speaking areas such as Tshixwadza, Sheshe, Mapuloni, Luheni (near Lake Fundudzi), Phadzima and Makonde are all located within the Afromontane mist belt of the bushveld biome of the Limpopo province, along the Soutpansberg mountain ranges. This particular bushveld biome is known to have exceptionally high plant species diversity. For instance, the Tree List of the Soutpansberg Mountain Range lists over 500 different indigenous species grouped in 98 plant families (ICONS, 2002). Although not all of these species are edible, this remarkable plant species diversity does not exist in the other two regions surveyed for the study due to unfavourable biophysical conditions such as the semi-arid nature of the prevailing climate and human-induced land degradation and environmental change.

Apart from fruit-bearing plant species featured in Table 4.7, plant parts such as leaves, twigs, flowers and bark of other plant species (~11) may be boiled in water and served as medicinal or herbal teas.

Table 4.8: Generalised overview of the seasonality of all fruit-bearing species in all of the areas surveyed.

| Common names | Latin names | Winter | Spring | Summer | Autumn |
|---|---|---|---|---|---|
| Baobab | *Adansonia digitata* | | ■ | ■ | |
| Wild custard apple | *Annona senegalensis* | | ■ | ■ | |
| Large hook-berry | *Artabotrys brachypetalus* | | ■ | | |
| Brown ivory | *Berchemia discolor* | | ■ | ■ | |
| Red ivory | *Berchemia zeyheri* | | ■ | ■ | |
| Sherperd's tree | *Boscia albitrunca* | | ■ | | |
| Velvet sweetberry | *Bridelia mollis* | | | ■ | |
| Forest num num | *Carissa bispinosa* | | ■ | ■ | |
| Spined num num | *Carissa edulis* | | ■ | ■ | |
| Sand forest num num | *Carissa tetramera* | | | ■ | |
| Wild watermelon | *Citrillus lanatus* | | | ■ | |
| Blue bush | *Diospyros lycioides* | | ■ | ■ | |
| Jackal berry | *Diospyros mespiliformis* | | ■ | | |
| Kei apple | *Doyvalis caffra* | | | ■ | |
| Wild apricot | *Doyvalis zeyheri* | | ■ | | |
| Puzzle bush | *Ehretia rigida* | | ■ | ■ | |
| Stem fruit | *E magalismontanum** | ■ | ■ | | |
| Magic quarri | *Euclea crispa* | | ■ | ■ | |
| Magic quarry | *Euclea divinorum* | ■ | ■ | | |
| Dune myrtle | *Euclea natalensis* | ■ | | ■ | ■ |
| Common wild fig | *Ficus thonningii* | ■ | ■ | ■ | ■ |
| White-berry bush | *Flueggia virosa* | | ■ | ■ | |
| African mangosteen | *Garcinia livingstonei* | | ■ | | |
| Sand paper raisin | *Grewia flavescens* | | | ■ | ■ |
| Velvet raisin | *Grewia flava* | | ■ | ■ | |
| Grey raisin | *Grewia monticola* | | ■ | ■ | |
| Large-leaved raisin | *Grewia inequilateria* | ■ | | ■ | ■ |
| Shakama plum | *Hexalobus monopetalus* | | ■ | | |
| Thorny gardenia | *Hyperacanthus amoenus* | | | ■ | ■ |
| Sand apricot vine | *Landolphia kirkii* | | | ■ | ■ |
| Live-long | *Lannea discolor* | | ■ | | |
| Red milkwood | *Mimusops zeyheri* | | ■ | ■ | |
| Sweet prickly pear | *Opuntia ficus indica* | | ■ | | |
| Mobola plum | *Parinari curatellifolia* | | ■ | | ■ |
| Jacket plum | *Pappea capensis* | | | ■ | ■ |
| Cape gooseberry | *Physalis peruviana* | | | ■ | |
| Common forest grape | *Rhoicissus tomentosa* | | ■ | ■ | |
| Hard-leaved currant | *Rhus tumilicola* | | ■ | | |
| Wild bramble | *Rubus rigidus* | | | ■ | |
| Corky monkey orange | *Strychnos cocculoides* | | ■ | | |
| Black monkey orange | *Strychnos madagascariensis* | | ■ | | |
| Spine monkey orange | *Strychnos pungens* | | ■ | | |
| Green monkey orange | *Strychnos spinosa* | | ■ | ■ | |
| Marula | *Sclerocarya birrea* | | | ■ | ■ |
| Water berry | *Syzigium cumini* | | ■ | ■ | |
| Natal mahogany | *Trichilia emetica* | | ■ | | |
| Wild medlar | *Vanguira infausta* | | ■ | | |
| Blue sourplum | *Ximenia americana* | | ■ | ■ | |
| Large sourplum | *Ximenia caffra* | | ■ | | |
| Buffalo thorn | *Ziziphus mucronata* | | | ■ | |

**Englerophytum magalismontanum*

These plants involve species such as bush tea (*Athrixia phylicoides*), bushman's teas (*Catha edulis; C. transvaalensis*), lemon grass (*Cymbopogon citratus; C. nardus*), mopane (*Colophospermum mopane*), common wild pear (*Dombeya rotundifolia*), wild tea (*Monsonia* *angustifolia*), purple-pod cluster leaf (*Terminalia prunioides),* fever tea (*Lippia javanica*) and the weeping boer-bean (*Schotia brachypetala)*. The only notable exception amongst these plants is the large-leaved yellow raisin (*Grewia inequilateria*), whose berries are utilised for the brewing of traditional tea.

The harvesting of all plant species listed in Table 4.7 is generally open to all community members except for species that grow on cultivated lands and individual homesteads or are listed as protected and specially protected species. It can be observed from Table 4.8 that the proportion of fruit-bearing species that can be harvested during the months of winter and autumn seasons is rather low, estimated at 10% and 18%, respectively. The proportions of species that can be harvested during the spring and summer month are comparatively higher, estimated at 73% and 64%, respectively. Besides these estimates, the amount of fruits that can be harvested from the species listed in Table 4.8 is subject to various area-specific constraints that rural communities have to grapple with, if they are to utilise these species on a sustainable basis.

#### 4.5.3 The identification and selection of high potential beverage-making plants

Given that a total of 63 different plant species were identified and collected during the surveys in the various areas of the Limpopo province it was necessary to select those with favourable potential for the commercial production of beverages in the Limpopo province. Only plant species which satisfied all selection criteria may be regarded as having potential for making beverages. As explained in Chapter 3, the first selection criterion involved percent nominations (%). This criterion was derived from the local use values (x 100) calculated for the various plant species mentioned across the three main study areas. It was decided that plant species with at least 15% nomination, warranted further investigation. This cut-off position included 24% (or 15/63) of all plants collected for the study and entailed species such as *Athrixia phylicoides, Berchemia discolor, Doyvalis caffra, Englerophytum magalismontanum, Euclea divinorum, Grewia flavescens, Hyphaene coriacea, Landolphia kirkii, Mimusops zeyheri, Opuntia ficus indica, Parinari curatellifolia, Sclerocarya birrea, Strychnos cocculoides, Vanguira infausta* as well as *Ximenia americana.*

The next selection (ii) criteria was based on the manner in which plants were harvested by the locals for obtaining materials required for beverage-making. On the one hand, species that are harvested through unsustainable methods by local communities were considered not suitable for commercial beverage-making purposes because in such instances, the plant parts usually targeted are the roots, stems and the bark. Usually, after such harvesting practices, affected plants die due to the damage sustained. For instance, the traditional preparation of an alcoholic beverage from ilala palms (*Hyphaene coriacea* and *H. petersiana*) require their stems to be pierced in order to extract the sought-after cell sap. However, the rural communities involved in this practice currently lack the know-how and the remedy for regenerating damaged plants, and consequently many of the affected plants eventually die after the harvesting period. In a study by Govender *et al.* (2005) on the socio-economic status and development potential of one of the rural communities along the Maputaland coast in the KwaZulu-Natal province, it has been noted that the wild populations of ilala palms are being reduced drastically because damaged trees are unable to recover and if practices of this nature are allowed to proceed unabatedly, there will be loss of botanical diversity in exploited ecosystems (Govender *et al.,* 2005).

Similarly, the wild date palm (*Phoenix reclinata*) is harvested in a destructive manner by the locals and is therefore not suitable for the sustainable production of beverages in the Limpopo province. Other plants likely to be damaged by unsustainable harvesting methods involve the mopane (*Colophospermum mopane*) and the weeping boer-bean (*Schotia brachypetala*) whose bark are stripped off to brew medicinal (teas) decoctions. In addition, some of the fruit-bearing plant species listed in Table 4.8 may also become endangered due to harmful root collection and bark-stripping practices for ethno-medicinal purposes. The plant species at risk include *Berchemia zeyheri, Boscia albitrunca, Euclia crispa, E. divinorum, E. natalensis, Pappea capensis, Sclerocarya birrea, Strychnos madagascariensis, Trichilia emetica* and *Vanguira infausta* (Geldenhuys, 2004). With respect to root harvesting, species such as *Annona senegalensis, Athrixia phylicoides, Dombeya rotundifolia, Euclea divinorum, Lippia javanica, Parinari curatellifolia, Strychnos spinosa* and *Ximenia caffra,* are equally in danger. Despite the anthropogenic threats facing these species, the Schedule 11 List of the 47 Protected and Specially Protected plant species in the Limpopo province recognises only four (i.e. *Adansonia digitata; Boscia albitrunca; Catha edulis and Sclerocarya birrea*) endangered indigenous plant species. The overall implication of these findings is that ethnobotanical studies have an important role to play in advancing knowledge pertaining to the conservation biology of affected plant species.

The next selection criterion (iii) involved the environmental status of sought-after species (whether they are indigenous or invasive and alien species). Some of the species listed in Table 4.8 do not have the potential for the commercial production of beverages because they are classified in South Africa as alien invasive species, even though they have naturalised successfully and certain rural communities rely on them for satisfying some of their livelihood needs. Hence, their production and propagation anywhere in South Africa (including the Limpopo province) violates the provisions and restrictions espoused in the recently amended Regulations 15 and 16 of the Conservation of Agricultural Resources Act (CARA), (1983) and the new National Environmental Management: Biodiversity Act (NEMBA), (2004). According to these Acts, landowners are legally responsible for the control and management of invading alien plants (IAPs) on land falling within their jurisdiction. IAPs are regarded as one of the biggest threats to national plant and animal biodiversity in South Africa and for this reason the Department of Water Affairs and Forestry (DWAF) has introduced control measures such as the multi-sectoral Working for Water (WfW) initiative. This initiative represents a national campaign aimed at engaging and modifying the attitudes and behaviour of the South African public towards the negative environmental impacts of IAPs.

The sweet prickly pear (*Opuntia ficus indica*), cited by some of the respondents (during the surveys) in certain rural areas of the Limpopo province, falls within the Category 1 list of declared weeds and invader species compiled by the Department of Water Affairs and Forestry (DWAF). In keeping with the Conservation of Agricultural Resources Act (CARA), (1983) and the National Environmental Management: Biodiversity Act (NEMBA), (2004), plants classified under such a category should not be propagated on any land-surface in South Africa. In addition, the wild bramble (*Rubus rigidus)* is regarded as a sprawling herb, able to hybridise with problematical species such as the American sand bramble (*Rubus cuneifolius*) (a declared Category 1 IAP) and others within the same *Rubus* genus. The latter plants grow as weeds along roads, streams and disturb ecosystems in South Africa (Van Wyk and Gericke, 2003; Global Invasive Programme (GISP), 2003). Other environmentally unsustainable plants cited by respondents, involved the Cape gooseberry (*Physalis peruviana*) and the jambolan (*Syzygium cumini*), an evergreen species of Asian origin that has been cultivated in South Africa as an ornamental plant and for its edible fruits (SABONET, 2009). Areas vulnerable to jambolan invasion include coastal bushes and some of the frost-free savanna areas in South Africa. Table 4.9 summarises the use of all these criteria (i; ii and iii) for selection purposes based on the characteristics of the plant species identified in the surveys. Only plants that were identified by at least 15% of the respondents and exhibited a sustainability or suitability index of 1 were deemed suitable for further study.

Table 4.9: The final selection* of potential beverage–making indigenous plant species in the Limpopo province.

| Common name | % Nomination | Non-invasive status | Harvesting methods | Final suitability for selection |
|---|---|---|---|---|
| *Adansonia digitata* | *9%* | 1 | Fruits (1) | 0 |
| *Athrixia phylicoides* | *29%* | 1 | Leaves (1) | 1 |
| *Annona senegalensis* | *4%* | 1 | Fruits (1) | 0 |
| *Artabotrys brachypetalus* | *3%* | 1 | Fruits (1) | 0 |
| *Berchemia discolor* | *18%* | 1 | Fruits (1) | 1 |
| *Boscia albitrunca* | *2%* | 1 | Roots (0) | 0 |
| *Bridelia mollis* | *1%* | 1 | Fruits (1) | 0 |
| *Catha edulis* | *9%* | 1 | Leaves (1) | 0 |
| *Colophospermum mopane* | *2%* | 1 | Bark (0) | 0 |
| *Citrillus lanatus* | *2%* | *1* | Fruits (1) | 0 |
| *Diospyros mespiliformis* | *5%* | 1 | Fruits (1) | 0 |
| *Dombeya rotundifolia* | *3%* | 1 | Leaves (1) | 0 |
| *Doyvalis caffra* | *16%* | 1 | Fruits (1) | 1 |
| *Ehretia rigida* | *4%* | 0 | Fruits (1) | 0 |
| *E. magalismontanum** | *55%* | 1 | Fruits (1) | 1 |
| *Euclea divinorum* | *15%* | 1 | Fruits (1) | 1 |
| *Ficus thonningii* | *11%* | 1 | Fruits (1) | 0 |
| *Flueggia virosa* | *6%* | 1 | Fruits (1) | 0 |
| *Garcinia livingstonei* | *9%* | 1 | Fruits (1) | 0 |
| *Grewia flavescens* | *16%* | 1 | Fruits (1) | 1 |
| *Grewia inequilateria* | *9%* | 1 | Fruits (1) | 0 |
| *Hexalobus monopetalus* | *6%* | 1 | Fruits (1) | 0 |
| *Hyphaene coriacea* | 36% | 1 | Stem (0) | 0 |
| *Hyperacanthus amoenus* | 3% | 1 | Fruits (1) | 0 |
| *Landolphia kirkii* | *18%* | *1* | Fruits (1) | 1 |
| *Lannea discolor* | *5%* | 1 | Fruits (1) | 0 |
| *Lippia javanica* | *9%* | 1 | Leaves (1) | 0 |
| *Mimusops zeyheri* | *17%* | 1 | Fruits (1) | 1 |
| *Opuntia ficus indica* | *21%* | 0 | Fruits (1) | 0 |
| *Parinari curatellifolia* | *44%* | 1 | Fruits (1) | 1 |
| *Pappea capensis* | *7%* | 1 | Fruits (1) | 0 |
| *Physalis peruviana* | *4%* | 0 | Fruits (1) | 0 |
| *Phoenix reclinata* | *3%* | *1* | Fruits (1) | 0 |
| *Rhoicissus tomentosa* | *1%* | *1* | Fruits (1) | 0 |
| *Rhus tumilicola* | *7%* | 1 | Fruits (1) | 0 |
| *Rubus rigidus* | *3%* | 0 | Fruits (1) | 0 |
| *Schotia brachypetala* | 4% | 1 | Bark (0) | 0 |
| *Strychnos cocculoides* | *45%* | 1 | Fruits (1) | 1 |
| *Rhus lancea* | *11%* | 1 | Fruits (1) | 0 |
| *Sclerocarya birrea* | *29%* | 1 | Fruits (1) | 1 |
| *Syzigium cumini* | *2%* | 0 | Fruits (1) | 0 |
| *Trichilia emetica* | *4%* | 1 | Fruits (1) | 0 |
| *Vanguira infausta* | *20%* | 1 | Fruits (1) | 1 |
| *Ximenia americana* | *25%* | 1 | Fruits (1) | 1 |
| *Terminalia prunioides* | *2%* | 1 | Leaves (1) | 0 |
| *Ziziphus mucronata* | *9%* | 1 | Fruits (1) | 0 |

*Species recommended for further research involved only those which have scored at least a 15% nomination and have a final sustainability index of 1, based on their non-IAPs status and the use of environmentally friendly methods for harvesting.

It can be deduced that amongst the tea-producing species there is only one plant species recommended for further study (Table 4.9) in Chapter 5 – bush tea (*Athrixia phylicoides*). This species earned a 29% nomination by respondents in all three study areas and it is not classified as an invasive alien species. More importantly, when the harvesting methods are carried out on a sustainable basis, the natural populations are not likely to be harmed, unless harvesting pressure becomes extremely excessive.

Apart from bush tea, Table 4.9 depicts other plant species (12) also suitable for an in-depth literature study in Chapter 5. These plant species are as follows: the stem fruit (*Englerophytum magalismontanum)* (55%), corky monkey orange (*Strychnos cocculoides*) (45%), mobola plum (*Parinari curatellifolia*) (44%), blue sourplum (*Ximenia americana*) (25%), wild medlar (*Vanguira infausta*) (20%), brown ivory (*Berchemia discolor*) (18%), sand apricot vine (*Landolphia kirkii*) (18%), red milkwood or "*moepel"* (*Mimusops zeyheri*) (17%), Kei apple (*Doyvalis caffra*) (16%), sand paper raisin (*Grewia flavescens* (16%) and the magic quarri (*Euclea divinorum*) (15%). Lastly, one of these plant species is the marula tree (29%) from which commercially successful beverages are already being produced in the Limpopo province. However, the marula tree was not selected for further study because it has been examined by many other researchers.

# CHAPTER 5

## RESEARCH FINDINGS AND DISCUSSION: BEVERAGE-MAKING PLANT SPECIES, PREPARATION METHODS AND NUTRITIONAL ASPECTS

### 5.1 INTRODUCTION

This chapter consists of three parts. The first section reviews selected potential beverage-making indigenous plant species. This section is followed by a discussion on the traditional preparation methods of juices, alcoholic beverages and tisanes (teas). The section also outlines how samples of value-added liqueurs were prepared for the study. As indicated earlier, these liqueurs were not prepared by the respondents who participated in the study. The final section focuses on the nutritional aspects of selected beverages.

### 5.2 A REVIEW OF SELECTED INDIGENOUS BEVERAGE-MAKING PLANTS

#### 5.2.1 Stem fruit (*Englerophytum magalismontanum)*

According to Palgrave (2002), the stem fruit is a small to medium (3-10 m) evergreen tree species, occurring on a variety of ecological habitats such as rocky outcrops and hills, wooded ravines and along river banks. It belongs to the Sapotaceae family (or milkwood plant family), with about 22 native species distinguished by features such as a milky latex and simple alternate leaves (Van Wyk and Van Wyk, 1997). The species, *Englerophytum magalismontanum* has an extensive geographical distribution, ranging from Kwa-Zulu Natal in South Africa up to Zimbabwe (Van Wyk and Gericke, 2003).

*Englerophytum magalismontanum* is one of the key species already involved in local subsistence trade and domestication trials. The species is much sought-after by poor rural communities in areas where it occurs naturally, not only for its ethnomedicinal importance (Du Preez, 2003; More *et al.,* 2008) but also for its edible, mildly astringent and sweet-tasting fruits (Shackleton *et al*., 2002; Du Preez *et al.*, 2003; Van Wyk and Gericke, 2003). These fruits (Figure 5.1) are 15-25 mm long and 10-18 mm in diameter and vary from dark and glossy red to light pink (Du Preez, 2003). The ripe fruits are edible and may also be brewed into a non-alcoholic fruit juice and a potent alcoholic drink.

Figure 5.1: Fruits of *Englerophytum magalismontanum* species.
*Source*: <www.metafro.be/prelude/view_countrycc=ZA>

The fruits of *Englerophytum magalismontanum* are known to have a high vitamin C content, reported to be 20 mg/100g by Du Preez (2007). However, some geographical variations in fruit composition have been highlighted as well. In particular, fruit samples collected in Nelspruit (in the Mpumalanga province) exhibited relatively higher concentrations of certain nutrients than those obtained from Thohoyandou (Limpopo province) (Du Preez, 2007). The mean carbohydrate content in the former samples was 43 g/100g while it was found to be 24.9 g/100g for the latter samples (Du Preez, 2007). In addition, mean vitamin A concentration for samples collected from Nelspruit was found to be 14 Retinol Equivalents (RE) per 100g whereas a value of 7.1 RE/100g was obtained for samples obtained from the Limpopo province. Other interesting variations involved the energy values (430-718 kJ/100g) as well as potassium content (190-514 mg/100g) (Du Preez, 2007). In view of these geographical variations in fruit composition, harvesting from the wild is not a feasible option for commercialisation purposes.

The Institute for Tropical and Subtropical Crops (ITSC) at Nelspruit has made some progress on propagation trials and genetic selection involving the stem fruit species, the purpose being to help standardise and prevent geographical variations in nutritional composition. So far, it has been established that fresh seeds germinate easily (Du Preez, 2007). In the same vein, the Department of Forest Science at the University of Stellenbosch is involved with the propagation trials of *Englerophytum natalense* as well as *E. magalismontamum* (Ham, 2004). Seed germination of *E. magalismontanum* at the ITSC has been found to be rapid and 40% germination was achieved within three weeks from planting (Du Preez, 2003). Regeneration trials from cuttings were also successfully carried out. However, any commercialisation initiative regarding the stem fruit must take heed of all relevant constraints, including the fact that the fruits are susceptible to insect damage during certain growth stages. Problem insect species include *Bahiria ximeniata*, *Nola poliotis, Ceratitis rosa* and *C. capitata.* These insect species were noted in a study assessing the damage sustained on wild fruit samples collected at Toppieshoek, near Broederstroom (De Lange *et al.,* 2005).

### 5.2.2 Corky monkey orange (*Strychnos cocculoides*)

The corky monkey orange species belongs to the family Loganiaceae (Van Wyk and Van Wyk, 1997). The common name, corky monkey orange, derives from its creamy brown, deeply corky and longitudinally ridged bark that is armed with well developed curved spines which often end in a terminal spine (Palgrave, 2002). Many species in the *Strychnos* genus are rich in alkaloids and are extremely poisonous, thus caution must be exercised regarding their use. *Strychnos cocculoides* (Figure 5.2) is a semi-deciduous shrub or small tree with a rounded crown and broadly ovate-oblong to almost circular leaves and occurs in woodlands, mixed forests and bushveld in southern as well as eastern Africa (Van Wyk and Van Wyk, 1997; Palgrave, 2002; Akinnifesi *et al.,* 2006). Usually it prefers ecological habitats with sandy soils or rocky terrain.

Most species in the genus are used in traditional medicine against fever and malaria (Ruffo *et al.*, 2002). In particular, their indolomonoterpenic alkaloids are associated with antiplasmodial activity against chloroquinone-susceptible strain of *Plasmodium falciparum*. The roots as well as the leaves are used to treat ailments such as eczema, gonorrhoea, stomach disorders and sexually transmitted diseases (Food and Agricultural Organisation (FAO), 1983; Ruffo *et al.,* 2002). In addition, the fruits of *Strychnos cocculoides* may be mixed with honey to treat coughs (IPGRI-SAFORGEN Report, 2001). The fruits are characteristically round, speckled and about 6 cm in diameter (Figure 5.2). Their ripening is associated with a colour change from green to yellowish brown and fruits may remain on the tree for some time.

The fruits of the corky monkey orange have multiple seeds embedded in a thick fruit pulp (Van Wyk and Gericke, 2003) and along with those of *Strychnos spinosa* are extremely pleasant to taste and have considerable food value in poor rural communities, despite the unexplored degree of toxicity in the pips. The fruits are consumed by both children and adults and, given their pleasant taste, local rural communities often collect them early in the season before their ripening for storage. Around homesteads, they are buried beneath a sandy layer to allow their fruit pulp to liquefy adequately. Non-alcoholic juices as well as fermented drinks may be prepared from *Strychnos cocculoides* fruits.

Figure 5.2: The corky monkey orange (*Strychnos cocculoides*) tree with several unripe fruits.

The corky monkey orange has been selected as one of the priority indigenous fruit trees in five Southern African Development Co-operation (SADC) countries, the aim being to improve the income generation capacity of poor rural households. Unlike in South Africa, this species is highly prioritised for domestication and cultivation in countries such as Malawi, Mozambique, Tanzania, Zambia and Zimbabwe (IPGRI-SAFORGEN Report, 2001). The wild fruits are sold by poor rural households in Zimbabwe and the income generated is used to buy staple foods as well as other household goods (Akinnifesi *et al.*, 2006). However, it is difficult to germinate from seeds, despite a number of pre-treatments (Akinnifesi *et al.,* 2006). This difficulty also applies to *Strychnos spinosa* due to the presence of a seed coat thought to contain a germination inhibitor (Prins and Maghembe, 1994). In order to overcome propagation constraints such as these, the seeds must be thoroughly washed before being stored for a prolonged period (~2 years) at room temperatures prior to sowing (Akinnifesi *et al.,* 2006). Vegetative propagation by grafting has also proved to be successful (40-79%), although it depends on numerous factors such as:

- the skill of the person doing the grafting,
- the time of the year scion is obtained,
- the time frame between scion collection and grafting,
- proper alignment between scion and rootstock,
- stock nutrition,
- disease condition of scion and rootstock and
- the relative humidity of propagation environment.

*Source:* Akinnifesi *et al*. (2004, *cited* in Akinnifesi *et al.,* 2006)

### 5.2.3 Mobola plum (*Parinari curatellifolia*)

The mobola plum belongs to the plant family Chrysobalanaceae (or the coco plum family). This family is comprised of three indigenous species in the southern African region (Van Wyk and Van Wyk, 1997). Related species such as *Chrysobalamus icaco* are also harvested for their fruits. In South Africa, *Parinari curatellifolia* (Figure 5.3) occurs in areas classified as bushveld in the north-eastern areas of the Limpopo province. It usually thrives in deep, sandy soils on both gently sloping terrain and mountainous areas. The tree is evergreen and may grow up to 10 metres high (Figure 5.3) under favourable conditions. The leaves develop from sagging branches and are mostly dark greenish on the upper surface and grey to brown on the lower surface (Van Wyk and Van Wyk, 1997).

The fruits are characteristically single-seeded, oval to round, brownish to yellow in colour and have distinctive greyish scales. The fruits are usually harvested between October and January and are known to have a pleasant taste and may also be used to make delicious syrups, jams, refreshing juices as well as various intoxicating traditional beverages. The research conducted on the mobola plum has focused largely on the nutrient content of the fruits (Du Preez *et al.,* 2003). It has been established that the fruits have a relatively high vitamin C content, ranging from 65-75 g/100g of fruit mass (Du Preez *et al.,* 2003). In a study conducted in Malawi, the total carbohydrate content of these fruits was found to be approximately 88% (Saka and Msonthi, 1994). The kernels (nuts) have also been found to be rich in nutrients such as thiamine, magnesium, phosphorus and zinc.

Figure 5.3: Mobola plum (*Parinari curatellifolia*) in Venda.

Although *Parinari curatellifolia* can be regenerated vegetatively, other propagation methods have been constrained because seeds do not germinate easily without pre-treatment (Prins and Maghembe, 1994; Ruffo *et al*., 2002; Du Preez, 2007).

### 5.2.4 Blue sourplum (*Ximenia americana)*

The blue sourplum shrub belongs to the Olocaceae family (or sourplum family), comprised of woody and mostly semiparasitic plants that are armed with spine-tipped branchlets and stamens twice the number of petals (Palgrave, 2002). The Olocaceae family is rather small given that it has only five plant species (Van Wyk and Van Wyk, 1997). Two of the species in this family - the large sourplum (*Ximenia caffra*) and the blue sourplum (*Ximenia americana*) - have received significant research attention in respect of their ethnomedicinal properties.

The chemical constituents in their roots and leaves *(*Figure 5.4*)* have been reported to have anti-microbial, anti-inflammatory as well as anti-schistosomic properties and have, thus been utilised in the treatment of conditions such as inflamed eyes, dysentry, sexually transmitted diseases and diarrhoea (Fabry *et al*., 1996; Ndubani and Hojer, 1999; Sparg *et al*., 2000; Ogunleye and Ibitoye, 2003; Mathabe *et al*., 2006). The roots of the blue sourplum are used in the treatment of internal parasites and menorrhagia (Arnold and Gulumian, 1984, *cited* in Steenkamp, 2003; McGaw and Eloff, 2008).

The fruits of *Ximenia americana* and *X. caffra* (Figure 5.4) are edible and have a sour-sweet (and sometimes bitter) flavour (Van Wyk and Gericke, 2003). They are widely consumed in rural areas. Additionally, they are utilised to produce non-alcoholic and alcoholic beverages. The vitamin C content of blue sourplum fruits was found to be 49 mg/100mg while their vitamin A concentration was 1987 RE/100g (Du Preez, 2007). Fruit samples analysed by Wehmeyer (1986) exhibited remarkably high levels of potassium, estimated at 718 mg/100g while their carbohydrate content ranged from 20 g/100g (Du Preez, 2007) to 28.5 g/100g (Wehmeyer, 1986).

Figure 5.4: Large sourplum (*Ximenia caffra*) with fruits.
*Source*: <www.bidorbuy.co.za>

Any commercialisation initiatives regarding *Ximenia americana* and *X. Caffra* species must recognise their multiple uses, especially the industrial role of their volatile oils. These oils have been commercialised successfully in the indigenous plant lipids sector as well as in the cosmetic niche market (Du Plessis, 2004; Mevy *et al.,* 2006; Mitei *et al.,* 2008). *Ximenia* seed oil has been found to be exceptionally rich in long chain unsaturated fatty acids (nearly 92%), implying that it has marked herbal and cosmetic value (Esoteric Oils, 2009). In fact, cosmetic products derived from *Ximenia* oil sourced from countries such as Swaziland and Namibia are already being sold worldwide and Du Plessis (2004) estimated that this niche market was worth nearly R1 million as of 2005.

### 5.2.5 Wild medlar (*Vanguira infausta*)

The wild medlar has a wide geographical distribution in southern Africa. Outside South Africa, it occurs in countries such as Botswana, Kenya, Malawi and Tanzania (Leakey, 1999; IPIGRI-SAFORDEN Report, 2001). It is a deciduous single- or multi-stemmed small tree (Figure 5.5), about 3-7 m in height, depending on ecological conditions (Green-A-Planet, 2009). It grows well under arid or semi-arid conditions in the eastern and northern regions of South Africa (Du Preez, 2003). The wild medlar belongs to the family Rubiaceae, comprising approximately 160 indigenous species. *Vanguira infausta* occurs in bushveld, open woodland and grassland, usually in rocky terrain (Palgrave, 2002). The roots have ethno-medicinal importance in the treatment of conditions such as malaria and pneumonia (Palgrave, 2002).

Figure 5.5: A young wild medlar (*Vanguira infausta*) plant.

Figure 5.6: Ripe (light brown) and unripe (still green) fruits of the wild medlar (*Vanguira infausta*).

The plant bears nearly round edible fruits, 2.5-3.5 cm in diameter (Figure 5.6) and are yellowish to brown when ripe. The fruits have a dry sweet-sour flesh (Van Wyk and Gericke, 2003), which may be regarded as an important nutritional source of calcium (249 mg/100g fruit mass) and potassium (521 mg/100g fruit mass) minerals (Wehmeyer, 1986). In Malawi, the fruit flesh of *Vanguira infausta* exhibited 26.5% dry matter, 5.7% crude protein, 78.1% total carbohydrate, 10.2% fibre and 2.6% fat (Saka and Msonthi, 1994). Vitamin C concentration ranged from 4.7 mg/100g in Malawi to 16.8 mg/100g in Botswana (Leakey, 1999). This variations may be attributed to geographical differences in soil types and climate. The fruits are much sought-after as food source by poor local communities in areas where they occur naturally, especially during times of famine (Du Preez, 2003). A number of foodstuffs such as beverages and additives to lightly fermented porridge can be produced from them (Cunningham and Shackleton, 2004).

As a result, *Vanguira infausta* has been a subject of numerous propagation trials since the early 1990s (Prins and Maghembe, 1994; Van Wyk and Gericke, 2003). Although not easy to be germinated from seeds, some measure of success may be achieved when the date of sowing is taken into consideration. For instance, Mateke (2003) reported that seeds that were sown in June had a 56% germination rate meanwhile those grown in November exhibited a success rate of 98%. The discrepancies in the germination rates were ascribed to seasonal temperature differences as well as time spent during storage. Vegetative propagation has also been attempted and a success rate of 100% has been achieved (Akinnifesi *et al*., 2006). Other successful propagation trials on the wild medlar have been undertaken in Israel (Van Wyk and Gericke, 2003). More beneficially, propagated trees were larger than those occurring in the wild.

### 5.2.6 Brown ivory (*Berchemia discolor*)

The brown ivory (Figure 5.7) is a semi-deciduous tree growing up to nearly 20 m in height, depending on ecological conditions (IPGRI SAFORDEN Report, 2001). It is prevalent in arid and semi-arid bushveld and rocky terrain. Branches are erect and spread to produce a heavy rounded crown. Like many other indigenous species, the bark and leaves have ethno-medicinal uses for conditions such as infertility, menorrhagia (Arnold and Gulumian, 1984, *cited* in Steenkamp, 2003; Van Wyk and Van Wyk, 1997) and cattle diseases (McGaw *et al.,* 2007b).

Figure 5.7: Branches of the brown ivory (*Berchemia discolor*).
*Source:* <www.aluka.org>

Fruits are ovoid in shape (Figure 5.7), yellow to pale orange and have a single stone (Van Wyk and Van Wyk, 1997). In terms of nutritional composition, Wehmeyer (1986) reported a vitamin C content of 50.3 mg/100g and a potassium concentration of 270 mg/100g fruit mass. If these findings are coupled with the 6.1% protein content in the fruit pulp (IPGRI SAFORDEN Report, 2001), it becomes clear that this species has untapped food potential in South Africa, especially with respect to satisfying the dietary needs of poor rural communities. Regarding traditional uses, a number of foodstuffs such as pleasantly flavoured porridge as well as non-alcoholic and alcoholic beverages may be produced from these fruits. Consequently, in some of the African countries, propagation trials are being undertaken in order to facilitate their domestication, selection of superior germplasm for adoption and enhancement as well as the commercialisation transition from informal to formal markets (IPGRI SAFORDEN Report, 2001).

### 5.2.7 Sand apricot vine (*Landolphia kirkii*)

The sand apricot vine is a woody climber which occurs in dense bushveld or thickets in rocky outcrops across northern KwaZulu-Natal and the Limpopo provinces (Schmidt *et al.*, 2002). Outside South Africa, it occurs in several countries such as Kenya, Mozambique, Tanzania and Zimbabwe (IPGRI-SAFORGEN Report, 2001). This species belongs to the Apocynaceae family, comprised of nearly 40 native species characterised by opposite or whorled leaves and a milky or watery latex (Van Wyk and Van Wyk, 1997).

Figure 5.8: Unripe fruits of the sand apricot vine (*Landolphia kirkkii*) species.

The sand apricot vine bears spherical fruits (Figure 5.8), about 80 mm wide, which hang on a long and slender stalk. The fruit skin is thin and greenish at first although it turns into a thicker woody shell which ultimately becomes pale brown when ripe. The edible pulp surrounding the seeds is very sweet and is preferred by monkeys (Schmidt *et al.*, 2002). According to Wehmeyer (1986), the fruit flesh has 193 mg/100g potassium and relatively very little vitamin C concentration (10.3 mg/100g) when compared to other wild fruits. However, there is scarcity of literature regarding further nutritional composition, phytochemical properties, ethnomedicinal aspects as well as propagation potential.

### 5.2.8 Red milkwood (*Mimusops zeyheri*)

*Mimusops zeyheri* occurs largely in the Limpopo province and other areas towards the north of South Africa (Du Preez, 2003). According to Palgrave (2002), the plant prefers a range of ecological habitats such as thickets on rocky hillsides, riverine boundaries and in dry open woodland and bushveld. It belongs to the Sapotaceae (milkwood) family, with about 22 native species, mainly characterised by combination of a milky latex and simple alternate leaves without large stipules or conspicuous stipular scars (Van Wyk and Van Wyk, 1997).

Figure 5.9: Ripe fruits of the red milkwood *(Mimusops zeyheri*).
*Source:* <www.bidorbuy.co.za/item/17905407/Mimusops_zey...>

The roots of *Mimusops zeyheri* are of ethnomedicinal importance in the treatment of ulcers and wounds (Du Preez *et a*l., 2003; Amusa, 2009).

The fruits ripen around spring and are sweet-tasting and highly sought-after in certain rural areas. Apart from direct consumption as ripe fruits (Figure 5.9), their pulp may be utilised to brew non-alcoholic and alcoholic beverages. In a study identifying indigenous fruit trees with suitable attributes for the semi-arid conditions prevailing in the Limpopo province, the red milkwood was top-ranked as the most important indigenous fruit tree species (Mashela and Mollel, 2001). When compared to *Englerophytum magalismontanum* and *Strychnos pungens*, it has been found that the fruits of *Mimusops zeyheri* are least susceptible to insect damage (De Lange *et al*., 2005). In terms of nutritional importance, their edible flesh contains 28% carbohydrates (Du Preez, 2003). Vitamin C content ranges from 50 to 90 mg/100g (Venter and Venter, 1996), while in one analysis the vitamin A content was recorded as 1932 RE/100g (Du Preez, 2007), suggesting that the red milkwood has a relatively high nutritional status.

### 5.2.9 Kei apple (*Doyvalis caffra*)

*Doyvalis caffra* is a subtropical shrub which occurs in the bushveld and woodlands, coastal forests and riverine bush along the eastern areas of the Limpopo, KwaZulu-Natal and the Eastern Cape provinces in South Africa (Van Wyk and Van Wyk, 1997; Palgrave, 2002; Du Preez, 2003). It belongs to the Flacourtiaceae (wild peach) family, comprised of more than 30 tree species. It has separate sexes and is regarded as drought resistant and able to tolerate saline soil (Van Wyk and Van Wyk, 1997). The thorns of *Doyvalis caffra* have ethnomedicinal importance in the Venda region of the Limpopo province for therapeutic conditions such as amenorrhoea (Tshisikhawe, 2002; Steenkamp, 2003). The Kei apple bears nearly spherical fleshy fruits (Figure 5.10), 25-40 mm long, with a smooth but tough skin (Du Preez, 2003). Although the fruits are highly acid, they are also pleasantly flavoured to make foodstuffs such as jelly, jam as well as beverages.

Figure 5.10: Kei apple with fruits in different stages of ripening.
*Source:* <www.forums.vietbao.com>

Compared with most indigenous fruit species in South Africa, *Doyvalis caffra* has received considerable research attention in terms of its nutritional properties (Wehmeyer, 1966; Wehmeyer, 1986; Du Preez *et al.,* 2003; Du Preez, 2007; De Beer, 2006). Fifteen amino acids have been identified in the fruit while a carbohydrate concentration of 14.2 g/100g has been found (Du Preez *et al.,* 2003). The fruits are also a good source of mineral elements such as potassium (232-606 mg/100g) (Wehmeyer, 1986; Du Preez, 2007). All fruit samples collected from different localities appear to have a very high vitamin C content, ranging from 83 mg/100g (Du Preez, *et al*., 2003) and 117 mg/100g (Wehmeyer, 1966; Wehmeyer, 1986), to 347 mg/100g (Du Preez, 2007). De Beer (2006) reported the highest vitamin C (as total ascorbate) concentration in the fruit flesh of the Kei apple, estimated at nearly 778 mg/100g dry weight. The concentration of polyphenols in the entire fruit were also high, being 943 mg of Gallic Acid Equivalents (GAE)/100g dry weight, thus more than the 126-402 mg/100g dry weight noted for *Rubus* raspberries (De Beer, 2006).

Given the various uses of *Doyvalis caffra* species, the need for propagation cannot be overemphasised. So far, it has been possible to produce superior genetic selections through grafting techniques at the ITSC at Nelspruit, Mpumalanga province (Du Preez, 2007).

### 5.2.10 Sand paper raisin (*Grewia flavescens*)

*Grewia flavescens* is a spreading multi-stemmed shrub (Figure 5.11) with drooping branches (IPGRI-SAFORGEN Report, 2001). It belongs to the Tiliaceae family. Ecologically, it occurs in a range of habitats such as open woodlands, rocky koppies and river fringes in bushveld (Palgrave, 2002; Wyk and Gericke, 2003). Hairy leaves are typically greyish green and are browsed by both game and livestock (Van Wyk and Van Wyk, 1997). The roots have ethnomedicinal importance as they are used in the treatment of infertility (Mabogo, 1990; Steenkamp, 2003).

Figure 5.11: Ripe berries of the sand paper raisin (*Grewia flavescens*).

Fruits are globose (Figure 5.11), mostly 2-4 lobed, less than 10 mm in diameter and yellowish brown when ripe (Van Wyk and Gericke, 2003; Motlhanka *et al.,* 2008). Wehmeyer (1986) reported high concentrations of minerals such as phosphorus (107 mg/100g), calcium (147mg/100g), magnesium (177mg/100g) and potassium (926mg/100g) in these fruits. Their crude fibre content was 45.6 g/100g. In Namibia, the fruits are soaked in water for two or three days to make a refreshing drink (Van Wyk and Gericke, 2003).

### 5.2.11 Magic quarri (*Euclea divinorum*)

The magic quarri (*Euclea divinorum*) (Figure 5.12) is an evergreen shrub belonging to the family Ebenaceae *(*Ebony family*)*. It is dioecious (with separate sexes on different plants) and has a wide geographical distribution across eastern and southern Africa. In South Africa, its occurrence is restricted to the eastern parts of the country (Van Wyk and Gericke, 2003). The genus has hard, leathery leaves with undulate or wavy margins. Along with species such as *Acacia brevispica*, *Carissa edulis* and *Ferula communis*, the leaves are mostly preferred by the black rhinoceros (Ghebremeskel *et al.,* 1991).

Regarding indigenous plant uses, *Euclea divinorum*, has multiple applications. The roots are one of the most common sources of colour-fast dye in southern Africa due to their pigment-rich naphthoquinones (Van Wyk and Gericke, 2003). More remarkably, extracts of *Euclea divinorum* have been found to exhibit promising antimicrobial activity (Mothana *et al.,* 2009). Other phytochemical studies have led to the isolation of naphthoquinones, triterpenes and flavonoids in the root bark (Mebe *et al.,* 1998). These findings support the fact that *Euclea divinorum* has long-standing ethnomedicinal importance in the treatment of diseases such as diarrhoea, skin disease, and gonorrhoea (Mebe *et al.,* 1998). Furthermore, the root bark may be chewed as mouthwash while the frayed ends of twigs are used as toothbrush for dental hygiene (Van Wyk and Gericke, 2003; Bussmann *et al.,* 2006).

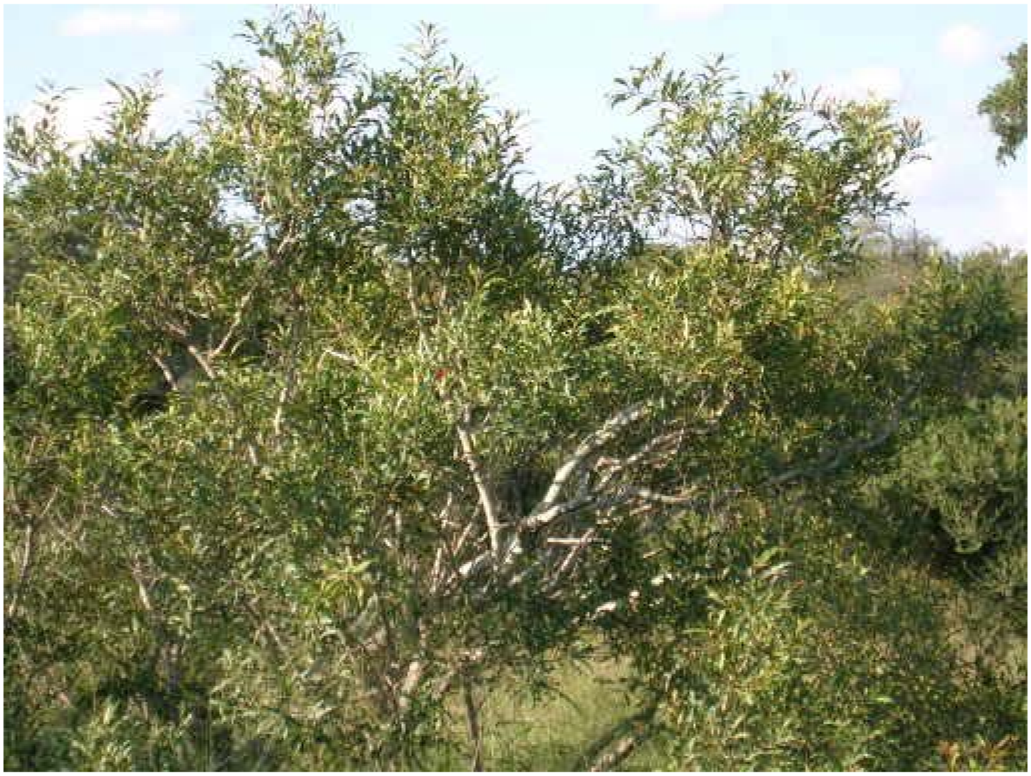


Figure 5.12: The magic quarri (*Euclea divinorum*) tree.
*Source:* < www.parks-sa.co.za>

The fruits of *Euclea divinorum* are edible, though not pleasant to taste. Currently, there is very little literature on their nutritional composition and associated foodstuffs. Nevertheless, a traditional beer can brewed from them (Palgrave, 2002).

### 5.2.12 Bush tea (*Athrixia phylicoides*)

The so-called "bush tea" is derived from the *Athrixia phylicoides* species and has been briefly reviewed in section 2.2.3. The species is characterised by an erect shrub and silvery leaves with purple flower heads. As indicated earlier, it belongs to the Asteraceae (Daisy) family, comprised of 14 species in the various mountainous areas of southern Africa (Mudau *et al.*, 2007). Some rural communities located along its natural habitats use it as a multipurpose plant and it is believed to have commercial development potential (Van Wyk and Gericke, 2003; Rampedi and Olivier, 2005; Olivier, 2010, *personal communications*).

The bush tea plant (Figure 5.13) is used as a medicinal tea in the treatment of a wide range of human illnesses such as skin disruptions, cardiovascular disorders, tiredness and respiratory ailments (Mudau *et al*., 2007; Olivier *et al*., 2008). During the last decade or so bush tea has witnessed rapidly growing research attention for its ethnopharmacological and herbal properties.

A higher total phenolic content relative to some of the commercialised indigenous teas species in South Africa has been reported by McGaw *et al.* (2007a) while the presence of a new flavonol derivative has been confirmed by Mashimbye *et al*. (2006).

Figure 5.13: The *Athrixia phylicoides* species.
*Source:* < www.plantzafrica.com>

The bush tea plant is also being traded in the informal economic sector, where it is harvested for the purpose of making traditional brooms (Shackleton and Campbell, 2007). Although there is a strong demand for such brooms, the harvesting practices associated with this use are not environmentally sustainable. This is because harvesters uproot the entire plant, thus allowing for no future regrowth. If such harvesting practices proceed unabatedly, natural populations of this species may be severely reduced. Given its multi-purpose nature, including use as herbal tea, one of the solutions to meet rapidly rising demand is to propagate it in order to reduce human pressure in vulnerable habitats.

## 5.3 BEVERAGE PREPARATION METHODS

This section deals with the various methods of making beverages from indigenous plant species. Firstly, the local traditional methods of making fruit juices are discussed. Secondly, other methods of making fruit juices are also examined. The latter (non-traditional) methods have been introduced by external agencies involved in local community development partnerships in rural settlements such as Makonde in Venda. The goal of these partnerships is to help improve livelihoods by using local plant biodiversity without damaging the natural environment.

### 5.3.1 Fruit juices

In this section, three different preparation methods are discussed. The first method is traditional and village-styled whereas the other two have some elements of modern production techniques.

5.3.1.1 The traditional village-style method for preparing fruit juices

Non-alcoholic indigenous fruit juices are prepared through a very simple process. Mature and ripe fruits are collected from nearby woodlands during the harvesting period. The fruits are initially cleaned with water to remove dust and dirt and then peeled with a kitchen knife to remove the skin and seeds. The fruit pulp is then sliced into small pieces and soaked in water (1 part per 10 parts) after adding about 6 g of table sugar for sweetening. However, more sugar (>10g) may be required for juices derived from sour or bitter fruits such as the blue sourplum. Thereafter, the mixture is allowed to stand overnight. The next step involves squeezing the fruit pulp physically by hands in order to extract the juice.

5.3.1.2 First non-traditional method for preparing juice from indigenous fruits

Ripe fruits are first cleaned with water. The seeds and the skin cover of the fruit are removed with a sharp knife. Thereafter, the remaining fruit pulp is crushed with a pestle for about 15 minutes. Water is, then, added (1 part per 7 parts) to the loosened fruit pulp, along with about 6 g of table sugar per litre. The mixture is allowed to stand for 3 hours or more, before being filtered through a fine mesh sieve or kitchen cloth. The resulting juice is served cold.

#### 5.3.1.3 Second non-traditional method for preparing juice from indigenous fruits

The second non-traditional method of extracting juice from indigenous fruits entails a modification of the method discussed in section 5.3.1.2. With this method, the whole fruit and skin cover are pounded by means of pestle and mortar after carefully removing seeds. The crushed fruit pulp is then mixed with water (1 part per 7 parts) for a soaking period lasting 3 hours. However, due to the tannins in the fruit skin the resulting mixture is inclined to be very astringent and bitter. This unpleasant taste is usually reduced by adding relatively more (>10g) table sugar.

In addition, the mixture is then boiled for 30-40 minutes to enhance the extraction of soluble constituents in the fruit pulp. Usually, the boiling is accompanied by a change to a dark brownish or reddish colour, depending on the type of pigments present in the fruit species used. Whilst still hot, the mixture is carefully filtered slowly through a fine mesh sieve and the resultant juice is served cold. However, if the purpose is to brew an alcoholic beverage the mixture of the fruit pulp is not boiled as the increase (~100$^{o}$C) in heat will destroy the fermenting microorganisms.

The method outlined above in this section is nearly similar with the procedure reported by Nyanga *et al*. (2008), as practised by certain rural communities of Zimbabwe. Specifically, the similarity pertains to the brewing of a local traditional fruit juice known as "*mahewu"* in Zimbabwe. The latter beverage is prepared from dried fruits of local "*masau"* (*Ziziphus mauritiana*) plant species. Their fruit pulp is pounded as well, making use of a pestle and mortar before being mixed with water to make slurry. After leaving this slurry for a few hours in the sun, the beverage is ready for consumption without any attempt to separate liquid and solid constituents.

The important difference with the method specified by Nyanga *et al*. (2008) is that in Zimbabwe the locals do not remove the seeds from the fruit pulp and the resulting mixture is not boiled to enhance the extraction process. Another difference is that in the Limpopo province, the rural communities involved use fresh fruits rather than dried fruits as specified by Nyanga *et al*. (2008) and depending on the level of astringency and bitterness, table sugar is added as indicated in the methods for the Limpopo fruit juices.

### 5.3.2 Methods of preparing alcoholic beverages

Depending on the size of the fruits, the fruit flesh is sliced into small pieces whilst the seeds are removed. Nevertheless, if the fruits being utilised are small (less than 3-4cm), they are simply immersed into water for overnight soaking (Figure 5.14). After about 12 hours of soaking, the fruit pulp begins to loosen from the skin cover and seeds and at this stage about 3 g of table sugar (per litre) may be added to the mixture. Without boiling, the mixture is poured into a plastic container and deliberately placed in a warm place to initiate the fermentation process. After 2-3 days of fermentation, at an average ambient temperature of $25^{o}C$, the resulting product consists of a characteristic thickened solid-like mass suspended in liquid (slurry). Bubbles of carbon dioxide gas may also be seen on the surface of the mixture, signifying the breakdown of fermentable sugars into alcohol. At this stage, the beverage is regarded as a traditional beer or "*mukumbi*" and what follows thereafter is a filtration of the mixture through a fine mesh sieve or cloth, before being served. The resulting alcohol content ranged from 0.8% v/v for beer derived from mobola plum (*Parinari curatellifolia*) to 2.1% v/v for traditional beer fermented from cell sap obtained from ilala palm (*Hyphaene coriacea*).

The village-style preparation methods noted in the study areas use only fruit pulp, sugar and water as main ingredients for making traditional beer. By contrast, these methods differ with the procedures described by Lues *et al*. (2009) for preparing another type of indigenous traditional beer in a semi-urban area in South Africa. This beer is prepared from combining ingredients such as King Korn brand of "*Mthombo Mmela"* (maize), brown bread, compressed yeast and brown sugar, all mixed in a container of lukewarm water prior to fermentation (Lues *et al.*, (2009). Other differences relate to some of the cultural procedures practiced elsewhere in Africa. For instance, in rural Benin pulp juice extracted from baobab (*Adansonia digitata*) fruits is usually added to a paste enriched with ingredients such as maize, millet and sorghum before a period of fermentation (Chadare *et al*., 2010). The resulting fermented paste or "*mutchayan* is diluted in water and used as a traditional drink or consumed as a main dish with sauces" (Chadare *et al*., 2010: 9).

With respect to the current surveys in the Limpopo province, an alcoholic content of 0.8% v/v was determined for one of the traditional beers brewed from the fruit pulp of the mobola plum (*Parinari curatellifolia*), after only two days of fermentation. However, the amount of alcohol fermented from the sap obtained from the stem of ilala palm (*Hyphaene coriacea*) was relatively higher than this, as it measured 2.1% v/v.

Spirited beverages can also be produced from fruit pulps and this require a period of spontaneous fermentation, followed by an extended distillation process, using a low source of heat such as fuelwood, in order to isolate the alcohol content (distillate). This latter distillation process invariably yields spirited beverages with a potent alcoholic content. For instance, the amount of ethanol content distilled from mobola fruit pulp was found to be 32% v/v. Usually, 5 kg of dried fruit mass may provide about 6-7 litres of alcoholic spirit after a distillation process lasting 10-12 days. In general, the traditional method of preparing potent spirits in the study areas bears closer resemblance to those practiced in other African countries (Gadaga *et al*., 1999), the most notable difference being that no additional non-food ingredients such as bark of *Ziziphus mauritiana* are added to render the distillate more intoxicating (Brett *et al*., 1992; Nyanga *et al*., 2008).

Figure 5.14: Fruits of the blue sourplum (*Ximenia americana*) immersed and soaked in water in order to extract the juice required for fermentation.

#### 5.3.2.1 Liqueurs produced from indigenous fruits

In an attempt to add value to some of the alcoholic beverages prepared by respondents who participated in the study, some liqueurs were produced in association with the Agricultural Research Council (ARC), based in Nelspruit (Mpumalanga province) (De Jager and Du Preez, 2008, *personal communications*). By definition, liqueurs are generally flavoured and often sweetened distilled alcoholic beverages derived from neutral spirits (Chapman, 2006). The flavouring can be obtained by using nuts, spices, cream, herbs and fruits (Chapman, 2006). The liqueurs prepared in this study involved the flavouring and sweetening of cane spirit with individual indigenous fruits obtained from the Limpopo province. The indigenous fruits selected for making these liqueurs were as follows: (1) African mangosteen (*Garcinia livingstonei*), (2) Kei apple (*Doyvalis caffra*), (3) sand paper raisin (*Grewia flavescens*) as well as the (4) stem fruit (*Englerophytum magalismontanum*). These fruits were chosen on the basis of their sweet-tasting and mildly astringent flavour mix. A limited amount of cane spirit was purchased from a local liquor store. Thereafter, individual fruits were cleaned and carefully sliced after removing their seeds and skin cover. The sliced fruit fleshes were then placed into the cane spirit inside a canned fruit bottle. Thereafter, the individual mixtures were allowed to steep for 3 months. The resulting mixtures were constantly shaken (at least three times per week) to enhance the mixing and flavouring process. At the end of the steeping period, the liquid and solid constituents were carefully separated by means of filter paper and depending on the resulting flavour, table sugar or sugar syrup were added to enhance the degree of sweetness.

### 5.3.3 Traditional teas

Indigenous teas cited by respondents in the current study are prepared from various plant materials such as roots, bark, twigs, leaves and even fruits. The most common method of preparing tea from these materials involves boiling about 10 g in 2 litres of water for a period of nearly 10 minutes or more (a decoction). The mixture is then carefully strained and 2 to 3 cups may be drunk per individual. The tea may be consumed with or without milk and sugar, depending on personal preferences. If more tea is required, additional water may be added throughout the day. The remaining tea is usually stored in a cool place to prevent spoilage. The method of tea preparation outlined in this section (5.3.3) is similar to the traditional methods reported by Van Wyk and Gericke (2003); Joubert *et al*. (2008) as well as Olivier *et al*. (2008).

## 5.4 THE NUTRITIONAL ANALYSES OF SELECTED BEVERAGES

The nutritional composition of samples (beverages) analysed for this study were compared (where relevant) with the corresponding nutrient data pertaining to some of the commercial beverages. Such a comparison is important as it can indicate whether or not there are favourable nutrient-related characteristics with new product development potential. In addition, their nutritional importance was assessed by making comparisons with the recommended dietary reference intakes (DRIs), as summarised in Table 5.1. Table 5.2 provides a list of all beverages which received laboratory analyses.

Table 5.1: Recommended dietary reference intakes (DRIs).

| Life Stage Group | Carbohydrate (g/day) | Total dietary fibre (g/day) | Protein (g/day) | Vitamin C (mg/day) |
|---|---|---|---|---|
| *Infants* | | | | |
| 0-6 months | 60* | Not determined | **9.1** | 40* |
| 7-12 months | 95* | Not determined | **11** | 50* |
| *Children* | | | | |
| 1-3 y | **130** | 19* | **13** | **15** |
| 4-8 y | **130** | 25* | **19** | **25** |
| *Males* | | | | |
| 9-13 y | **130** | 31* | **34** | **45** |
| 14-18 y | **130** | 38* | **52** | **75** |
| 19-30 y | **130** | 38* | **56** | **90** |
| 31-50 y | **130** | 38* | **56** | **90** |
| 51-70 y | **130** | 30* | **56** | **90** |
| *Females* | | | | |
| 9-13 y | **130** | 26* | **34** | **45** |
| 14-18 y | **130** | 26* | **46** | **65** |
| 19-30 y | **130** | 25* | **46** | **75** |
| 31-50 y | **130** | 25* | **46** | **75** |
| 51-70 y | **130** | 21* | **46** | **75** |
| *Pregnant* | | | | |
| 14-18 y | **175** | 28* | **71** | **80** |
| 19-30 y | **175** | 28* | **71** | **85** |
| 31-50 y | **175** | 28* | **71** | **85** |
| *Lactating* | | | | |
| 14-18 y | **210** | 29* | **71** | **115** |
| 19-30 y | **210** | 29* | **71** | **120** |
| 31-50 y | **210** | 29* | **71** | **120** |

Note: This table presents Recommended Dietary Allowances (RDAs) in bold type and Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). Both RDAs and AIs may be used as goals for individual intake (US National Academy of Sciences, 2008). Vitamin C comparisons are provided in mg/day whilst carbohydrate intakes per day are given in g/day (*see* Rolfes, *et al.,* 2009).

*Sources:* US National Academy of Sciences (2008); Rolfes *et al.* (2009).

Table 5.2: List of beverages analysed for nutritional characterisation.

| Common name and plant part used | Latin name | Type of beverage |
|---|---|---|
| Lemon grass (leaves) | *Cymbopognon citratus** | Tea |
| Mopane (bark) | *Colophospermum mopane* | Tea |
| Bush tea (leaves and twigs) | *Athrixia phylicoides* | Tea |
| Wild tea (leaves and twigs) | *Monsonia angustifolia* | Tea |
| Rooibos (leaves) | *Aspalathus linearis* | Tea |
| Honeybush (leaves) | *Cyclopia intermedia* | Tea |
| Large-leaved raisin (fruits) | *Grewia inequilateria* | Tea |
| Mobola plum (fruits) | *Parinari curatellifolia* | Fruit juice |
| Sand apricot vine (fruits) | *Landolphia kirkii* | Fruit juice |
| African mangosteen (fruits) | *Garcinia livingstonei* | Fruit juice |
| Marula (fruits) | *Sclerocarya birrea* | Fruit juice |
| Brown ivory (fruits) | *Berchemia discolor* | Fruit juice |
| Blue sourplum (fruits) | *Ximenia americana* | Fruit juice |
| Forest num num (fruits) | *Carissa bispinosa* | Fruit juice |
| Blue sourplum (fruits) | *Ximenia americana* | Beer |
| Mountain karee (fruits) | *Rhus lancea* | Beer |
| Ilala (cellsap from stem) | *Hyphaene coriacea* | Beer |
| Mobola plum (fruits) | *Parinaria curatellifolia* | Beer |
| Nigerian palm (imported) (cell sap) | Unspecified palm* | Beer |

Species with an asterisk* are not prepared or produced from indigenous plant species in South Africa. However, the species were brought into the study for comparative purposes.

### 5.4.1 The nutritional aspects of fruit juices

The results on the nutritional aspects of fruit juices produced by both traditional and non-traditional methods are examined in subsections 5.4.1.1 and 5.4.1.2. Subsection 5.4.2 assesses the nutritional characteristics of selected alcoholic beverages while the nutritional properties of teas are examined in subsection 5.4.3.

5.4.1.1 Fruit juices produced by traditional methods

***Carbohydrates***

The amounts of total non-structural carbohydrates (TNC), comprised of monosaccharides and disaccharides (Cruz and Moreno, 2001) are shown in Figure 5.15 for four indigenous fruit juices prepared from the African mangosteen (*Garcinia livingstonei*), mobola plum (*Parinari curatellifolia*), sand apricot vine (*Landolphia kirkii*) and the forest num num (*Carissa bispinosa*) species.

Amongst the samples analysed, the forest num num fruit juice exhibited the lowest total non-structural carbohydrate content, found to be 0.16% while the values for African mangosteen (0.55%), mobola plum (0.55%) and sand apricot vine (0.52%) samples were almost similar. The low TNC amounts imply that they are not a good source of typically high energy-yielding carbohydrates such as glucose and fructose, thus of special importance to health-conscious consumers.

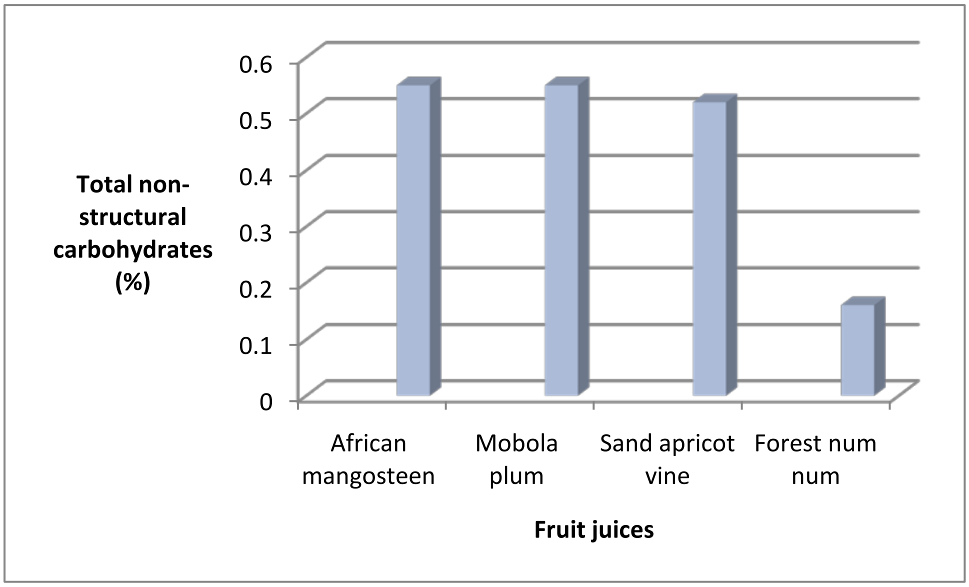



Figure 5.15: Total non-structural carbohydrate content (TNC) (%) of fruit juices analysed.

Figure 5.16 indicates a detailed sugar analyses for six different indigenous fruit juices. In general, sucrose levels were low for the majority of fruit juices analysed, ranging from a concentration of 0.13 g/100ml (sand apricot vine) to 0.23 g/100ml (African mangosteen). However, there were two notable exceptions, specifically blue sourplum (*Ximenia americana*) (1.31 g/100ml) and marula (*Sclerocarya birrea*) fruit (2.22 g/100ml) juices. Their relatively higher concentrations of sucrose are due to the addition of (common table sugar) sugar during preparation in order to reduce their astringence and bitterness. Fructose levels ranged from 0.13 g/100ml in the juice made from sand apricot vine to 0.15 g/100ml in the juice derived from forest num num fruits. Fructose levels recorded for marula (0.28 g/100ml) and blue sourplum (0.45 g/100ml) juices were higher. No maltose was detected in forest num num and blue sourplum fruit juices whereas in beverages such as African mangosteen, mobola plum, sand apricot vine and marula it was below 0.25 g/100ml. Glucose levels ranged from 0.07 g/100ml regarding mobola plum juice to 0.39 g/100ml in the blue sourplum juice. Based on these results, the blue sourplum and the marula fruit juices appear to have more natural sugars (with the exception of sucrose) than the other four fruit juices depicted in Figure 5.16.

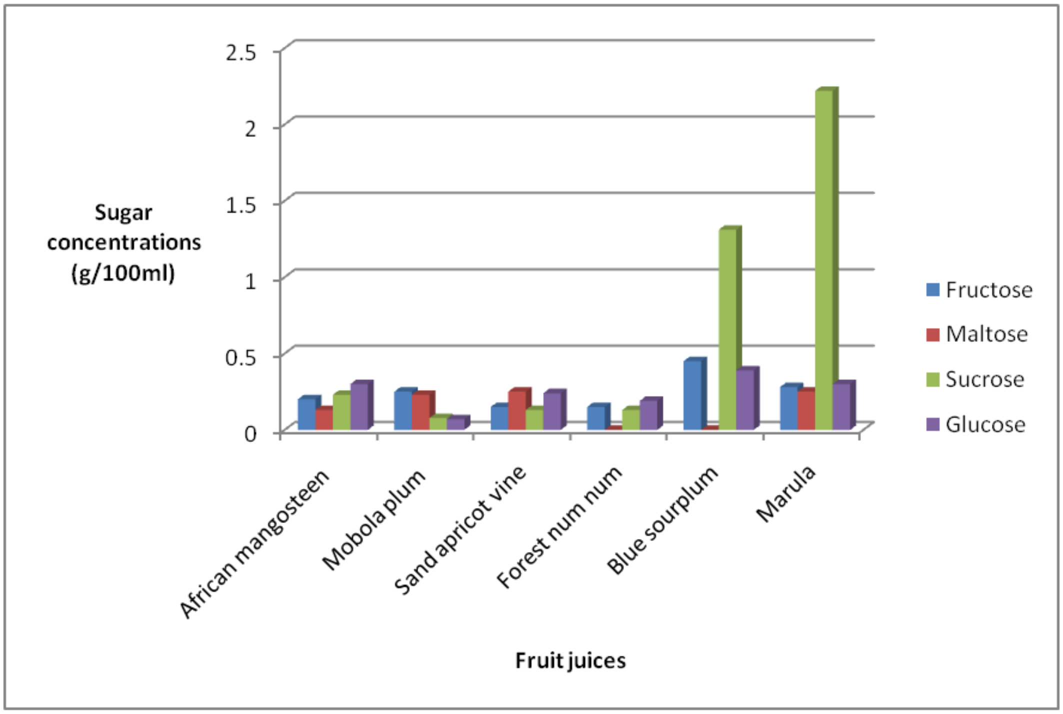


Figure 5.16: Detailed sugar analyses for the different indigenous fruit juices examined.

Detailed sugar analysis is an important aspect in the commercial production and manufacturing of fruit juices because it determines the degree of quality, adulteration or contamination and may, thus lead to better product standardisation (Rodriguez-Saona *et al*., 2001). For instance, commercial apple juices are expected to contain 1-3% sucrose, 2-3% glucose and 5-8% fructose (Brause and Raterman, 1982; Karadeniz and Eksi, 2002) while Dillon (1990) reported typical sugar ranges in orange juice of 3.0-5.5% sucrose, 1.8-2.8% glucose and 1.8-2.8% fructose. Based on these proportions, the characteristic fructose/glucose (F/G) ratio for commercial apple juices usually range from 2.0 to 2.5 while for orange juices it is typically 1.0 to 1.2 (Rodrigues-Saona *et al*., 2001). Indigenous juices derived from the African mangosteen, blue sourplum, marula and forest num num fruits, exhibited F/G ratios of 1.09, 1.15, 1.2 and 1.0 (respectively), all within the ratios commonly associated with commercially available orange juice. However, the total sugar content of the indigenous fruit juices analysed are considerably lower than their commercial counterparts.

***Total dietary fibre***

Figure 5.17 indicates total dietary fibre values amongst the indigenous fruit juices analysed. The African mangosteen fruit juice exhibited the lowest amount of dietary fibre (0.02 mg/100ml) whereas the brown ivory (*Berchemia discolor*) juice had the highest concentration (0.7

mg/100ml). However, this latter amount is still insignificant because a 300 ml serving of this beverage does not even represent 1% of the recommended adequate intakes (25 g/day) for children aged 4-8 years (Rolfes *et al*., 2009). It is worth noting, that these recommended adequate intakes (Table 5.1) exceed the total dietary fibre levels of some of the commercial fruit juices such as the wild berry fruit juice (0.02 mg/100ml), fruit blend of gojiberry, peach and granadilla (0.01 mg/100ml) as well as orange juice (0.3-0.5 g/100ml).

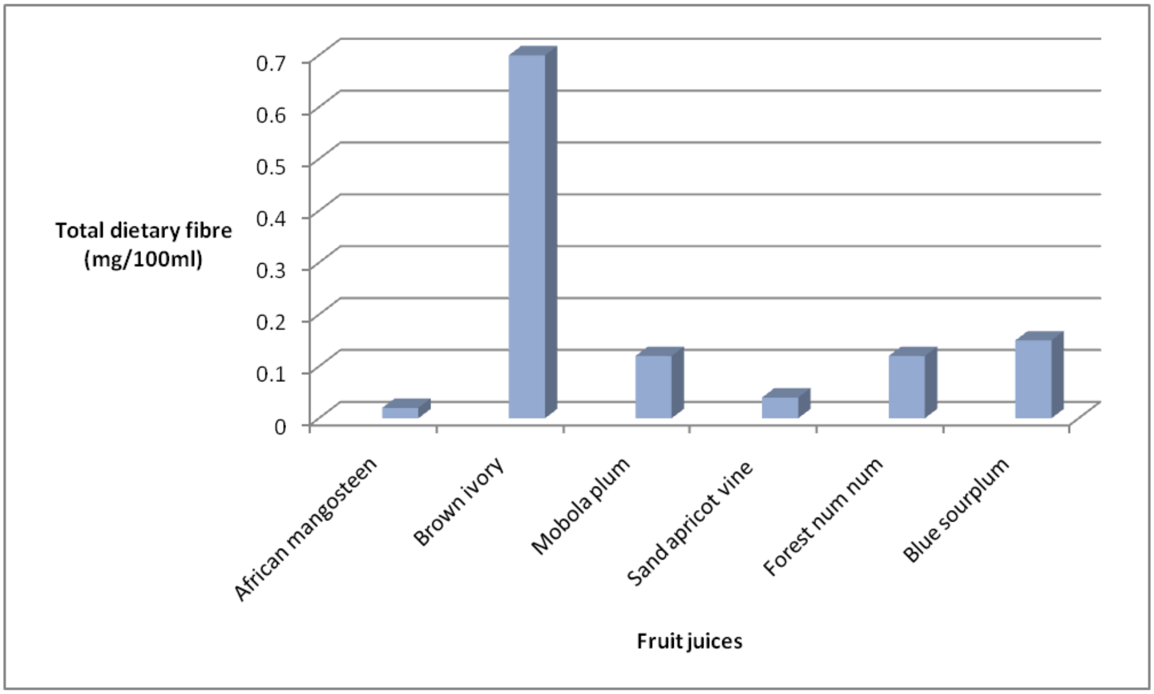



Figure 5.17: Concentrations of total dietary fibre (mg/100ml) amongst fruit juices analysed.

***Protein***

Figure 5.18 illustrates the protein concentrations of the various fruit juices examined. The mean protein concentration was found to be 0.312 mg/100ml, higher than the amount (0.0001 mg/100ml) of protein associated with one commercial orange juice. Protein concentrations in the brown ivory and the blue sourplum were relatively higher than all of these values - 0.9 mg/100ml and 0.8 mg/100ml, respectively. The fruit juice derived from the sand apricot vine exhibited the least amount (0.02 mg/100ml) of protein. As a whole, all the protein levels determined for the beverages depicted in Figure 5.18 are very small in terms of the recommended dietary allowance of 56 g/day, as specified by Rolfes *et al*. (2009).


Figure 5.18: Amounts of protein (mg/100ml) in fruit juices analysed.

***Vitamin C***

The vitamin C concentrations of the various juices examined are depicted in Figure 5.19. Fruit juices brewed from the sand apricot vine (0.23 mg/100ml) and the forest num num (0.03 mg/100ml) exhibited extremely low amounts of vitamin C. These concentrations differ markedly with the amounts established for ripe fruits (10 mg/100g), as reported by Wehmeyer (1986). Similarly, the values (i.e. 0.23 and 0.03) of vitamin C in these beverages are extremely small when compared to the recommended daily allowance of 15 mg/day for children aged 1-3 years (Table 5.1). In ascending order, they were followed by fruit juices derived from the mobola plum (0.63 mg/100ml), African mangosteen (0.71 mg/100ml) and the blue sourplum (8.25 mg/100ml).

The marula fruit juice exhibited the highest vitamin C content amongst the samples compared, as it was found to be 23.66 mg/100ml, considerably higher than the 3.6 mg/100ml vitamin C content specified for a certain commercial orange juice. From a dietary context, a 300 ml serving of this (marula) fruit juice could contribute 93% of the recommended dietary allowance for women aged between 19-70 years (US National Academy of Sciences, 2008). These comparisons also suggest that as little as 100 ml of this beverage satisfies 52% of the recommended daily allowance for children aged 9-13 years (Table 5.1) (Rolfes *et al.,* 2009).

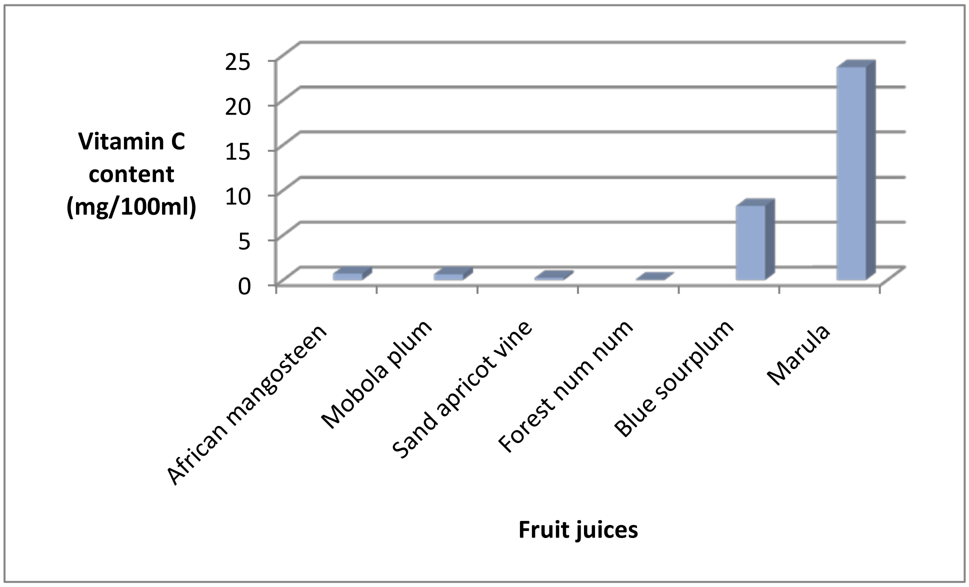



Figure 5.19: Vitamin C concentrations in the various indigenous fruit juices examined.

5.4.1.2 Mobola-based fruit juice prepared by a non-traditional method

Given the limited shelf-live and perishability of fruit juices examined in the study, only one additional fruit (mobola plum) juice was analysed further for the study. The latter beverage was prepared by means of the method described in section 5.3.1.3, the goal being to determine if there are any differences in the nutritional composition as compared to the sample brewed through the local traditional method as described in section 5.3.1.1. The nutritional parameters selected included carbohydrates (sugar) analyses, total dietary fibre, energy yield and vitamin C content.

***Carbohydrates***

The sugars present in the mobola fruit juice included fructose, glucose and sucrose. The concentrations of these sugars were as follows: fructose (1.14 g/100ml), glucose (0.56 g/100ml) and sucrose (17.52 g/100ml), respectively. All of these values are greater than concentrations observed with respect to the traditionally prepared mobola fruit juice. However, the value of sucrose (17.52 g/100ml) is artificially very high, clearly suggesting that relatively more table sugar was added during the preparation stages. The respondents in this study indicated that without adding this sugar, the beverage would remain extremely astringent and bitter.

Another parameter examined was the F/G ratio of the non-traditional mobola fruit juice. This ratio was found to be 2.0 as was the case with the juice prepared by means of traditional methods. This finding suggests marked similarity in the use of fruits (raw materials) with a similar carbohydrate composition. Furthermore, the total concentration of available carbohydrates in the non-traditional mobola fruit juice was found to be 16.5 g/100ml, approximately 38% higher than the 12 g/100ml usually associated with commercial fruit juices. In terms of dietary significance, the carbohydrate content of this mobola fruit juice contributes 13% of the recommended daily adequate intakes for individuals aged 9-50 years (Rolfes *et al*., 2009).

***Total dietary fibre and energy yields***

The total dietary fibre in the non-traditional mobola fruit juice was found to be 800 mg/100ml, considerably higher than 0.11 mg/100ml recorded for the traditional mobola fruit juice. However, it was found to be far below the recommended daily adequate intakes (26 000 mg/day) for women aged between 9-18 years (Table 5.1) (Rolfes *et al*., 2009). Other discrepancies noted pertained to marked variations observed with respect to energy values. Whereas the traditional mobola fruit juice exhibited an energy value of only 5 kilojoules/100ml, the sample prepared by one of the non-traditional methods (section 5.3.1.3) displayed an energy value of 295 kilojoules/100ml.

***Vitamin C***

Based on recommended dietary reference intakes (DRIs) (Table 5.1), the non-traditional mobola fruit juice exhibited appreciable quantities of vitamin C, as this nutritional parameter was found to be 19.8 mg/100ml. This concentration was found to be markedly superior to the value (0.63 mg/100ml) obtained for the traditional mobola fruit juice. The vitamin C content of 19.8 mg/100ml also exceeds the vitamin C concentration reported for banana (9 mg/100ml) and avocado (18 mg/100ml) juices (Akubor, 1996). From a nutritional context, a vitamin C concentration of 19.8 mg/100ml is equivalent to 44% of the recommended dietary allowance for individuals aged 9-13 years (US National Academy of Sciences, 2008; Rolfes *et al*., 2009) and also falls within the range (9-70 mg/100ml) commonly observed for commercially available fruit juices. Although the vitamin C concentration of mobola fruit juice was lower than that (i.e. 67mg/100ml) reported by Akubor (1996) for the African bush mango (*Irvinga gabonensis*) juice, the DRIs comparisons made in this study suggest that mobola fruit juice, with process optimisation could become a vital dietary source of vitamin C.

***Mineral elements***

Given the promising nutritional properties associated with the non-traditional mobola fruit juice, further analyses were conducted to determine the mineral concentrations. Table 5.3 summarises the mineral concentrations determined for this juice as well as associated DRIs in percentages. Mineral elements such as potassium (1537 mg/l), calcium (233 mg/l), magnesium (140 mg/l), and sodium (66.2 mg/l), occurred in relatively high concentrations. In terms of dietary reference intakes (DRIs), the amounts of potassium and calcium were equivalent to nearly 33% and 18%, respectively, of the recommended adequate intakes (RAIs) for women aged 14-18 years, based on values suggested by Rolfes *et al*. (2009). Sodium content satisfied about 4% of the recommended dietary allowance (RDA) for women aged 14-18 years. In addition, levels of magnesium and phosphorus mineral elements represented 39% and 6% of the recommended dietary allowance (RDA), respectively (Rolfes *et al*., 2009).

Table 5.3: Mineral content of fruit juice derived from the mobola plum (*Parinari curatellifolia*). DRIs comparisons made pertain only to females, aged 14-18 years.

| Mineral | Content (mg/l) | % DRIs[c] for females aged 14-18 years (mg/day); ~% RDA |
|---|---|---|
| Potassium | 1537 | 4700; ~33% [a] |
| Calcium | 233 | 1300; ~18% [a] |
| Magnesium | 140 | 360; 39% [b] |
| Sodium | 66 | 1500; ~4% [b] |
| Phosphorus | 69 | 1250; 6% [b] |
| Zinc | 2.26 | 9-11; ~25%-20% [b] |
| Iron | 2.37 | 15; ~16% [b] |
| Selenium | 0.29 | 0.055; ~527% |
| Manganese | 0.689 | 1.6; 43%[a] |
| Copper | 0.550 | 0.89; 62% [b] |

[a] Denotes Recommended Adequate Intake (RAI), [b] Denote Recommended Dietary Allowance (RDA), Both RAIs and RDAs may be used as goals for individual intakes. RDAs are set to meet the nutritional needs of almost all individuals in a group. For healthy breastfed infants, RAI is the mean intake.
[c]*Sources*: US National Academy of Sciences (2008); Rolfes *et al*. (2009).

Regarding trace minerals, the concentrations of zinc, iron, manganese, copper and selenium are also shown in Table 5.3. Two mineral elements occurred in relatively higher concentrations – zinc (2.26 mg/l) and iron (2.37 mg/l). These values satisfy approximately 25% and 16% (Table 5.3) of the recommended dietary reference intakes for women aged 14-18 years (US National Academy of Sciences, 2008). On the other hand, the concentration of copper (0.55 mg/l) amounted to 62% of the RDA for women aged 14-18 years while manganese (0.689 mg/l) content was equivalent to 43% of recommended adequate intakes (RAIs) for the same group.

Of health concern, though, is that the concentrations of some of the mineral elements determined may easily exceed maximum tolerable upper intake levels, if mobola fruit juice in the study areas is consumed excessively. This precautionary observation was deduced from the tolerable upper intake levels as specified by Rolfes *et al*. (2009). For instance, the maximum tolerable daily upper intake level of selenium should not be greater than 0.4 mg/day (or 400 *u*g/day) (Rolfes *et al*., 2009). However, the non-traditional mobola fruit juice analysed in this study exhibited a concentration of 0.29 mg/l – just 38% below the specified health threatening threshold.

**5.4.2 Analyses of the nutritional aspects of selected alcoholic beverages**

In the present study, samples of four different traditional beers were prepared from locally available indigenous plant species in the Limpopo province. Three of the traditional beers analysed were derived from the alcoholic fermentation of fruits, namely mobola plum (*Parinari curatellifolia*), blue sourplum (*Ximenia americana*) and mountain karee (*Rhus lancea*). The fourth sample from the Limpopo province was prepared from a cell sap tapped from the stem of ilala palm (*Hyphaene coriacea*) species while the fifth beer (manufactured from an unspecified palm species in Nigeria) sample is already commercialised.

5.4.2.1 Protein

The amounts of protein regarding the beverages analysed are depicted in Figure 5.20. Beer samples brewed from the blue sourplum and mobola plum species exhibited the highest protein level (0.3 g/100ml). The latter value differs only slightly with the protein level of 0.2 g/100ml determined for beers produced from the mountain karee, Nigerian palm as well as the South African ilala palm species. The values of protein content observed for all of the beers analysed in Figure 5.20 are below the 3-5 g/100ml threshold (Bamforth, 2002) associated with modern beer manufactured from hops and barley.

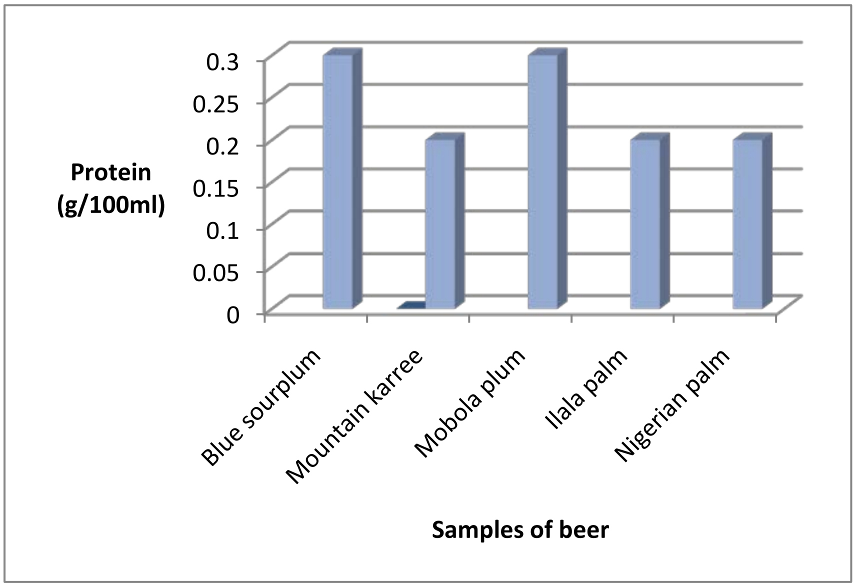



Figure 5.20: Protein levels (g/100ml) amongst beer samples analysed.

5.4.2.2 Carbohydrates

The different carbohydrate concentrations in the beer samples analysed are illustrated in Figure 5.21. The traditional beer brewed from the mountain karee exhibited the lowest carbohydrate content (0.1g/100ml). This was followed by the carbohydrate content of traditional beers brewed from the fruits of the blue sourplum and ilala palm (*Hyphaene coriacea*) sap, which were 3.1 g/100ml and 2.3 g/100ml, respectively. The highest amounts were noted for beers derived from mobola plum and Nigerian palm species, which displayed comparatively higher carbohydrate amounts, found to be 5.6 g/100 ml and 5.1 g/100ml, respectively.

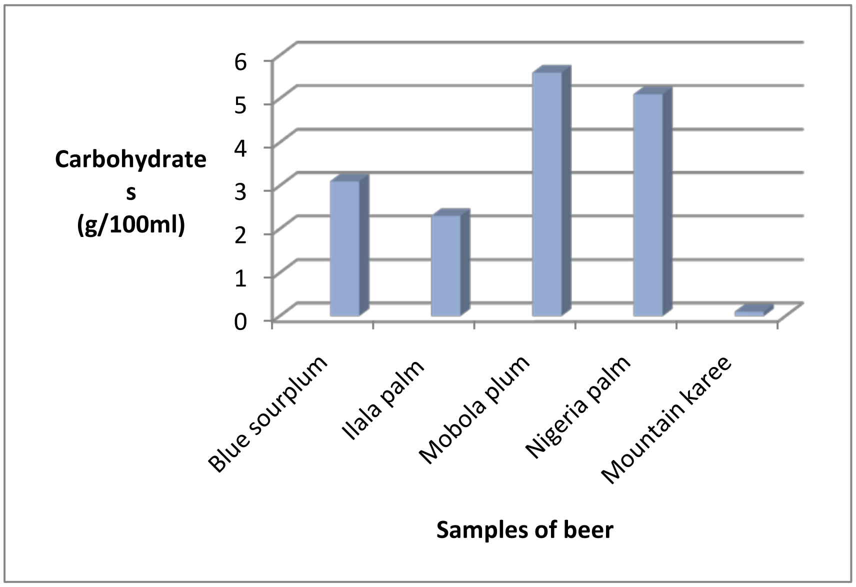



Figure 5.21: Carbohydrate content (g/100ml) amongst the beer samples analysed.

Further analyses of carbohydrate content showed that sucrose was not detected in four (blue sourplum, mountain karee, ilala palm and Nigerian palm) of the beer samples examined. However, with respect to mobola fruit-based beer, some sucrose content (0.26 g/100ml) was detected because (table) sugar was indeed added during the preparation process. Less glucose was detected in beer brewed from mountain karee (0.3 g/100ml) and ilala palm (0.7 g/100ml) while relatively higher glucose level was observed for the Nigerian palm beer as it exhibited an amount of 1.9 g/100ml. No fructose was detected in beers prepared from the sourplum and mountain karee fruits whereas beer samples derived from mobola plum and Nigerian palm exhibited fructose levels of 1.0 and 4.0 g/100ml, respectively.

5.4.2.3 Total dietary fibre

Three of the beer (blue sourplum, mountain karee and Nigerian palm) samples analysed, exhibited equal amounts (0.1 g/100ml) of total dietary fibre, as shown in Figure 5.22. The amount of dietary fibre recorded for mobola fruit-based beer was slightly higher than 0.1 g/100ml as it was found to be 0.7 g/100ml, very much within the range (0.5-1.0 g/100ml) recognised for commercialised beer produced from malted barley and hops (Baxter, 2000).

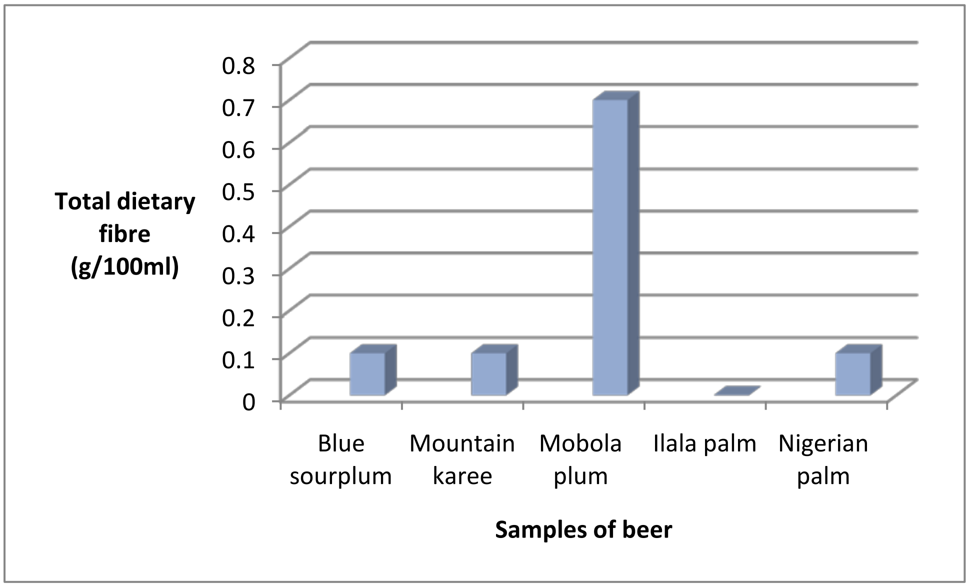



Figure 5.22: Total dietary fibre contents amongst the beers analysed.

5.4.2.4 Energy values

Another parameter analysed for the study was energy values. Figure 5.23 illustrates the different energy values of all the beer samples analysed. The Nigerian palm beer exhibited the highest energy value, of 269 kJ/100ml, followed by the mobola fruit-based beer which had a value of 156 kJ/100ml. The higher energy values for these two beverages may be partly ascribed to their relatively higher concentration of available carbohydrates, which measured 5.1 g/100ml and 5.6 g/100ml, respectively. The energy values recorded for the Nigerian palm beer and mobola fruit-based beer, were followed in descending order by values obtained for the blue sourplum beer, ilala palm beer and mountain karee beer, which were 58, 46 and 26 kJ/100ml, respectively.

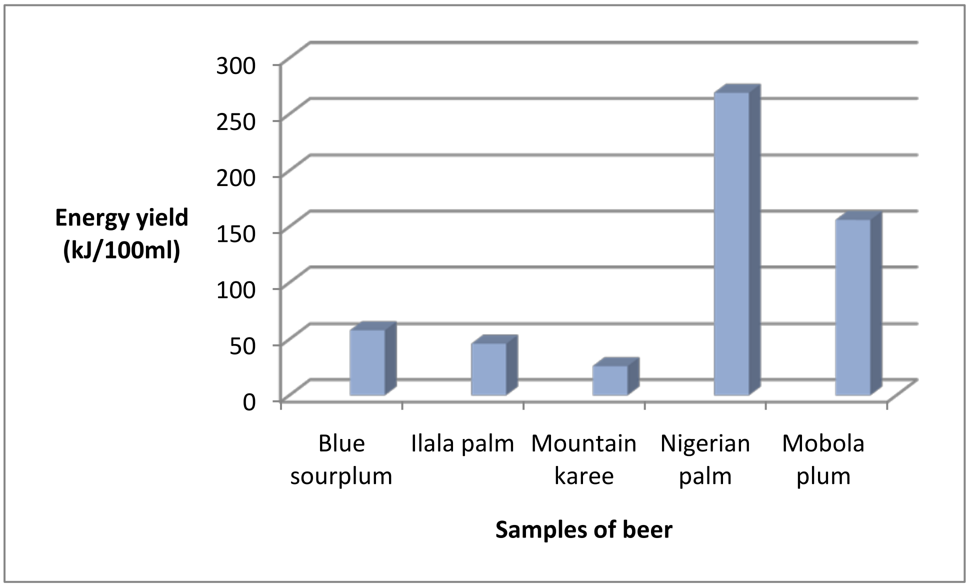



Figure 5.23: Energy values calculated for the different beer samples analysed.

5.4.2.5 Vitamins

Although vitamin C was not detected in the mountain karee beer, other beverages exhibited appreciable quantities of this nutrient. The traditional beers derived from the blue sourplum and the mobola plum, for instance, exhibited a vitamin C content of 16.2 mg/100ml and 25.4 mg/100ml, respectively. These two values exceed the vitamin C concentration of 5 mg/100ml reported by Akubor (1996) for the African bush mango (*Irvingia gabonensis*) wine. However, levels of their vitamin $B_6$ and $B_{12}$ were found to be less than 0.05 mg/100ml during laboratory analyses.

### 5.4.3 The nutritional properties of selected traditional teas

5.4.3.1 Total non-structural carbohydrates

The amounts of total non-structural carbohydrates in the various teas (beverages) are depicted in Figure 5.24. The wild tea (*Monsonia angustifolia)* species exhibited the highest amount (16.4%) of total non-structural carbohydrates and was closely followed by bush tea (*Athrixia phylicoides*) and (non-indigenous) lemon grass (*Cymbopogon citratus*) which had 15.6% and 9.89%, respectively. The indigenous teas made from the berries of the large-leaved raisin (*Grewia inequilateria*) and mopane (*Colophospermum mopane)* bark showed the least amounts of total non-structural carbohydrates, measured as 0.23% and 0.14%, respectively. Generally, the lower the amount of total non-structural carbohydrates, the lesser the concentration of energy-yielding carbohydrates.

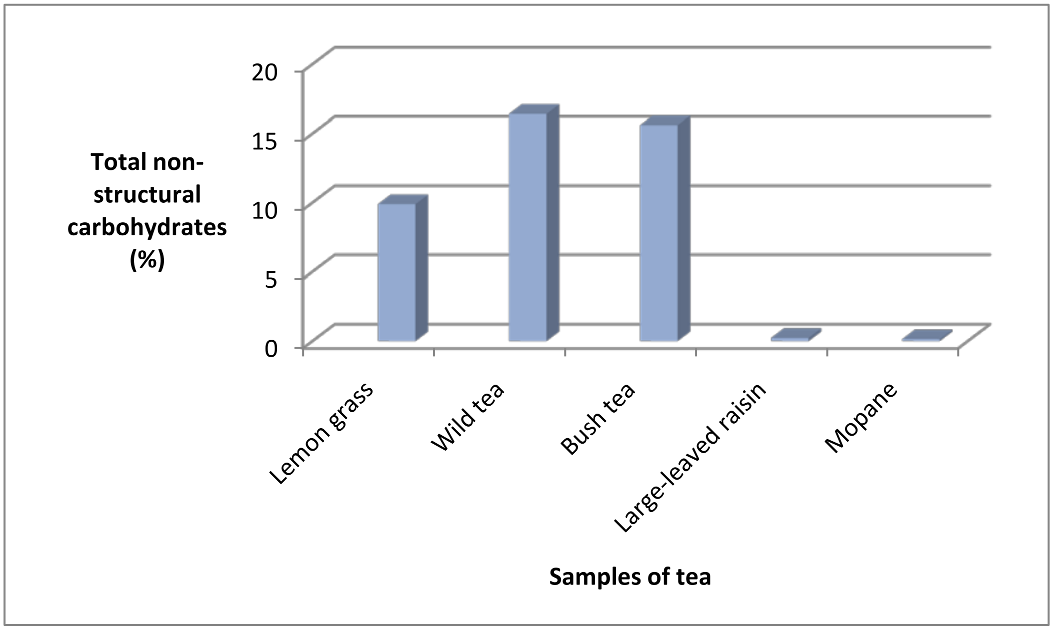



Figure 5.24: Amounts of total non-structural carbohydrates (%) amongst selected beverages.

5.4.3.2 Caffeine and tannins

Caffeine is a compound widely regarded as an addictive substance, including dependence, tolerance and withdrawal and to cause a range of adverse health effects such as palpitations, nervous irritability as well as gastrointestinal disturbances when consumed excessively (Kuczkowski, 2009; Temple, 2009; Pohler, 2010). In the samples analysed in this study, no caffeine was detected in any of the traditional teas (*Athrixia phylicoides, Colophospermum mopane* and *Grewia inequilateria)* analysed. Similar findings were obtained for *Athrixia phylicoides* by McGaw *et al.* (2007a). The results obtained indicate that the traditional teas analysed for the study are similar to other African indigenous teas such as rooibos and honeybush, which also lack caffeine (Van Wyk and Gericke, 2003).

However, with respect to tannin levels, some variations were observed. For instance, teas prepared from (the berries) *Grewia inequilateria* and (the bark of) *Colophospermum mopane* species had the lowest amounts of tannins – measured to be 0.09% and 0.14%, respectively. On the other hand, bush tea (*Athrixia phylicoides*) displayed relatively higher tannin concentration (12%).

5.4.3.3 Vitamins

The vitamin concentrations of bush tea and mopane tea are compared in Figure 5.25. Bush tea exhibited relatively higher concentrations in all of the vitamins analysed. However with respect to vitamin C, concentrations differed only slightly, although bush tea was still slightly higher (2.67 mg/100ml) compared to mopane tea (2.54 mg/100ml).

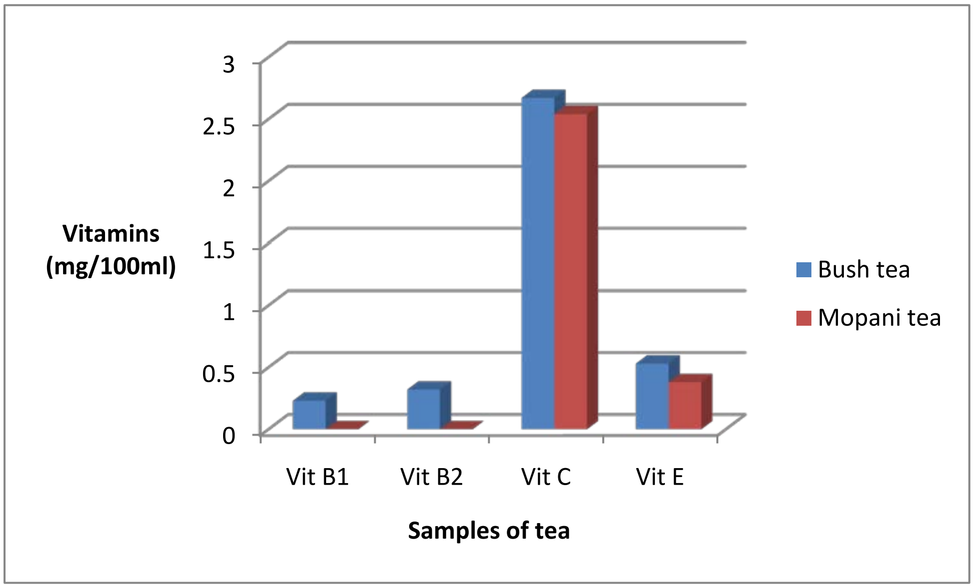



Figure 5.25: Vitamin concentrations in selected indigenous teas.

5.4.3.4 Mineral elements

Figure 5.26 displays the concentrations of macro mineral elements analysed in bush tea (*Athrixia phylicoides*), rooibos tea (*Aspalathus linearis*) and honeybush tea (*Cyclopia* spp). These indigenous teas contained most of the minerals analysed for the study, although there were variations. Notably, bush tea exceeded all the other (commercialised) indigenous teas (rooibos and honeybush) in terms of calcium, magnesium, potassium and sulphur concentrations. Moreover, a 250 ml cup of bush tea is the richest source of potassium (30.04 mg/250ml) amongst the samples analysed as it exceeded others - rooibos (6.40 mg/250 ml) tea and honeybush tea (7.84 mg/250ml). However, phosphorus levels for the three beverages analysed were in the same range.

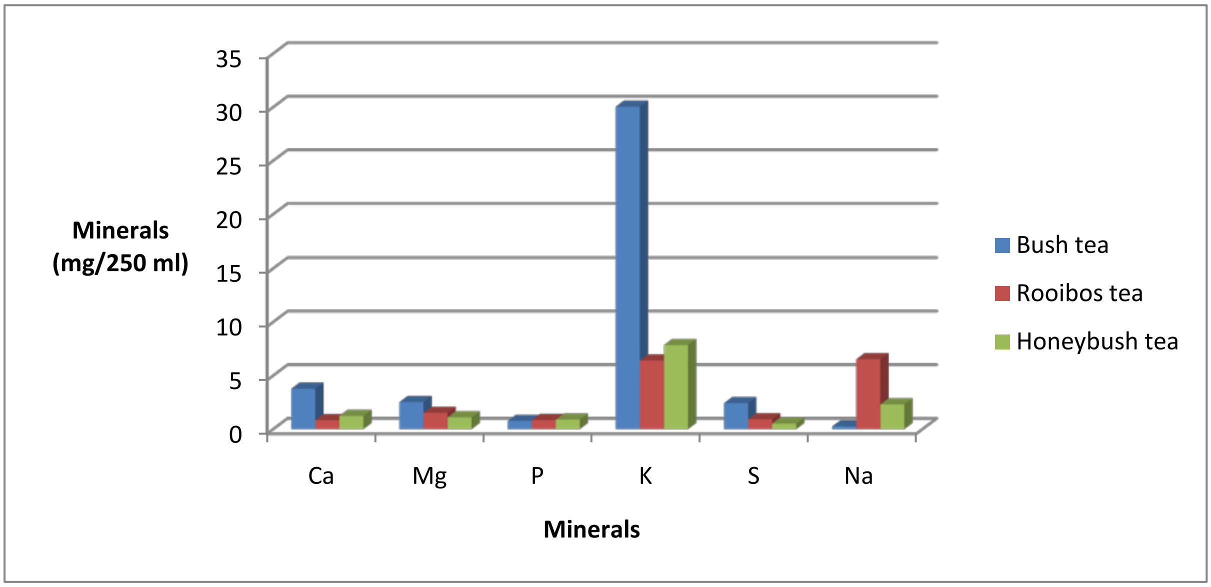



Figure 5.26: Concentrations (mg/250ml) of six major mineral elements in bush tea, rooibos tea and honeybush tea (infusions).

## 5.5 SUMMARY OF THE RESEARCH FINDINGS

This section provides a brief summary of the research findings presented in this chapter. Section 5.5.1 provides a brief overview on key indigenous plant species regarded as having a high commercial development potential for the production of various kinds of beverages. Section 5.5.2 summarises the traditional methods of making these beverages as well as how value-added liqueurs can be produced from certain plant species. The last section (5.5.3) summarises the nutrient-related aspects of some of the beverages analysed for the study.

### 5.5.1 Selected indigenous plant species

Twelve indigenous plants have been reviewed regarding their nutritional, ethnomedicinal and phytochemical properties. Where relevant, their ethnobotanical aspects as well as uses have been specified. Based on the literature reviewed, at least seven of these plants, notably the brown ivory (*Berchemia discolor*), stem fruit *(Englerophytum magalismontanum)*, corky monkey orange (*Strychnos cocculoides*), blue sourplum (*Ximenia americana*), wild medlar (*Vanguira infausta*) and the Kei apple (*Doyvalis caffra*) have already been selected as key priority species for enhancing local subsistence trade and propagation potential either in South Africa or elsewhere in Africa. The bush tea (*Athrixia phylicoides*) has also received research attention and it is currently undergoing commercialisation initiatives.

Amongst all the indigenous plants reviewed, the Kei apple (*Doyvalis caffra*) has received relatively more research attention regarding fruit composition, ethnomedicinal uses, phytochemical aspects as well as propagation potential, while the red milkwood (*Mimusops zeyheri*) was once top-ranked by Mashela and Mollel (2001) as the most important indigenous fruit species in the Limpopo province. However, there is less scientific knowledge on the development potential of indigenous plant species such as the sand apricot vine (*Landolphia kirkii*), magic quarri (*Euclea divinorum*) and the sand paper raisin (*Grewia flavescens)*.

### 5.5.2 Beverage production methods

The preparation techniques for various non-alcoholic and alcoholic beverages were explained in section 5.3. As discussed, there are several methods for making non-alcoholic fruit juices in the study areas in the Limpopo province. The local traditional techniques for preparing fruit juices in the study areas need improvement, hence some non-traditional methods are being introduced to help optimise existing processes.

The preparation of alcoholic beverages such as traditional beer basically requires the presence of fermentable carbohydrates in any plant part (cell sap or fruit flesh). Such carbohydrate sources are then mixed with sugar in a water medium to allow for spontaneous fermentation. However, this simple process differs with some of the traditional techniques described by Lues *et al*. (2009) and Chadare *et al*. (2010), whereby relatively more ingredients are used and are processed in rather “complex” patterns.

Besides the local preparation of traditional beers in the study areas by spontaneous fermentation of the fruit pulp, it is also possible to produce spirited beverages over an extended period (10-12 days) of fermentation and distillation. The methods employed are fairly straightforward and there are no attempts to modify the intoxicating nature of the final distillate as it is practiced in some of the rural areas of Zimbabwe (Nyanga *et al.*, 2008).

Of marketing significance, the local indigenous fruit types cited by some of the respondents during surveys in the Limpopo province can be used to flavour neutral spirits, thus leading to the production of value-added products such as liqueurs. Lastly, a number of traditional teas can be prepared from certain plant species growing in the Limpopo province. When making teas, the plant parts targeted by locals are varied and include leaves, twigs, bark, roots as well as berries. Regardless of which part is utilised, the method followed is the same and involves boiling tea material in a pot on a low heat source.

### 5.5.3 Nutrient aspects of selected beverages

Three different types of beverages (fruit juices, alcoholic beverages and traditional teas) were analysed regarding their nutritional composition in section 5.4. Their nutritional importance was assessed by comparing them with commercial beverages where corresponding data existed and also by determining their contributions to recommended dietary allowances for various individuals.

Regarding fruit juices, most nutrients analysed occurred in low concentrations. For instance, fruit juices prepared by village-style traditional methods consistently exhibited low TNC and protein amounts. The sugar analyses performed indicated that sucrose occurred in several fruit juices, depending upon how much table sugar was added during the preparation stages in order to reduce the degree of bitterness and astringence. The amounts of fructose and glucose were invariably very low. As it is the case with commercial fruit juices, the traditional fruit juices analysed for this study were found to be poor sources of total dietary fibre. However, the non-traditional fruit juice derived from the fruits of mobola plum exhibited relatively high levels of total dietary fibre, even though it was still inadequate to satisfy the recommended daily adequate intakes.

In terms of vitamin C content, fruit juices prepared from the blue sourplum, marula and the mobola plum indicated relatively high amounts, 8.25 mg/100ml, 23.66 mg/100ml and 19.8 mg/100ml (respectively), depending upon the method followed. In addition, the non-traditional mobola fruit juice proved to be a rich source of some of the mineral elements analysed, especially in respect of potassium (1537 mg/l), calcium (233 mg/l), magnesium (140 mg/l) and sodium (66.2 mg/l). It is also evident that the values obtained for trace minerals such as zinc (2.26 mg/l) and iron (2.37 mg/l) could make an important contribution towards the recommended dietary reference intakes suggested by Rolfes *et al*. (2009), as long as these concentrations do not exceed maximum tolerable upper intakes detrimental to human health.

With respect to alcoholic beverages, the values of protein content for all of the beers analysed were below the 3-5 g/100ml threshold (Bamforth, 2002) commonly associated with modern beer manufactured from hops and barley. Beer samples derived from the mobola plum and the

Nigerian palm exhibited relatively higher carbohydrate concentrations, leading to higher energy values. The beer sample prepared from the fruits of mobola plum exhibited 0.7 g/100ml total dietary fibre, within the range (0.5-1.0 g/100ml) characteristic of commercial beer produced from malted barley and hops (Baxter, 2000). More remarkably, the traditional beers prepared from the blue sourplum and the mobola plum exhibited a vitamin C content of 16.2 mg/100ml and 25.4 mg/100ml (respectively), thus exceeding the vitamin C concentration of 5 mg/100ml reported by Akubor (1996) for the African bush mango (*Irvingia gabonensis*) wine.

The traditional teas analysed had relatively higher contents of total non-structural carbohydrates, notably 16.4% for the so-called wild tea (*Monsonia angustifolia),* 15.6% for bush tea (*Athrixia phylicoides*) and 9.89% for (the non-indigenous) lemon grass (*Cymbopogon citratus*). It was also established that indigenous teas such as *Athrixia phylicoides, Colophospermum mopane* and *Grewia inequilateria* lack caffeine in their chemical composition, thus similar in that respect with other African teas such as rooibos and honeybush.

Lastly, bush tea derived from the *Athrixia phylicoides* species was compared with other indigenous teas in terms of selected mineral elements. Bush tea exceeded both rooibos and honeybush tea in terms of calcium, magnesium and sulphur content. Most importantly, the amount of the potassium mineral in bush tea was found to be approximately 3 times higher than amounts observed for honeybush and rooibos, which are already commercialised in South Africa.

# CHAPTER 6

## RESEARCH FINDINGS AND DISCUSSION: ASSESSMENT OF THE COMMERCIAL DEVELOPMENT POTENTIAL OF SELECTED INDIGENOUS PLANT-BASED BEVERAGES

### 6.1 INTRODUCTION

This chapter deals with the commercial development potential of some of the indigenous plant-based beverages in the Limpopo province selected for this study. The potential of these concept beverages was estimated from sensory analyses as well as ratings (or evaluation) of product acceptability on a hedonic scale. The development potential was also estimated from market development indicators such as willingness on the part of panellists to make purchases or recommend them to other people, prices they were willing to pay, changes they recommended for the final products and some findings from surveys.

Only one indigenous plant-based fruit juice was assessed because it was difficult to obtain fruits of a sufficient quantity and quality to prepare fresh beverages. Another challenge involving the preparation of non-alcoholic fruit juices was maintaining their microbiological quality (safety) and freshness without the use of preservatives. Consequently, the only fruit juice assessed was derived from the mobola plum (*Parinari curatellifolia*) plant species, which occurs in abundance in many areas of Venda. A traditional beer derived from the same plant (*Parinari curatellifolia*) species was also analysed for sensory characterisation.

Other types of alcoholic beverages, specifically liqueurs, prepared from the fruits of indigenous plants species were also assessed for market development potential. The liqueurs were derived from the fruits of the sand paper raisin (*Grewia flavescens*), African mangosteen (*Garcinia livingstonei*), Kei apple (*Doyvalis caffra*) and the stem fruit (*Englerophytum magalismontanum*).

Only one indigenous tea (the so-called bush tea) derived from *Athrixia phylicoides* was assessed through sensory analyses and indications of market development potential. As stated earlier, bush tea has a favourable nutrient and medicinal profile and it was not difficult to obtain reliable supplies of sufficient quality and quantity in the areas surveyed for the study. Other indigenous teas derived from plant species such as mopane (*Colophospermum mopane*), fever tea (*Lippia javanica*) and purple pod cluster leaf (*Terminalia prunioides*) were not analysed in this chapter due to growing scarcity in their natural habitats or unsustainable means of harvesting them. The results obtained in each category of beverages are presented in section 6.2 while section 6.3 provides a summary of these findings.

## 6.2 SENSORY ANALYSES AND ASSESSMENT OF MARKET POTENTIAL FOR SELECTED NON-ALCOHOLIC AND ALCOHOLIC BEVERAGES

### 6.2.1 Beverages derived from the mobola plum, *Parinari curatellifolia*

The first batch of samples made available for sensory analyses and assessment of market potential were derived from mobola plum. The samples were prepared by members of the rural community of Makonde (in the Limpopo province) who participated in the research project. The samples provided were of two types – a non-alcoholic fruit juice and a traditional beer.

Given the low quantities of samples provided, only two different groups of assessors (panellists) were involved in the evaluation phase. The first group of panellists was comprised of participating Unisa staff (in the Department of Environmental Sciences) while the second group of panellists belonged to a scientific laboratory (based in Woodmead) which specialises in new product development as well as sensory analyses.

6.2.1.1 Sensory evaluation of the mobola fruit juice

At Unisa, the juice prepared from the fruits of mobola plum was evaluated by 10 panellists. The responses of all panellists on the aroma characteristics of this beverage are shown in Figure 6.1. Thirty nine percent of Unisa panellists indicated that the fruity note was the most distinctive aroma attribute. Additionally, six percent and 22% of them indicated that there were shadows of pineapple (6%) and guava (22%) odours, as well. An equal proportion (11%) of Unisa panellists highlighted woody, grassy and a herbal note linked to a ginger theme. Those who liked this aroma note constituted 30%. The majority of panellists at the specialised (Woodmead) laboratory also identified the fruity aroma as the main characteristic note of the juice derived from the mobola plum.

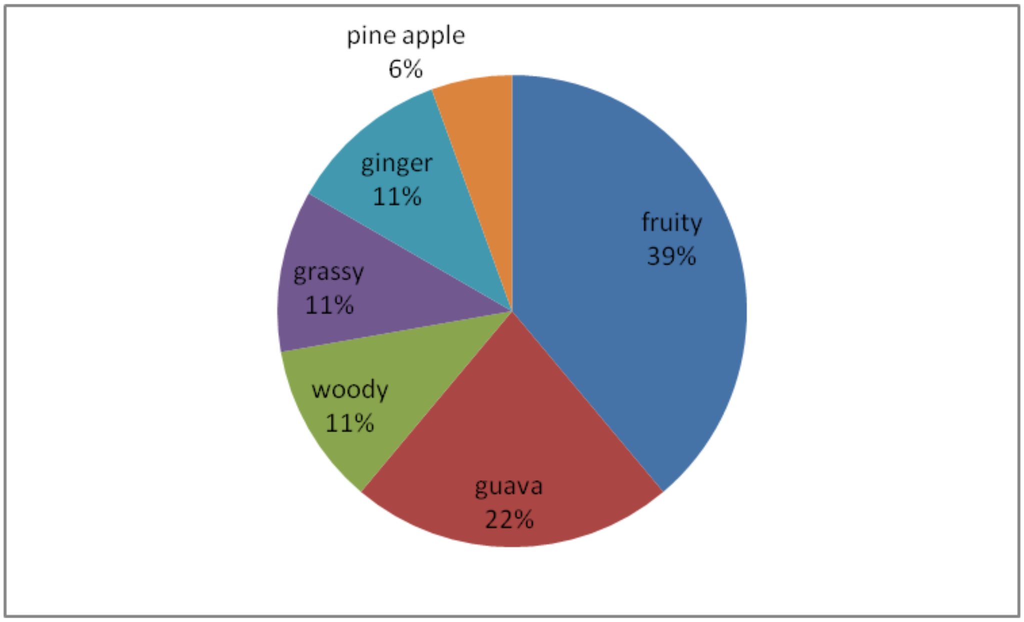



Figure 6.1: The percentages of Unisa panellists who identified the aroma notes of juice derived from mobola plum (*Parinari curatellifolia).*

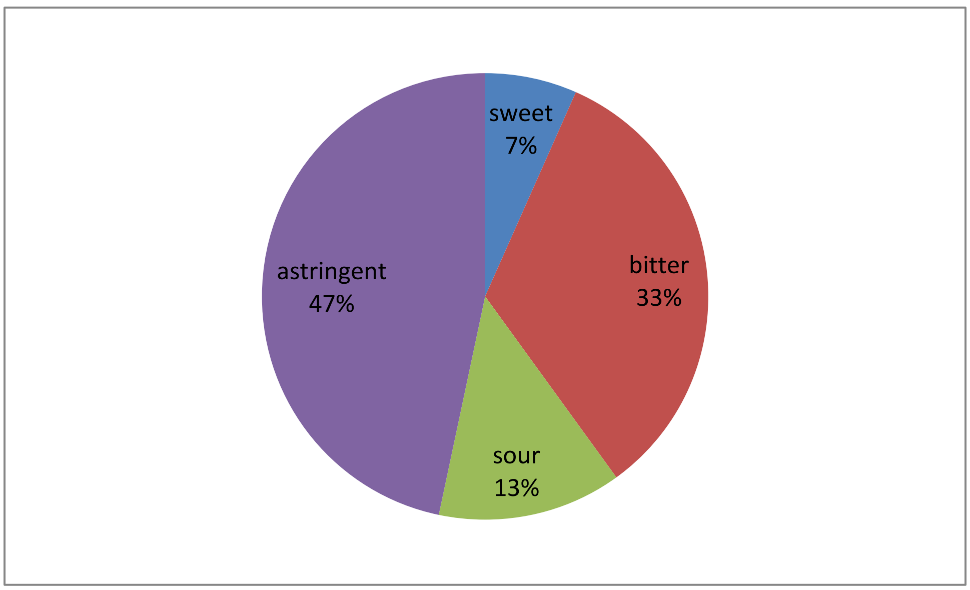



Figure 6.2: The various percentages of Unisa panellists who identified flavour attributes of mobola fruit juice.

The attributes of the flavour composition of the mobola plum fruit juice, based on responses from Unisa panellists, are shown in Figure 6.2. Despite the pleasant aroma expressed by Unisa panellists, 80% of them indicated that they did not like its acrid and mouth puckering effects although its light brownish colour was acceptable. These off-tastes are shown as 33% and 47%

of panellists who indicated marked bitter and astringent notes, respectively. The sour and sweet notes were recognised by only 13% and seven percent of panellists, respectively.

The results from evaluating panellists at Woodmead laboratory also indicated the presence of bitter and astringent notes, suggesting that the juice requires the addition of sweeteners and a balance of acidity in order to improve its taste (Parsons, 2007, *personal communications*). Given the negative impressions picked by all groups of panellists, the mobola fruit juice subsequently scored very low on the product acceptability (hedonic) scale as shown in Figure 6.3. Generally, all of the panellists involved selected ratings ranging from 4 (which means disliked slightly) to 1 (disliked extremely).

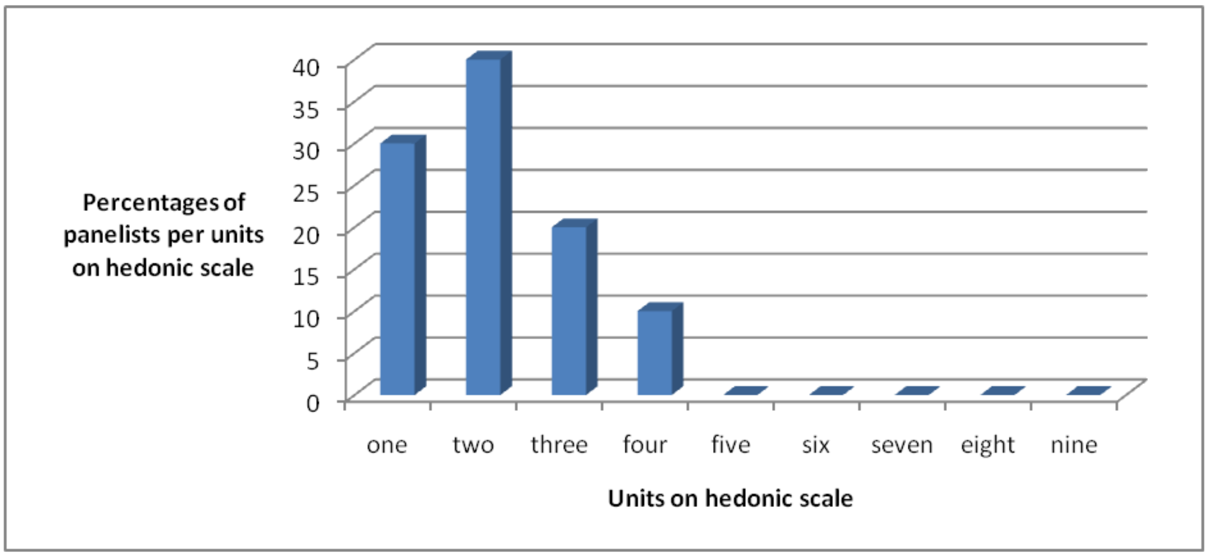



Figure 6.3: The percentages (%) of panellists who evaluated the mobola plum (*Parinari curatellifolia*) juice on the hedonic scale (1-9).

Figure 6.3 shows that 30% of panellists gave it a rating of one while 40% associated it with a rating of two, which implies very much disliked and extremely disliked, respectively. The major reason advanced by panellists for the negative ratings selected was its mouth puckering, acrid and bitter features and lack of clarity, suggesting that it cannot be commercially manufactured and marketed in its current form. Consequently, all panellists stated their unwillingness to buy it or recommend it to someone else, should it be commercialised in its current form in the future.

6.2.1.2 Evaluation of mobola fruit-based beer

The mobola fruit-based beer was evaluated by both (Unisa and Woodmead) teams of panellists. The alcohol content of the traditional beer was 0.8% v/v. Sixty one percent of Unisa panellists felt that the most outstanding aroma attribute was the fruity note and it was followed in descending order by the alcohol (16%), ginger (14%) and herbal (9) attributes. The reddish brown colour of the beer was acceptable to 38% of the panellists involved and suggestions were made to improve its clarity by eliminating sediment content.

The beer was also evaluated by a panel of specialists at laboratories in Woodmead and the following patterns emerged. Seventy eight percent of these panellists mentioned the fruity note as the most important aroma element and this was followed by those who sensed a floral note (10%) and the alcohol note (12%).

Regarding the flavour composition of mobola fruit beer, thirty nine percent of Unisa panellists found it to be bitter and unpleasant while 35% mentioned that it is astringent. The alcohol and sour notes were recognised by 17% and nine percent of panellists involved, respectively. The Woodmead panellists mentioned that the mobola beer has a pleasant and rich fruity flavour, although much has to be done to improve its overall composition and mouthfeel attributes. The proportions of Woodmead panellists on various flavour notes were as follows: sweetness (3%), sourness (18%), warming sensation (15%) associated with alcohol content, bitterness (29%) and astringence (35%).

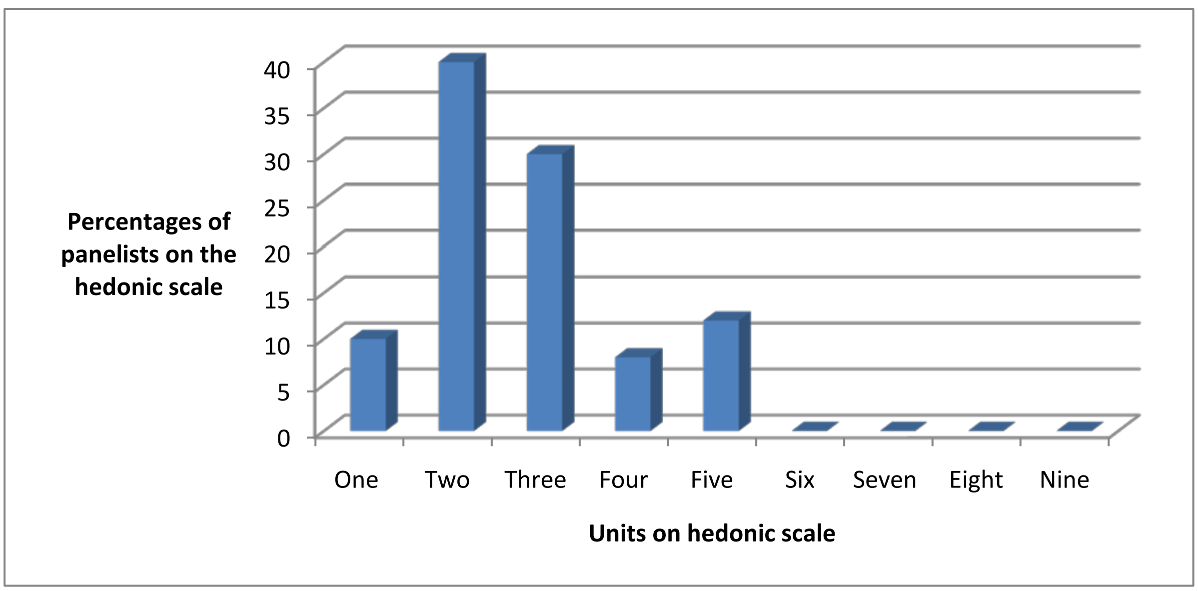



Figure 6.4: The different proportions (%) of Unisa panellists who evaluated the mobola fruit beer making use of the product acceptability scale (hedonic scale).

Figure 6.4 depicts the different scores allocated by Unisa panellists who evaluated mobola fruit beer. Basically, this beverage scored poorly on the hedonic scale. This is attested to by the fact that 88% of the panellists involved selected a rating of four or a lesser score. Given the poor flavour make-up of this beverage, the majority of Unisa panellists stated that they were not willing to buy or recommend it to anyone should it be commercialised without an enhancement of its taste and composition. Those that were willing to buy it would pay prices ranging from R6.00 to R12.00 per 750ml.

### 6.2.2 An evaluation of liqueurs

Unlike the traditional beverages derived from mobola plums, which were prepared by participating respondents in the village of Makonde in the Limpopo province, the liqueurs were prepared for the study as value-added concept products in association with the Agricultural Research Council (ARC) at the Institute of Tropical and Subtropical Crops (ITSC) at Nelspruit, Mpumalanga province.

6.2.2.1 Liqueur produced from the berries of the sand paper raisin, *Grewia flavescens*

The sensory analyses and evaluation of the liqueur produced from the berries of the sand paper raisin involved 10 Unisa panellists, 18 IPUF panellists and 31 Makro Centurion panellists. Amongst the Makro Store panellists, 84% of them liked the aroma attributes. This value was much higher amongst the Unisa panellists (90%) and the IPUF panellists (97%).

Sixty seven percent of Unisa panellists found the major aroma element to be overwhelmingly fruity. A pleasant shadow of apple-like odour was suggested as well, represented by 11% of them. At the same time, 11% of panellists also mentioned the following background notes: woody (11%) and alcohol (11%) attributes in equal proportions. Amongst IPUF panellists, 30% felt that the major aroma note was fruity and was closely followed by an odour note (28%) associated with the characteristic warming sensation of alcohol, measured to be 16% v/v by concentration. Fourteen percent of IPUF panellists detected other notes such as grassy, menthol and honey. Fifty five percent of Makro Centurion panellists associated this liqueur with a fruity aroma note while 9% suggested an apple-like shadow linked to this note. Twenty three percent of these panellists also picked the warming sensation stemming from the alcohol content. About 9% and 4% of them mentioned a herbal note as well as a grassy note, respectively. Ninety four percent of all tasters who participated in the sensory analyses of the

*Grewia flavescens* liqueur indicated that they liked its characteristic fruity and alcohol-like aroma.

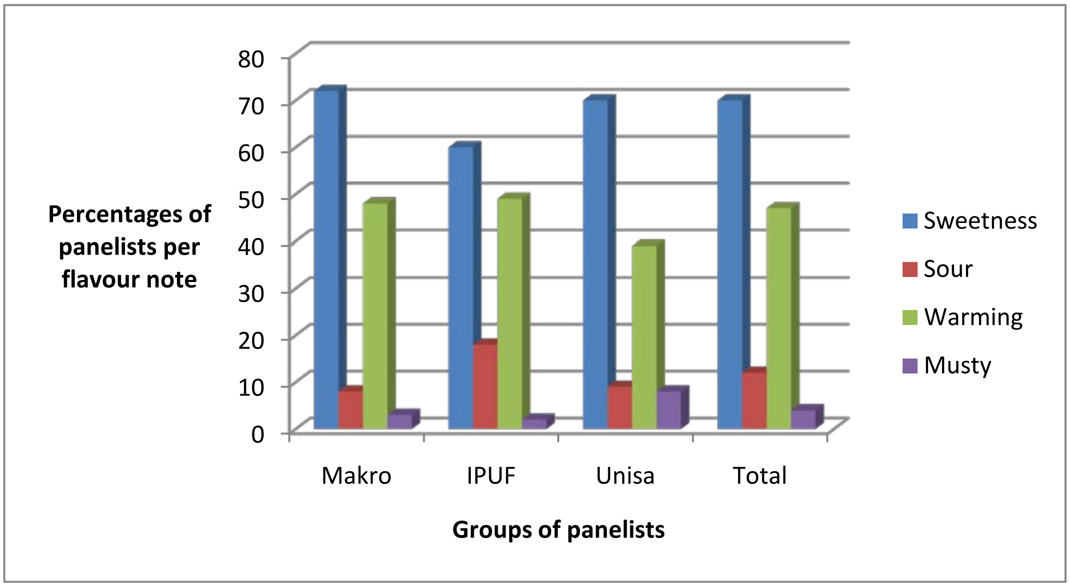



Figure 6.5: The various proportions (%) of panellists who identified the different flavour notes associated with the *Grewia flavescens* liqueur.

Figure 6.5 illustrates all the flavour notes associated with the *Grewia flavescens* liqueur. The major flavour element identified by 70% of all panellists was one of sweetness. This tendency (sweetness) was recognised by all groups of panellists involved. The warming sensation stemming from the alcohol content (16% v/v) was suggested by 46% of the panellists (Figure 6.5). This sensation was notably conspicuous amongst the IPUF and Makro Centurion panellists.

Although the golden brown colour of the *Grewia flavescens* liqueur was approved by 38% of the panellists, 44% of them felt that the colour was rather too dark as most liqueurs they were familiar with are lightly coloured. When the same beverage was evaluated on a hedonic scale, the following patterns emerged (Figure 6.6).

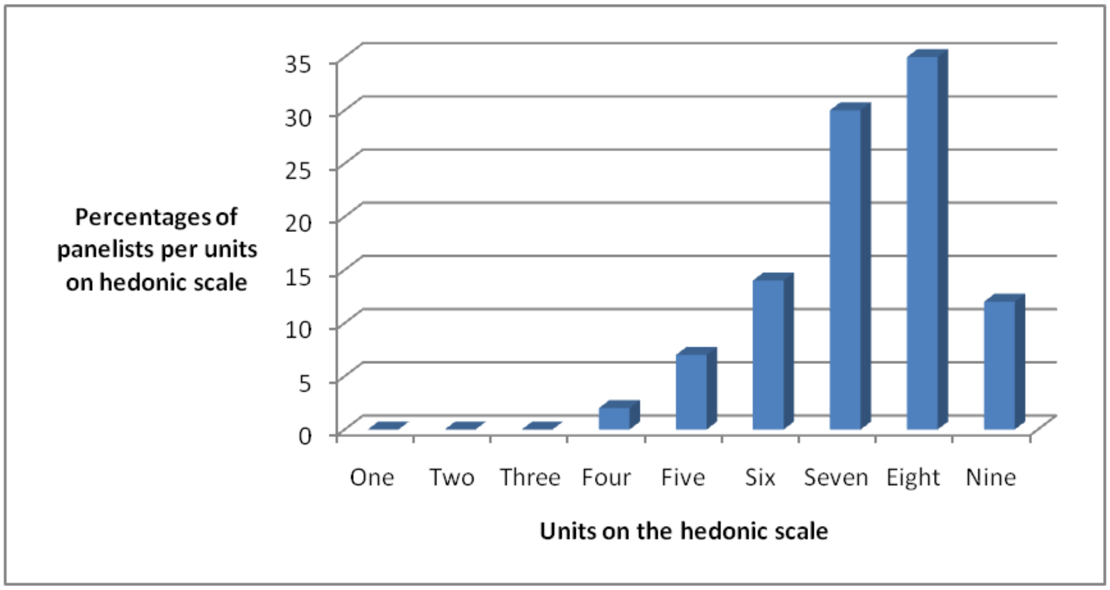



Figure 6.6: The various ratings of the sand paper raisin (*Grewia flavescens)* liqueur on a hedonic scale as evaluated by all panellists involved in the evaluation.

The majority of panellists associated the sand paper raisin liqueur with higher ratings such as 30%, 35% and 12% for the different units on the hedonic scale, seven (liked moderately), eight (liked very much) and nine (liked extremely), respectively. With only a smaller proportion (2%) of panellists assigning a score of four (dislike slightly) and seven percent of them being neutral (neither like nor dislike) (Figure 6.6), the assessment of this beverage was characterised by marked degree of acceptance. This degree of acceptance and likeness was notably higher amongst panellists from Makro Centurion and IPUF groups (Figure 6.7).

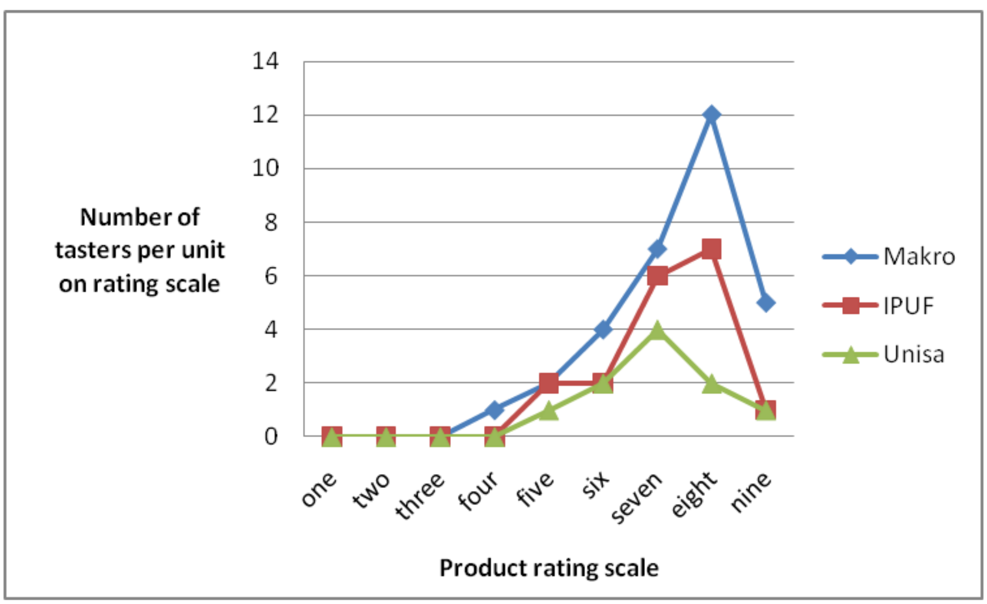



Figure 6.7: Ratings of the sand paper raisin (*Grewia flavescens*) on the product rating (hedonic) scale as evaluated by the three different groups of panellists.

Lastly, 88% of all the panellists who participated indicated their willingness to buy this beverage in retail liquor outlets should it be refined and commercialised in the future. However, the retail price they were willing to pay for it differed remarkably, from a low of R40 to a high of R180, the average price being R74 per 750ml.

6.2.2.2 Liqueur produced from the African mangosteen, *Garcinia livingstonei*

The liqueur produced from the fruits of the African mangosteen (*Garcinia livingstonei*) was evaluated by a panel of 29 tasters, of which 13 (45%), 5 (17%) and 11 (38%) of them were from Unisa, IPUF and Makro Centurion Store, respectively.

Seventy percent of Unisa panellists suggested the fruity attribute as one of the most important features of the aroma make-up. Other aroma elements were associated with three notes – alcohol, herbal and woody - in equal proportions (10%). Thirty three percent of IPUF panellists recognised the alcohol note as the most salient aroma element characteristic of this beverage and this was followed by notes such as fruity, malty and honey, each representing about 17% of the entire profile. On the background of the fruity note, 16% of IPUF panellists suggested a citrus undertone. Fifty five percent of Makro Centurion panellists mentioned the fruity odour note while 18% cited the alcohol-like odour note. Besides these notes amongst Makro Centurion panellists, there were three additional notes which were identified by 9% of panellists in equal proportions. These notes were herbal, musty and leathery.

When the different responses of all panellists (29) involved were combined (Figure 6.8), it was found that the fruity note was suggested by 52% of them. Linked to this fruity note was a background of citrus, highlighted by 4% of panellists. The fruity note was followed by the alcohol note, acknowledged by 18% of panellists. Ninety percent of all panellists involved in the aroma characterisation of the African mangosteen liqueur indicated that they liked its fruity and alcoholic aroma notes.

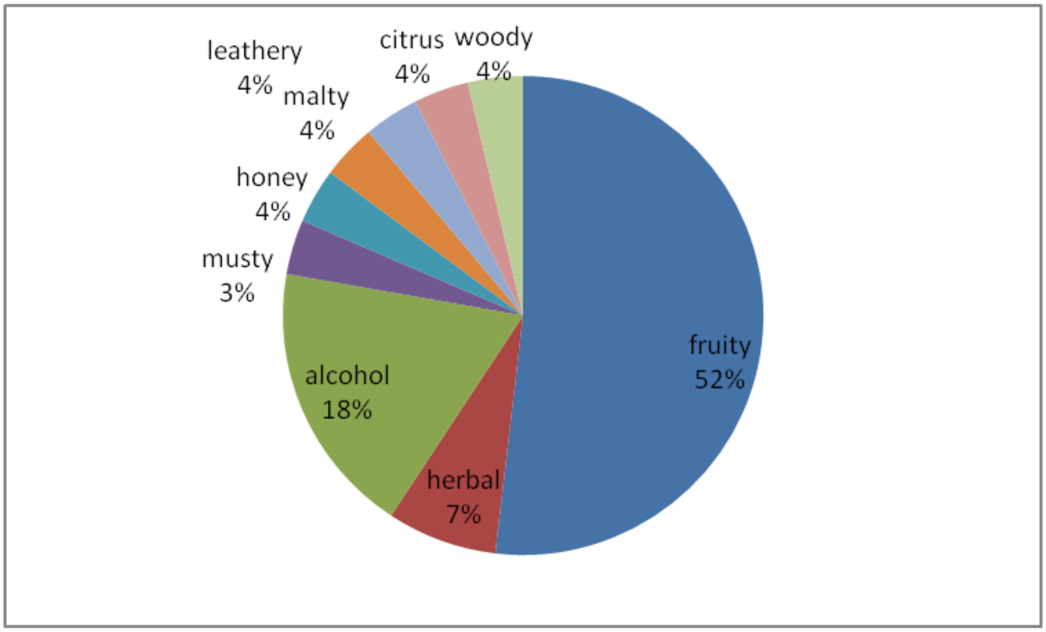



Figure 6.8: The overall aroma mix of the African mangosteen (*Garcinia livingstonei*) liqueur, based on the responses from all groups of panellists.

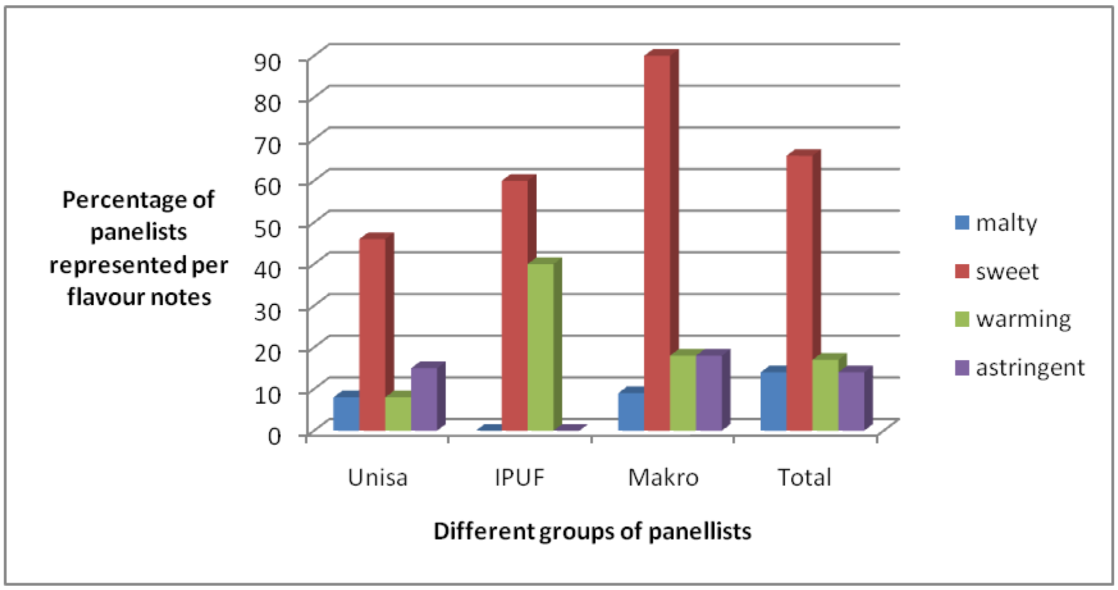



Figure 6.9: The proportion of panellists who identified and suggested the different flavour notes associated with the African mangosteen (*Garcinia livingstonei*) liqueur.

Figure 6.9 indicates the various proportions of panellists who identified and suggested the flavour notes associated with the African mangosteen liqueur. The sweetness element was markedly conspicuous in all of the tasting groups, ranging from 46% to 90% amongst Unisa and Makro Centurion panellists, respectively. As a whole, the amount of panellists who noted this sweetness constituted 66%. However, 30% of them did not like the intensity of this sweetness note, suggesting that it must be reduced if this concept product is to become successfully marketed in future. Moreover, this sweetness note was linked to an unpleasant astringent aftertaste, which was picked by about 14% of panellists.

The warming sensation associated with alcohol content (5.2% v/v) ranged from 8% amongst the Unisa panellists to about 40% for the IPUF group. If all the groups were taken into consideration, the alcohol sensation was detected by 17% of panellists. Figure 6.9 also indicates that there was a slight malt-like undertone, detected by 14% of all panellists involved.

With respect to the dark brownish colour and the presence of sediment in the sample, panellists offered some comments for product refinement. Twenty five percent of them suggested that the dark colour should be replaced by something lighter in appearance or be as transparent as some of the brands of the liqueurs they are familiar with. The presence of sediment in the sample was not appreciated as it yielded a coarse or rough mounthfeel, thus contributing negatively in the overall experience.

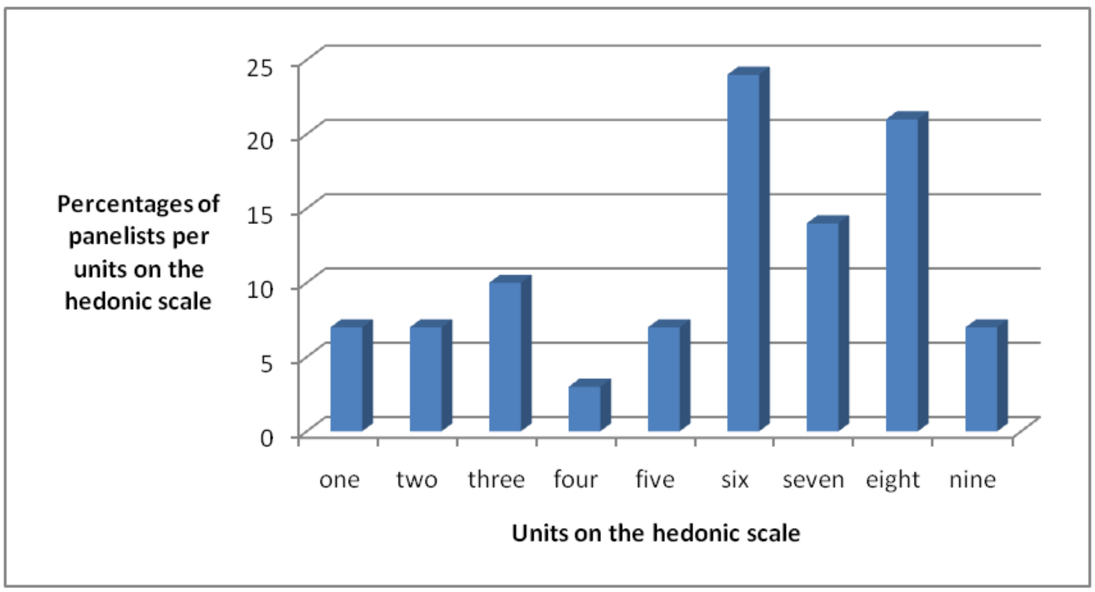



Figure 6.10: A summary of the different proportions of all panellists (%) who rated the African mangosteen (*Garcinia livingstonei*) liqueur on the hedonic scale.

Figure 6.10 illustrates the different percentages of panellists linked to each unit on the 1-9 hedonic scale. Although some panellists evaluated this beverage negatively (1-4) (Figure 6.10), the ratings of 6, 7 and 8 came out in relatively higher proportions for the combined group of panellists. The latter ratings were represented as follows: 24%, 14% and 21%, respectively.

These favourable ratings translated into some willingness on the part of many panellists to make purchases of this drink or recommend it to someone else, should it be refined and launched in retail outlets in future. All the 11 (i.e. 100%) Makro Centurion panellists who evaluated the African mangosteen liqueur indicated their willingness to buy it at a price ranging from R40 to R90 per 750ml while the other (78% of them) groups of panellists were willing to buy it at an average price of R47 per 750ml.

6.2.2.3 Liqueur derived from the Kei apple, *Doyvalis caffra*

The sensory analysis and evaluation of the liqueur brewed from the Kei apple involved 22 individual panellists. The entire group was comprised of 5 panellists within Unisa, 8 IPUF panellists as well as 9 Makro Centurion panellists.

Thirty three percent and 34% of Unisa panellists pinpointed alcohol and fruity aroma notes, respectively. Other notes suggested were the nutty (or nut-like) (22%) and the woody (11%) ones. Fifty percent of IPUF panellists identified the fruity note as the most important aroma attribute. On the background of this note, 10% of panellists suggested an apple theme while the alcohol and honey notes were proposed by equal proportions (20%) of panellists.

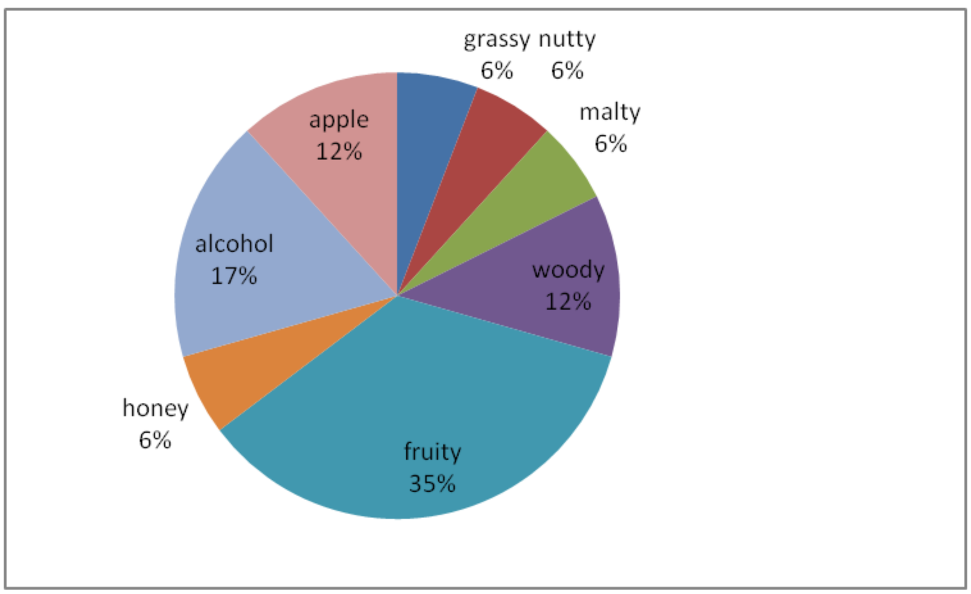



Figure 6.11: The aroma profile of the Kei apple (*Doyvalis caffra*) liqueur as determined from feedback obtained from Makro Centurion panellists.

Makro Centurion panellists identified the greatest number (8) of odour notes (Figure 6.11) associated with the Kei apple liqueur. The most important notes were the fruity and the alcohol ones, suggested by 35% and 17% of them, respectively. Twelve percent of panellists identified the woody odour note while the grassy, nutty, malty and honeylike notes occurred in equal proportions (of 6%).

Figure 6.12 shows all the different odour elements associated with the Kei apple liqueur as determined by all panellists who participated in the sensory analyses. The fruity note came out to be the most important note because it was mentioned by 35% of them, along with a background of an apple smell (8%). The fruity note was followed, in descending order, by the alcohol note which was highlighted by 22% of them. The woody, nutty and honey-like notes had equal proportions (8%) while the malty and the grassy notes were recognised by 6% and 5% of panellists, respectively. Sixty five percent of panellists involved in the sensory analyses of the Kei apple liqueur expressed their desire of this aroma as it was pleasant to smell.

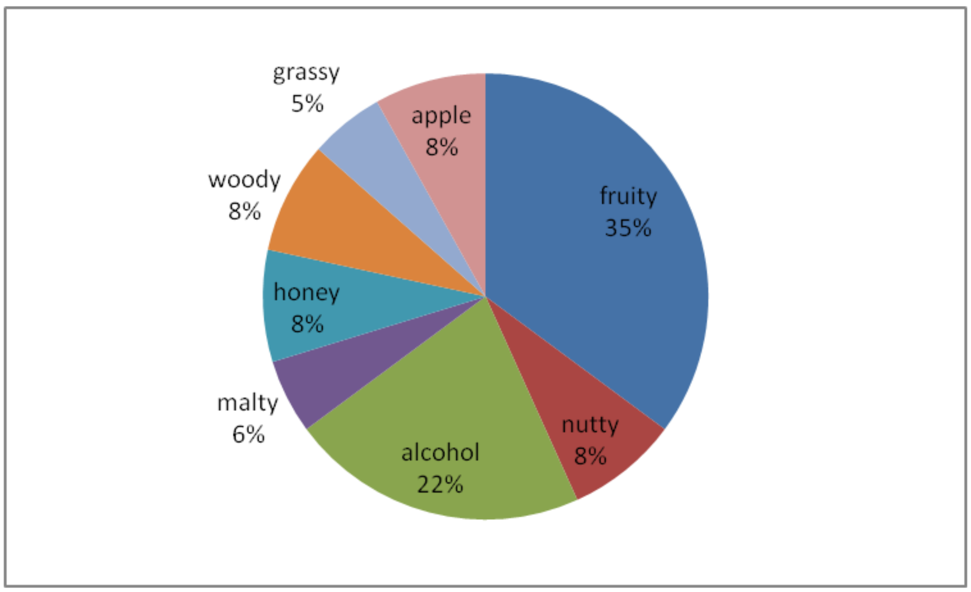



Figure 6.12: Overall proportions (%) of panellists based on the different odour notes they suggested for the Kei apple, *Doyvalis caffra*, liqueur.

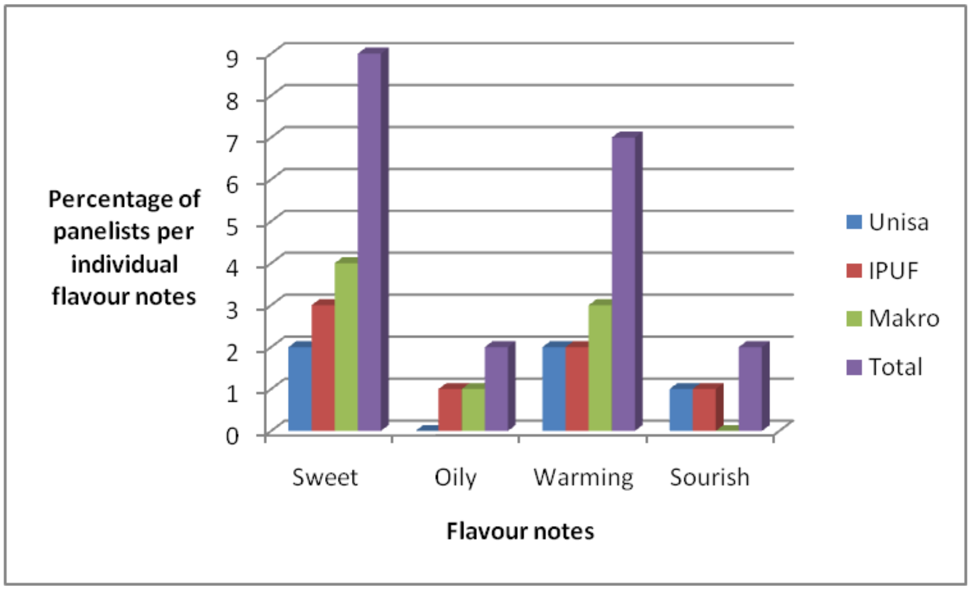



Figure 6.13: Percentages of different groups of panellists based on the flavour attributes they have outlined for the Kei apple (*Doyvalis caffra*) liqueur.

Figure 6.13 illustrates the different proportions of panellists based on the variety of flavour notes they have associated with the Kei apple liqueur. As a whole, the sweetness note was sensed by 50% of all panellists involved. This trend was very conspicuous amongst the Makro Centurion panellists, as 80% of them highlighted it. Another important note was the warming sensation associated with alcohol content (11% v/v). This note was captured by 39% of all panellist groups.

The light yellowish-brown colour of this liqueur was approved by most (58%) panellists. They were also delighted by the lack of sediment and clarity associated with this sample, with many of them stating that the beverage had a relatively pleasant mouthfeel and well balanced composition.

Figure 6.14 indicates the combined proportions of all panellists involved per various units on the product ranking (hedonic) scale. Seventy three percent of all panellists assigned it a favourable rating, ranging from 6 (like slightly) to 9 (like extremely). Other proportions for all ratings made on the hedonic scale are also shown, notably 18% and 41% for the units 6 (like slightly) and 7 (like moderately), respectively. Lastly, 76% of all panellists indicated their willingness to buy the *Doyvalis caffra* liqueur, should it be commercialised successfully in the future, at a price ranging from R50 to R90 per 750 ml.

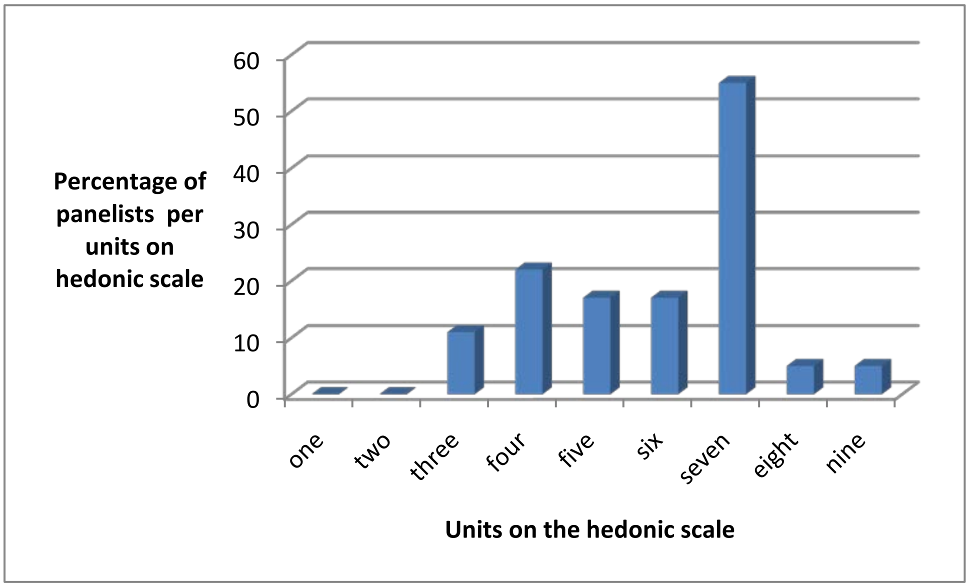



Figure 6.14: Percentages of all panellists per units on the hedonic scale regarding Kei apple (*Doyvalis caffra*) liqueur.

6.2.2.4 Liqueur derived from the stem fruit, *Englerophytum magalismontanum*

Owing to limited quantities of samples available, the liqueur prepared from the stem fruit was evaluated only by Unisa panellists (8) and by Makro Centurion panellists (4).

The aroma profile of this beverage is depicted in Figure 6.15, as assessed by Unisa panellists. Their proportions for three main aroma notes highlighted were as follows – alcohol smell (30%), fruitiness (25%) and woodiness (20%), respectively. In addition, the fruity note was associated with a citrus or tangerine (15%) background. Another note proposed was linked to the smell of herbs (10%).

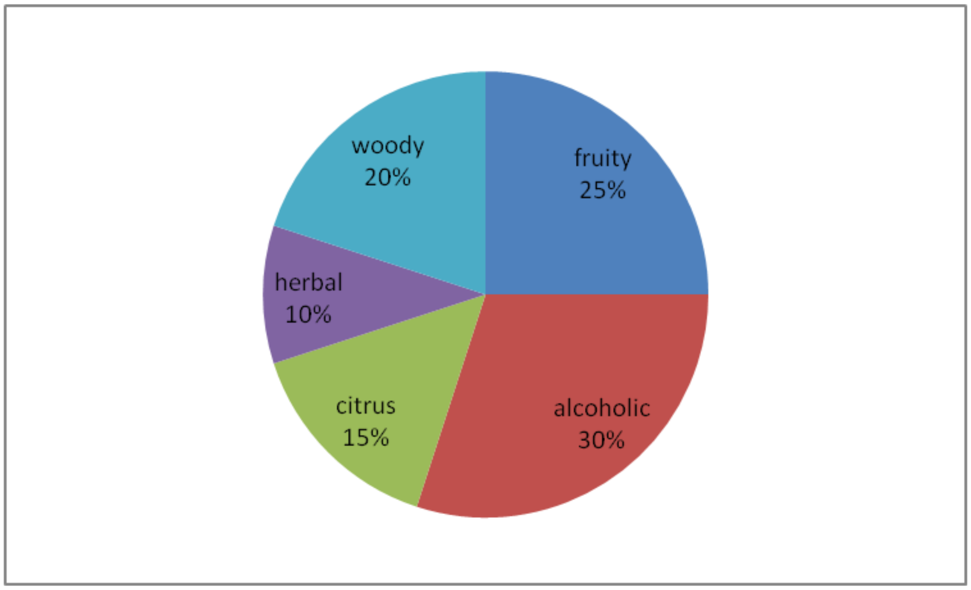



Figure 6.15: Aroma profile of the stem fruit liqueur based on responses from 8 Unisa panellists.

The main aroma notes highlighted by Makro Centurion panellists were alcohol (43%) and fruit-like (57%) odours, respectively. When responses from all panellists involved in this aroma analysis were taken into consideration, the following overall pattern emerged, as illustrated in Figure 6.16.

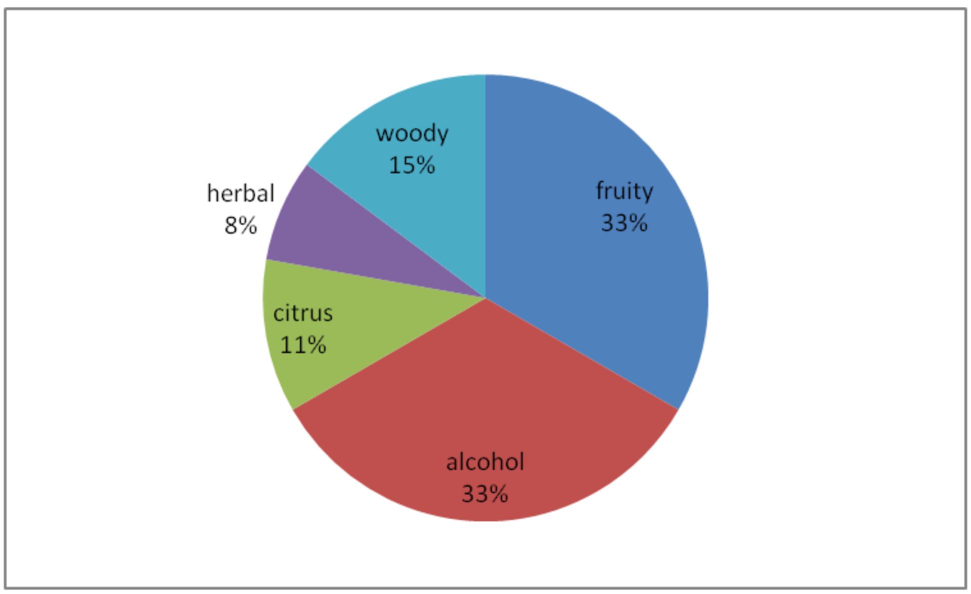



Figure 6.16: An aggregated set of responses made by different panellists who profiled the aroma attributes of the stem fruit liqueur.

This pattern was characterised mainly by the fruity and the alcohol notes which occurred in equal proportions (33%). Furthermore, 11% of the panellists were able to identify a citrus theme in the background while the proportions of panellists suggesting the woody and herbal notes were 15% and 8%, respectively. All of the tasters participating in the sensory analyses indicated that they liked the aroma mix associated with this beverage.

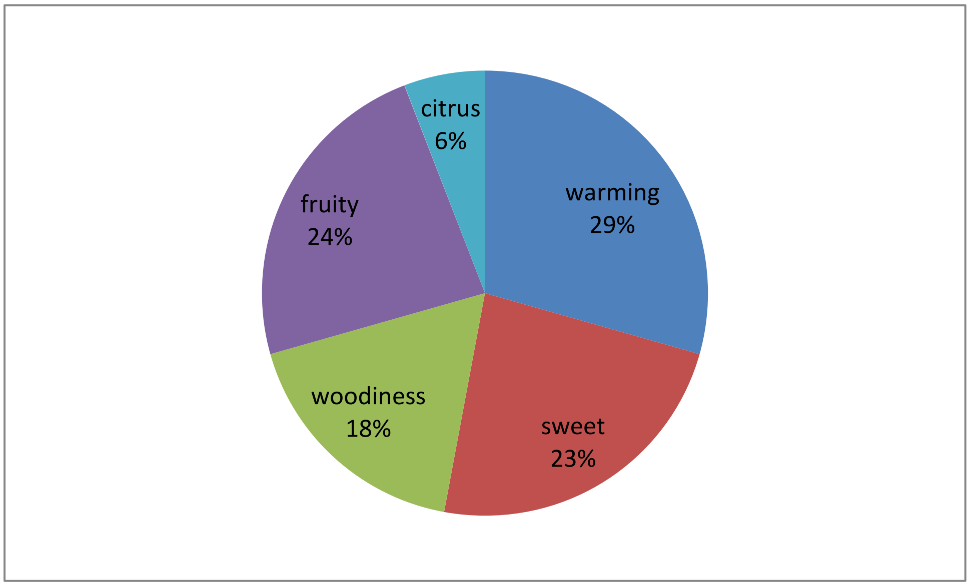



Figure 6.17: Flavour mix of the stem fruit liqueur based on responses from Unisa panellists.

Based on responses from Unisa panellists (Figure 6.17), the following proportions pertaining to flavour emerged – a warming sensation (29%) ascribed to the alcohol content and a very pleasant fruity note (24%). Six percent of panellists also mentioned a citrus undertone. Other flavour notes highlighted by 23% and 18% of these panellists were described as sweetness and some degree of woodiness, respectively.

Thirty three percent and 34% of Makro Centurion panellists indicated a warming sensation as well as a degree of sweetness, respectively. These notes were followed in descending order by the fruity and astringent notes, as highlighted by 22% and 11% of panellists, respectively.

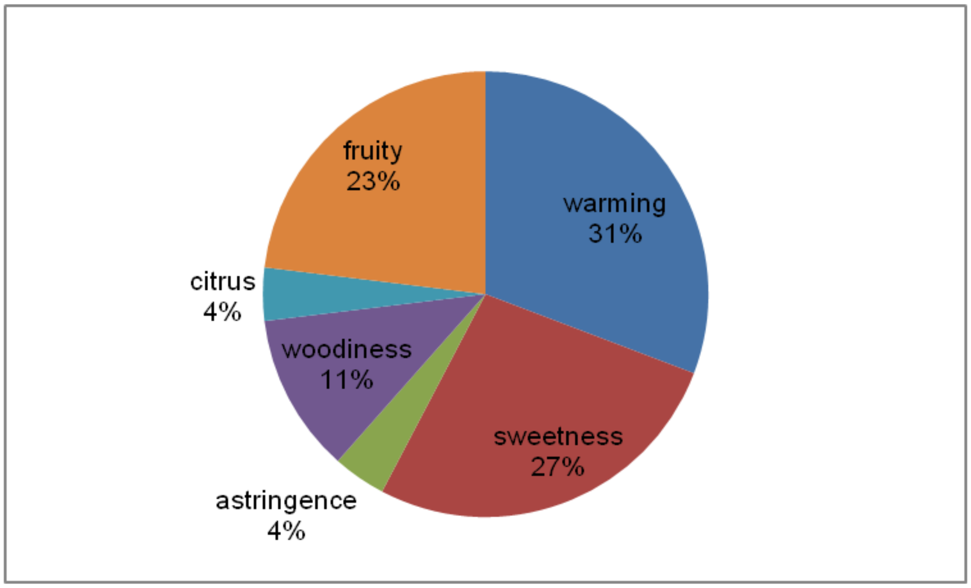


Figure 6.18: Total flavour mix of the stem fruit liqueur suggested by all (12 of them) panellists involved.

Figure 6.18 illustrates the entire flavour make-up associated with the stem fruit liqueur, based on all panellists who characterised it. In particular, the warming and sweetness sensations were picked by 31% and 27% of them, respectively. These were followed in descending order by notes such as fruity and woodiness, as represented by 23% and 11% of panellists, respectively. Also, four percent of panellists suggested a citrus undertone while a similar percentage of them highlighted a note of astringency.

The majority (90%) of all panellists who played a role in the sensory characterisation of this beverage were very impressed with it. This favourable assessment was also reflected on the hedonic scale (Figure 6.19). No panellists were indifferent to this beverage as they never accorded it a rating of five (neither liked nor disliked) on the hedonic scale. In addition, no rating below five (disliked slightly to disliked extremely) was selected, implying that the stem fruit liqueur exhibited attributes of a clear product winner.

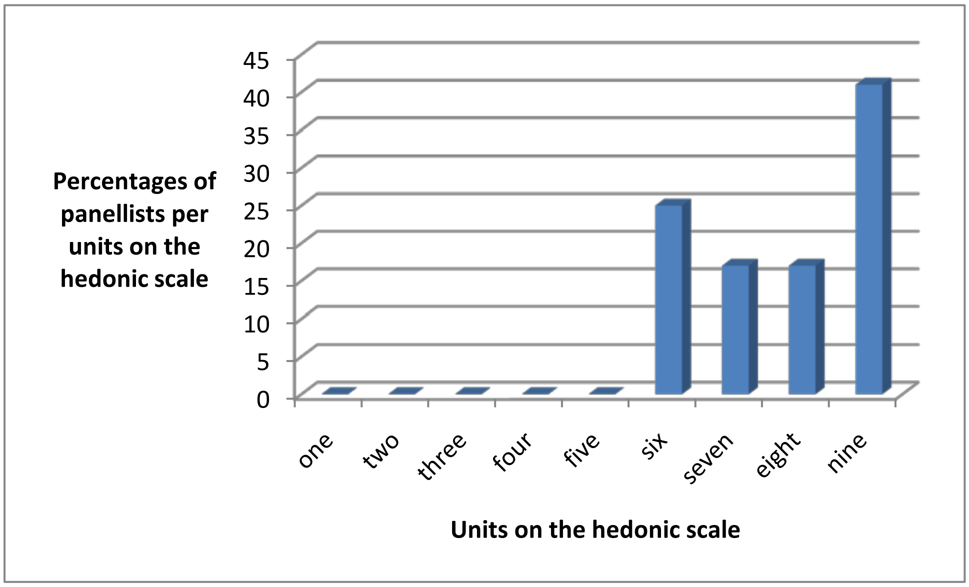



Figure 6.19: Percentages of panellists who rated the stem fruit liqueur on the hedonic scale.

An assessment of this nature signifies brighter prospects for successful commercialisation. It was, therefore not surprising when 86% of panellists were willing to buy the stem fruit liqueur or recommend it to someone they know, should it be available in retail liquor outlets. The prices they were willing to pay for it ranged from R60 to R78 per 750 ml.

### 6.2.3 Herbal tea derived from the bush tea plant species, *Athrixia phylicoides*

The bush tea derived from *Athrixia phylicoides* plant species was selected for assessment of market potential because it is possible to harvest it in sufficient quantity and quality. As stated in Chapter 3, primary data on the sensory descriptors of bush tea were obtained from a team of trained specialists at the science laboratories of the Agricultural Research Council (ARC) at Irene, near Pretoria.

The aroma profile of bush tea is summarised in Figure 6.20. Forty five percent and 38% of panellists associated it with dried sage and woody notes, respectively. These notes were followed in descending order by an array of odour attributes such as fresh thyme, lavender and peppery notes which were suggested in nearly equal proportions – 6%, 6% and 5%, respectively.

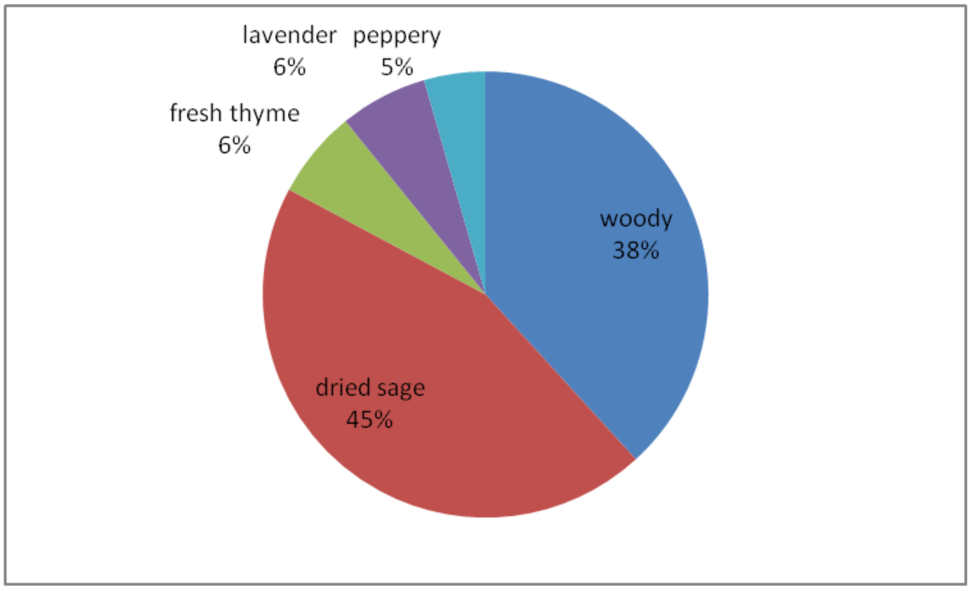



Figure 6.20: The different proportions of panellists who suggested the aroma notes characteristic of bush tea (*Athrixia phylicoides*).

Forty one percent of panellists identified the herbal flavour as the most important note, followed by 29% of panellists who pinpointed the woody note. Twelve percent and 18% of panellists recognised notes of bitterness and sweetness, respectively. In addition, notes of bitterness and woodiness gave rise to unpleasant aftertastes which must be eliminated before the tea can be promoted commercially.

6.2.3.1 An estimation of the market potential of bush tea, *Athrixia phylicoides*

A study conducted on the commercial development potential of the bush tea plant species (*Athrixia phylicoides*) identified some of the markets in which it could be possibly launched successfully (Rampedi and Olivier, 2005). This study was conducted in some of the densely populated townships such as Marabastad and Mamelodi in Pretoria and Soweto near Johannesburg. As shown in Figure 6.21, these townships are all located in the Gauteng province - the commercial heartland of South Africa. They are predominantly inhabited by African populations, of which some have urbanised permanently following migration from rural areas. The results of market surveys undertaken on bush tea, as summarised and synthesised in section 6.2.3.2, were published in the journal *Acta Academica* (Rampedi and Olivier, 2005).


Figure 6.21: Geographical location of Marabastad, Soweto and Mamelodi townships in the Gauteng province.
*Source:* Rampedi and Olivier (2005).

6.2.3.2 The mass market for bush tea

Although the bush tea (*Athrixia phylicoides*) is receiving rapidly growing research attention (Von Gadow *et al.,* 1997; Olivier *et al*., 2003; Araya, 2005; McGaw *et al.,* 2007a; Mudau *et al.*, 2007; Joubert *et al.,* 2008; Olivier *et al*., 2008), it is not yet commercialised in the formal economic sector in South Africa. However, large quantities of this plant species are harvested in the rural areas to meet rising economic demand in the African herbal markets, many of which are in the informal economic sector. These markets are located in several provinces such as the Limpopo, Mpumalanga, Eastern Cape and Gauteng. For instance, in the Gauteng province, bush tea is already sold in traditional herbal shops and by hawkers along street pavements (Rampedi and Olivier, 2005).

Of the 150 respondents who were interviewed for the study in the Gauteng province 82 (55%) indicated their willingness to make purchases should this beverage be available in formal health shops and retail supermarkets (Rampedi and Olivier, 2005). When the 82 respondents were stratified into various ethnic groups, the largest group of potential buyers came out to be the North-Sotho (Sepedi)-, Swazi- and Zulu-speaking people – comprising 64%, 50% and 50% of all respondents, respectively. The proportion of Tsonga- and Xhosa-speaking respondents was 39% and 28%, respectively (Rampedi and Olivier, 2005). When all respondent categories and associated proportions were judged against the total population size of the Gauteng province, based on Statistics South Africa (Stats SA) (2001) data, the total number of potential consumers of bush tea was estimated to be about 2 161 245 individuals. This estimate could be even higher, given the rapidly increasing movement of African migrants from the Limpopo, Mpumalanga, KwaZulu-Natal and Eastern Cape provinces into the Gauteng province. The next section examines prospects for the bush tea niche market.

#### 6.2.3.3 Identifying a niche-market for bush tea

Apart from the mass market highlighted above, potential consumers of bush tea could be the individuals (in the functional food and wellness market) who are already consuming other health-promoting teas such as rooibos and honeybush. Moreover, *Athrixia phylicoides* occurs naturally across four provinces (Limpopo, Mpumalanga, KwaZulu-Natal and Eastern Cape) in South Africa (Olivier and De Jager, 2005), thus of special significance in the *"muthi"* or traditional health market.

Worldwide, the health market niche has been growing tremendously in recent years due to the growth in the economic demand for wellness and non-caffeinated teas (Gruenwald, 2009). For instance, *Euromonitor International* has indicated that beverages worth nearly US$80 million were sold in the fortified/functional carbonates category in 2005 (Pohjanheimo and Sandell, 2009). Moreover, the sales of wellness beverages exceeded US$200 million in 2007 and were expected to reach more than US$350 million in 2010 (Pohjanheimo and Sandell, 2009). This wellness market niche is characteristically high-end, lucrative and open for international exports. The main drivers of market demand in this sector include convenience, exceptional quality assurance, improving health and appearance and a host of environmental considerations (Nel *et al.,* 2006; SA Good News, 2008). Given these projections, it was important to examine some of the broad trends in the domestic herbal tea market, based on product surveys undertaken in this study.

***Broad trends in the domestic herbal tea market – findings from surveys***

Product inspections in the various supermarkets in the Gauteng province have shown that there are around eight retail brands of commercialised indigenous teas in South Africa. These brands are derived from the manufacturing and promotion of herbal teas such as buchu (*Agasthoma betulina*), honeybush (*Cyclopia* species) and rooibos (*Aspalathus linearis*). Additional brands are derived from the blending of some of these teas, although rooibos on its own has the greatest number of brands and product offerings. All of these commercialised indigenous teas are sold in the formal mass market and in a number of niche markets.

In the mass market, commercialised indigenous teas are traded in four leading supermarkets in South Africa. These supermarkets offer the greatest mix of indigenous teas ranging from the very cheap to the most expensive. For instance, in one of these supermarkets there were six different brands of each tea sold at different prices. In the case of rooibos tea, the price for a package of 20 teabags ranged from R9.69 to R21.69 during the 2007-2008 period, a price differential of more than 50%. However, when rooibos was packaged in 40 to 100 teabags, retail prices were nearly similar, especially for the lower end of the market.

In addition, a limited range of premium indigenous teas are promoted in the higher end (niche area) of the domestic market. Of interest to recognise, however, was their distinctive packaging, colouring, labelling and appearance, which clearly differentiated them from mainstream brands (such as Laager, Vital and Freshpak). Invariably, the indigenous teas promoted in niche and specialised markets are sold at premium prices, estimated to be 25% higher than similar offerings in the mainstream mass market. Rooibos tea sold in specialised market niches (such as health shops) also commanded the highest premium prices. In one instance, the price of a box of 40 teabags of rooibos tea, for health needs such as mood calming, digestive aid and antioxidants effects, was found to be R60.00 per item and was claimed by the shopkeeper to be in relatively strong demand by consumers. The same trend was observed for specialty herbal teas such as chamomile tea which sell for approximately R70.00 in supermarkets and up to R80.00 in premium health shops.

Based on these trends, bush tea (*Athrixia phylicoides*) may be launched in any of these markets either as a herbal tea packaged in tea bags or as ready-to-drink (RTD) instant tea. In keeping with the innovation and dynamism within the tea market, it can also be launched successfully as a blend with popular herbal teas such as chamomile, rooibos and honeybush. In fact, launching tea in blend form is particularly advantageous, especially during early market development phase when the product is not yet well-known in the mindsets of consumers.

## 6.3 SUMMARY OF RESEARCH FINDINGS

The different sensory analyses and assessments of market potential presented in section 6.2 were undertaken specifically to determine whether or not the selected beverages examined met certain consumer requirements or expectations critical to successful marketing and commercialisation. The sensory sessions conducted on these beverages have highlighted some of their macroscopic features (i.e. clarity and colour) while responses received from panellists shed light on overall product acceptability as well as pricing aspects. The most important determinant of acceptability in this study appeared to be the flavour make-up as perceived by panellists. Consequently, beverages with off-flavours such as extreme bitterness and astringence or highly detectable sugar content were not assessed favourably.

Generally, the alcoholic beverages (especially the liqueurs) derived from the different indigenous fruit species in the Limpopo province were favourably evaluated by panellists involved in the study. Both their aroma and flavour notes were associated with distinctive fruity notes and a characteristically warming sensation associated with alcohol content. In the case of the liqueur derived from the African mangosteen (*Garcinia livingstonei*), close to 52% of all panellists recognised the fruity note in the aroma composition while 70% of Unisa panellists also proposed it. However, the same note was relatively less for beverages prepared from Kei apple (35%) and stem fruit (33%), suggesting the need to analyse and quantify the different types and concentrations of the volatile compounds present in order to account for discrepancies observed.

With respect to tastings, all of the liqueurs profiled were found to be uniquely flavoured and sweet. However, the panellists who evaluated the African mangosteen (*Garcinia livingstonei)* liqueur felt that it was too sweet for their liking, raising the need to control this attribute so that it is in line with potential consumer preferences. However, this off-taste (extreme sweetness) note cannot be regarded as a major barrier to new product development, as flavour can be modelled according to the type and amount of ingredients used (Pohjanheimo and Sandell, 2009; Villegas *et al.,* 2009).

With respect to product rankings on a hedonic scale, potential consumer acceptability scores accorded to each of the beverage characterised in the study were found to be generally high although there were a few exceptions. The beverage which attained the highest scores in terms of its aroma, flavour, colour and overall composition was the liqueur derived from the stem fruit

(*Englerophytum magalismontanum*). None of the panellists involved in its sensory characterisation assigned negative or neutral units on the hedonic scale used (Figure 6.19). The proportions of panellists in each of the favouarble ratings assigned were also found to be high (Figure 6.19). In addition, 86% of panellists involved in its evaluation were willing to buy or recommend it to someone else, should it be available in retail liquor outlets in the future. The prices that they were willing to pay for the stem fruit liqueur ranged from R60 to R78 per 750 ml.

In descending order, the next important liqueur was the one produced from the berries of the sand paper raisin (*Grewia flavescens*). Thirty five percent of panellists across all the groups assigned a rating of 8 (which denoted liked very much). The same concept product received a positive rating of 9 (which means extremely liked) from at least 7 panellists, who constituted approximately 12% of the panellists involved. The beverage was particularly favourably received by 90% of Makro Centurion panellists. Regarding willingness to make future purchases, 86% of all panellists involved indicated that they will buy it in retail liquor outlets if it can be refined further for formal commercialisation. However, the retail price they were willing to pay for it varied markedly, from a low of R40 to a high of R180, the average price being R74 per 750ml.

Unlike the liqueurs derived from the stem fruit and sand paper raisins, the product acceptability ratings for the Kei apple (*Doyvalis caffra*) liqueur were found to be widely distributed along the hedonic scale (1-9) as they ranged from 3 to 9 (Figure 6.14). Eighty nine percent of panellists in the Makro Centurion and IPUF tasting groups accorded this beverage ratings of above 5, denoting favourably impressive. In terms of willingness to make purchases, 76% of panellists involved mentioned that they would buy it or recommend it to someone they know should it be commercialised successfully in the future, at a price ranging from R50 to R90 per 750 ml.

In contrast to the positive feedback obtained from the sensory evaluation of most indigenous fruit-based liqueurs in the study, the non-alcoholic juice derived from the mobola plum (*Parinari curatellifolia*) fruits received very unfavourable responses from all panellists. Although it had an array of interesting fruity aroma notes, with a background of herbs such as ginger, it was unacceptable because of its bitter and astringent principles. This feedback may contribute towards the improvement and refinement of the product.

Lastly, amongst the indigenous teas that are not yet commercialised, bush tea derived from from *Athrixia phylicoides* plant species appears to be an interesting concept product, especially if its aroma and flavour profile can be refined further. Its greatest selling point would be its scientifically acclaimed medicinal and health-enhancing properties as well as the potential of producing other wellness products from it. The tea may be launched succesfully either in the mass market or the niche market as a herbal tea or ready-to-drink (RTD) tea.

# CHAPTER 7

## SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

### 7.1 INTRODUCTION

The purpose and research aim of this study was to assess the commercial development potential of selected indigenous plant-based beverages in the Limpopo province – the goal being to determine whether or not there is market potential for their successful commercialisation in the future**.** In Chapter 7, a summary of research findings and a conclusion is provided. In addition, recommendations for further studies are outlined.

### 7.2 SUMMARY OF RESEARCH FINDINGS

#### 7.2.1 Identification and documentation of indigenous plant species and associated beverages

The first research objective in this study entailed the identification and documentation of beverage-making indigenous plants, including beverages prepared from them. Questionnairre surveys were undertaken in Venda-, Tsonga- and North-Sotho speaking rural communities of the Limpopo province, which constituted study areas. Surveys were carried out by means of the snowball method to secure referrals and interviews with respondents. Although the majority of respondents had limited education, they have indicated an array of indigenous plants used for preparing non-alcoholic and alcoholic beverages, beside marula (*Sclerocarya birrea*) and sorghum (*Sorghum bicolor*) species. Sixty three different plant species were identified and collected from nearby ecosystems and woodlands in and around rural communities. Their common and Latin names were confirmed and verified with the assistance of trained taxonomists at the South African National Biodiversity Institute (SANBI), based in Lynnwood, Pretoria. All the plant species collected for the study are members of 36 different plant families, of which the largest were Ebenaceae (8%), Tiliaceae (7%), Apocynaceae (7%), Annonaceae (5%), Rhamnaceae (5%) as well as Anacardiaceae (5%). These plants also comprised 29 different genera, of which the most prevalent included *Grewia* (4 spp.), *Strychnos* (4 spp.), *Carissa* (3 spp.) and *Euclea* (3 spp.).

The identification and documentation of species has provided new knowledge on wild food plants utilised for beverage-making purposes, unlike previous studies which examined indigenous plants mainly from the perspective of ethnomedicinal uses. It is also clear that not all of the species cited by respondents during interviews were strictly indigenous, as nearly 10%

of them (i.e. *Cymbopogon citratus*, *C. nardus, Opuntia ficus indica, Physalis peruviana, Rubus rigidus* and *Zyzigium cumini*) were found to originate from other parts of the world, although they have naturalised successfully in the Limpopo province and other areas of South Africa.

Most of the plant species collected and identified for the study were fruit-bearing shrubs, climbers as well as trees, thus suggesting their ethnobotanical importance and popularity amongst local inhabitants. Fruits are used to prepare non-alcoholic juices and can also be fermented into traditional beer, depending on seasons of availability as well as quantity and quality of the harvest. In addition, the alcohol inherent in the fermenting fruit pulp can be distilled over several days into intoxicating spirits, with a much higher alcohol content. Apart from local uses of this nature, fruits harvested from large-leaved yellow raisin (*Grewia inequilateria*) species can be boiled in water (as decoctions) to brew traditional wellness tea. This particular local use was mentioned by some of the Tsonga-speaking respondents.

In a few instances, it was noted that not all fruits are targeted by locals for fermenting alcoholic beverages. For instance, species such as *Hyphaene coriacea* and *H. petersiana* are traditionally important in the preparation of traditional beer, although this beverage is not made from their fruits. Instead, it is brewed from their highly sought-after cell sap obtained from stems, even though the harvesting methods are not environmentally sustainable as plants are damaged.

Another category of beverages brewed from locally available species relate to traditional teas. These teas are prepared from species such as *Athrixia phylicoides, Catha transvaalensis, Colophospermum mopane, Dombeya rotundifolia, Ehretia rigida, Lippia javanica, Monsonia angustifolia, Schotia brachypetala* and *Terminalia prunioides*. In addition, a few non-indigenous species such as *Cymbopogon citratus* and *C. nardus* were mentioned regarding teas.

### 7.2.2 Beverage-preparation methods

In section 5.3, the preparation procedures for making non-alcoholic and alcoholic beverages were discussed. Regarding fruit juices, the fruit pulp is either carefully sliced or crushed before being diluted in water. If seeds are big enough to be handled, they are usually removed from the fruit pulp while sugar is usually added to improve the taste. After mixing the fruit pulp with water and allowing the mixture to stand overnight, the juice is extracted by means of hands from the slurry and served cold. However, in some non-traditional instances, the mixture of the fruit pulp, skin cover and water is actually boiled for about 30-40 minutes in an attempt to loosen and extract the soluble constituents in the fruit flesh. The study has highlighted certain similarities and differences with traditional methods practiced in other parts of Africa. The similarities noted emanate from procedures followed to disaggregate the fruit pulp prior to juice extraction while differences arise from the nature of ingredients utilised and the extraction process.

Regarding the preparation of alcoholic beverages, as a starting point it is important to have a source of fermentable carbohydrates in the form of fruit pulp or cell sap. For alcoholic beverages derived from fruit pulp (especially for beverages regarded as traditional beers), no boiling is effected as this will destroy the microorganisms responsible for spontaneous fermentation processes. The alcohol content of traditional beers examined in this study ranged from 0.8% v/v (*Parinari curatellifolia*) to 2.1% v/v (*Hyphaene coriacea*), nearly similar to the 2.0% v/v concentration established in another study for the so-called "*busulu*" wine. However, the alcohol content of the initial brew examined in the present study can be further increased (up to 32% v/v) by means of distillation. The process involves low intensity heating of the beer-making slurry in order to isolate and concentrate the alcohol (distillate) content. When the traditional beer-brewing methods in the Limpopo province were compared with indigenous techniques practiced elsewhere, main differences related to the diversity of ingredients utilised as well as the complexity of preparation processes.

**7.2.3 The nutrient evaluation of selected beverages**

The current study has examined the nutritional attributes of selected beverages and has attempted to estimate their dietary importance relative to some of the commercial beverages and also against dietary reference intakes (DRIs). This part of the study is essential for shedding light on the commercialisation potential of specific beverages because it quantified their nutrient-related characteristics and indicated how they compare with dietary standards and some of the commercial drinks.

Traditionally-prepared non-alcoholic juices derived from the fruits of plant species such as the African mangosteen (*Garcinia livingstonei*), sand apricot vine (*Landolphia kirkii*), mobola plum (*Parinari curatellifolia*) as well as the forest num num (*Carissa bispinosa*) exhibited extremely low levels of protein, natural sugars and total dietary fibre.

However, it has been shown that the vitamin C concentrations in some of the beverages analysed were remarkably high. For instance, the vitamin C content in juices made from fruits of marula (*Sclerocarya birrea*) (23.66 mg/100ml), blue sourplum (*Ximenia americana*) (8.25 mg/100ml) as well as mobola plum (*Parinari curateliifolia*) (19.8 mg/100ml) species exhibited marked dietary potential. In fact, a 300 ml serving of marula fruit juice analysed in this study contained a vitamin C content equivalent to 93% of the recommended dietary allowance for women aged between 19-70 years. These elevated vitamin C concentrations in the beverages analysed can be ascribed to the nutritional composition associated with fruits of these species.

Other findings related to the discrepancies observed between (mobola plum) juices brewed by traditional local methods and non-traditional ones. Whereas the traditionally brewed mobola fruit juice had a vitamin C concentration of only 0.63 mg/100ml, the sample prepared by means of a non-traditional method exhibited a value of 19.8 mg/100ml. This vitamin C content is considerably greater than the value established for the banana (9 mg/100ml) and avocado (18 mg/100ml) juices. This finding clearly suggests that with process optimisation and improvement, mobola fruit juice has untapped commercialisation potential and beverages prepared from it could assist in meeting the dietary (vitamin C) needs of some of the local inhabitants in the rural communities surveyed for the research. Mobola fruit juice was also found to be a rich source of certain mineral elements such as potassium (1537 mg/l), calcium (233 mg/l), magnesium (140 mg/l) as well as sodium (66.2 mg/l).

The nutritional properties of certain traditional teas in the Limpopo province were also analysed for the study, thus adding new knowledge to existing literature. The most striking result was that plant species such as bush tea (*Athrixia phylicoides*), mopane (*Colophospermum mopane*) and large-leaved yellow raisin (*Grewia inequilateria*), lacked caffeine in their chemical composition. This finding has commercial implications because the rapidly growing rooibos industry in South Africa uses the low caffeine content in their tea, together with its high antioxidant content, as a major marketing strategy.

### 7.2.4 Estimation of market development potential for selected beverages

Given that one of the research objectives for the research was an assessment of the market development potential of indigenous plant-based beverages, various small-scale surveys, including sensory analyses and market analyses were undertaken. The overriding purpose in these surveys was to establish the sensory characteristics of selected beverages and to determine whether or not they satisfied certain consumer expectations. This information is valuable in highlighting potential improvement areas so that in future they can be refined and marketed successfully.

The results from sensory analyses indicated an array of aromas and flavours in the concept products being assessed. In general, all beverages derived from fruits had distinctively fruity sensory notes with various undertones while bush tea (*Athrixia phylicoides*) prepared from leaves, flowers and twigs exhibited predominantly herbal and woody flavours. Respondents also highlighted off-tastes (for instance, too sweet, too bitter and some unpleasant after-tastes), thus denoting areas requiring further improvement and re-formulation.

With respect to the product evaluation of liqueurs using the hedonic scale, the scores were generally high although there were some exceptions. The study indicated that the most preferred and outstanding liqueur was made from fruits of the stem fruit (*Englerophytum magalismontanum*) species. Around 86% of panellists involved were willing to buy or recommend it to other people at a price ranging from R60 to R78 per 750 ml. Besides the stem fruit liqueur, similar beverages prepared from fruits of the sand paper raisin (*Grewia flavescens*), Kei apple (*Doyvalis caffra*) as well as African mangosteen (*Garcinia livingstonei*) species, also exhibited commercial development potential.

### 7.3 CONCLUSION

In conclusion, the surveys undertaken in this study have shown that there is an ethnobotanical basis for making beverages from wild plant species in the Limpopo province. However, the most important decisive factor for their domestication, propagation and future commercialisation arise from the extent to which they are suitable and sustainable for specific uses reviewed in the literature study and other sections. For instance, species such as ilala palm (*Hyphaene coriacea*) and mopane (*Colophospermum mopane*) are popular in Venda but they are not suitable for commercialisation purposes due to the destructive nature of the harvesting methods involved, unless alternative harvesting techniques can be developed. The same limitation applies to non-indigenous species (Cape gooseberry, prickly pear, and others) which cannot be propagated for commercialisation purposes because of legislative restrictions emanating from the Conservation of Agricultural Resources Act (CARA) (1983).

The present study has also highlighted various methods for the preparation of beverages (i.e. traditional fruit juices, teas, beers and spirits) derived from plant species occurring in the wild, thus providing vital information to the rapidly disappearing indigenous knowledge in the Limpopo province and other parts of South Africa. Improving these methods can assist in retaining and enhancing some of the desirable nutrient characteristics noted in this study as well as transforming them into economically viable food products.

Most of the beverages profiled for sensory properties and potential consumer acceptance have revealed a commercial opportunity for the manufacturing of new fruit-based beverages such as soft drinks and natural fruit smoothies as well as alcoholic drinks (liqueurs and spirits) in South Africa. Some of their aroma and flavour attributes can be used to flavour existing beverages, thus contributing towards the extension and diversification of existing product lines. This sort of innovation has recently been witnessed in South Africa, although on a very limited scale, whereby soft drinks are flavoured with indigenous marula fruits. Such new beverages are currently promoted in supermarkets and also in some of the premium convenience stores such as "*La Boutique"* and "*Bonjour*" at selected fuel filling stations along some of the traffic routes in the Gauteng province. Therefore, beverage producing companies in South Africa, particularly in the Limpopo province, must take note of the potential of indigenous plants for the development of new products.

However, Crouch *et al*. (2008: 355) cautions that "behind every commercially successful bioproduct lies substantial expenditure in the form of extensive screening programmes that will have discarded literally thousands of commercially non-exploitable candidates before discovering a single commercially exploitable product". Although this statement was made with respect to the development of pharmacological products predominantly for species with ethnomedicinal attributes, it can equally be extended to the transformation of other natural plant products, including food and beverages. The identification of sought-after plant species based on indigenous and localised knowledge and evaluation of their nutritional and sensory properties will not necessarily translate into commercialisable products as there are many barriers to be circumvented along the commercialisation pipeline. The following section, for instance, briefly explains some of the commercialisation challenges stemming from biodiversity laws and intellectual property rights in South Africa.

***Constraints stemming from biodiversity laws and intellectual property rights***

Although there is increasing evidence of how certain rural communities in South Africa derive income from the informal trade dealing with products derived from wild plant species, it is a different matter when it comes to the systematic transformation of raw materials (derived from wild species) into viable value-added products marketed mainly for the formal economic sector and exports. This is because of the need to strictly comply and adhere to national legislation such as the National Environmental Management: Biodiversity Act (NEMBA) (2004), in addition to the Conservation of Agricultural Resources Act (CARA) (1983) and in some cases internationally-binding standards and conventions. These laws deal with requirements such as the need for the protection and sustainable uses of ecosystems as well as the equitable sharing of benefits emanating from bioprospecting initiatives. Currently, there are many challenges in South Africa regarding the interpretation and implementation of these provisions, especially with respect to the identification of stakeholders qualifying for equal benefit-sharing and ownership of intellectual property rights. One of the main challenges in the context of the present study is identifying all the legitimate stakeholders regarding ownership of traditional knowledge and uses of beverage-making species in the Limpopo province. In deed, in such instances "not all ownership cases are clear-cut, particularly with respect to communal land ownership and related culture-based concepts of control" (Crouch *et al.*, 2008: 357).

## 7.4 RECOMMENDATIONS FOR FURTHER RESEARCH

Based on the subject literature reviewed in Chapter 2, most of the species which have been successfully commercialised were supported with adequate background research highlighting some of their marketable properties. Many important lessons in the future may be drawn from the commercialisation paths followed for species such as rooibos, honeybush and marula. Although the industrialisation trajectories of these species differ in certain respects, in all cases there is ample evidence of background research around their phytochemistry, propagation and cultivation potential, plant part harvested and yields, harvesting constraints, multiple and complementary uses as well as health-promoting characteristics. Health promoting attributes appear to play a big role in marketing and selling edible natural products.

### 7.4.1 Quality assurance, safety and manufacturing practices

Issues of quality assurance, adherence to safety standards and codes of good manufacturing practices must be addressed when developing indigenous plant products. One of the key factors around the successful commercialisation of rooibos tea lie in the ability of producers and processors along the value chain to comply with international best practice in terms of product quality, safety and hygienic standards as well as codes of good manufacturing procedures. Quality in the final natural product cannot be achieved if raw materials are obtained from geographically dissimilar areas as there will be variations in phytochemical properties.

If wild species are to be harvested for beverage production purposes, the quality of end products will markedly not be the same, pointing towards the need for studies which will provide cultivars (with desired properties) in order to standardise end product composition. However, propagating wild species to achieve standardisation and traceability of raw materials brings other challenges. For instance, it is not easy to propagate species such as mobola plum (*Parinari curatellifolia*), brown ivory (*Berchemia discolor*) and wild medlar (*Vanguira infausta*) from seeds, suggesting the need for the use of grafting techniques and other means for establishing sought-after populations.

### 7.4.2 Recommendations for further surveys and other studies

In some of the study areas in the Limpopo province, information on beverage-making indigenous plants were obtained from a limited number of villages. For further research, it is recommended that surveys be extended into other rural communities, particularly in the North-Sotho-speaking areas located in the northwest and the southwest of the Limpopo province.

Furthermore, based on the research findings emanating from this study, a variety of non-alcoholic and alcoholic beverages may be produced from the preparation techniques specified in Chapter 5. However, very limited research has been undertaken in South Africa to examine how such traditional preparation methods can be improved and optimised, especially with a view to retain some of the favourable nutritional properties inherent in species being investigated. Further studies are also required to isolate and specify the microorganisms responsible for the spontaneous fermentation processes noted during the surveys. Without the specification and knowledge of these organisms, there will be challenges in controlling the fermentation processes involved as well as overall product quality. Lastly, it is recommended that further studies on these beverages should address their physicochemical aspects as well as changes they undergo during preparation stages and storage as these parameters affect product shelf life and sensory properties.

## REFERENCES


ACNielsen. 2004. *Do the top brands have the highest budgets?* Johannesburg: ACNielsen.

Acocks, J.P.H. 1988. *Veld types of South Africa*, 3rd Edition. Botanical Research Institute, South Africa.

African Dawn. 2009. Estate rooibos tea. <www.africandawn.com/mothers.beauty.html> [Accessed 22/03/2009].

Agricultural Research Council (ARC). 2008. Honeybush research programme. ARC Strategic Planning Workshop. <www.arc.agric.za/home.asp?pid=4523> [Accessed 17/04/2009].

Akinnifesi, F.K., F.R. Kwesiga, J. Mhango, A. Mkonda, T. Chilanga, and R. Swai. 2004. Domesticating priority miombo indigenous fruit trees as a promising livelihood option for smallholder farmers in southern Africa. *Acta Horticulturae,* 632: 15-30.

Akinnifesi, F.K., F.R. Kwesiga, J. Mhango, T. Chilanga, A. Mkonda, C.A.C. Kadu, I. Kadzere, D. Mithofer, J.D.K. Saka, G. Sileshi, T. Ramadhani, and P. Dhliwayo. 2006. Towards the development of miombo fruit trees as commercial tree crops in southern Africa. *Forests, Trees, and Livelihoods,* 16: 103-121.

Akubor, P.I. 1996. The suitability of the African bush mango juice for wine production. *Plant Foods for Human Nutrition,* 49: 213-219.

Aloys, N. and N. Angeline. 2009. Traditional fermented foods and beverages in Burundi. *Food Research International,* 42: 588-594.

Al-Quran, S. 2009. Ethnopharmacological survey of wild medicinal plants in Showbak, Jordan. *Journal of Ethnopharmacology*, 123(1): 45-50.

Amarula Cream. 2009. Proudly local: amarula cream liqueur. <www.amarula.co.za> [Accessed 03/08/2009].

Amarula Report. 2008. Amarula cream still no.2 in global creams arena. <www.amarula.co.za/za/learn/press_releases/amarula_cream_still_no.2_in_global_cr> [Accessed 20/03/2008].

Amusa, O.O.G. 2009. Herbal medicine in Swaziland: an overview of African natural plant products: new discoveries and challenges in chemistry and quality. *ACS Symposium Series*, 1021: ISBN 13:9780841269873. Swaziland Institute for Research in Traditional Medicine, Medicinal and Indigenous Food Plants, University of Swaziland.

Association of Official Analytical Chemists (AOAC) International. 1990. Official methods of analysis. Washington: AOAC. <www.aoac.org/vmeth/omb.htm> [Accessed 15 /08/2006].

Association of Official Analytical Chemists (AOAC) International. 2000. Official methods of analysis. Washington: AOAC. <www.aoac.org/vmeth/omb.htm> [Accessed 21 /01/2006].

Araya, H.T. 2005. Seed germination and vegetative propagation of *Athrixia phylicoides* (bush tea). *MSc Agriculture Thesis*, Department of Plant Production and Soil Science, University of Pretoria.

Arendse, A. 2001. Rooibos tea and small-scale production. *Briefing Document: 4.* Cape Town: Environmental Monitoring Group.

Arnold, H.J. and M. Gulumian. 1984. Pharmacopeia of traditional medicine in Venda. *Journal of Ethnopharmacology,* 12: 35-74.

Bamforth, C.W. 2002. Nutritional aspects of beer- a review. *Nutrition Research,* 22: 227-237.

Bamforth, C.W. 2009. Beer and health. <www.science-direct-com> [Accessed 28/01/2010].

Barreiro-Hurle, J., S. Colombo, and E. Cantos-Villar. 2008. Is there a market for functional wines? Consumer preferences and willingness to pay for resveratrol-enriched red wine. *Food Quality and Preference,* 19: 360-371.

Baxter, D. 2000. Healthy ingredients in beer. *Ferment,* 13(1): 20-24.

Beverage Review. 2003. *Mageu* – where to for Africa's energy drink? *Food Review* March 2003.

Bezuidenhout, G. 2007. Green rooibos tea gains market popularity. <www.engineeringnews.co.za./articles> [Accessed 28/03/2009].

Biodiversity Explorer. 2009. Drinks. <www.biodiversityexplorer.org/encounter/food/drinks.htm> [Accessed 02/08/2009].

Botha, J., E.T.F. Witkowski, and C.M. Shackleton. 2001. An inventory of medicinal plants on the western boundary of the Kruger National Park, South Africa – African protected area conservation and science. *Koedoe*, 44(2): 27-46.

Bousious, A., I. Saldana-Oyarzabal, A.G. Valenzuela-Zapata, C. Wood, and S.R. Pearce. 2007. Isolation and characterisation of Ty1-copia retrotransposon sequences in the blue agave (*Agave tequilana Weber* var. *azul*) and their development as SSAP markers for phylogenetic analysis. *Plant Science,* 172: 291–298.

Bowie, J. 1830. Sketches of the botany of South Africa. *South African Quarterly Journal,* 1: 27-36.

Booysen, I. 2009. *Map database*. Geography, Geoinformatics and Meteorology Department. University of Pretoria.

Brause, A.R. and J. Raterman. 1996. Sugars. *Journal of the Association and Annals of Chemistry,* 65: 846-849.

Brett, T.R.L., E.N. Nyamupingidza, and R.C. Gurira. 1992. The analysis, identification and determination of toxic substances in *kachasu*. *Transactions of the Zimbabwe Science Association,* 66: 25–29.

Browne, K. 2005. Snowball sampling: using social networks to research non-heterosexual women. *International Journal of Social Research Methodology,* 8(1): 47-60.

*Business Day.* 2007. Tea therapy: know your herbal blends – Alex Gazola investigates. Johannesburg. [Dated 25/04/2007].

*Business Day.* 2008. Market swimming in rooibos tea. <www.fastmoving.co.za> [Accessed 09/02/2010].

Bussmann, R.W., G. Gilbreath, J. Solio, M. Lutura, R. Lutuluo, K. Kunguru, N. Wood, and S.G. Mathengwe. 2006. Plant use of the Maasai of Sekenani Valley, Maasai Mara, Kenya. *Journal of Ethnobiology and Ethnomedicine,* 2: 22.

Bruneton, J. 1999. Pharmacognosy, phytochemistry, medicinal plants. Paris: Lavoisier Publishing.

Cant, M. and R. Machado. 1999. *Marketing success stories.* New York: Oxford University Press.

Carbonell, L.L., L. Lizquirdo, I. Carbonell, and E. Costell. 2008. Segmentation of food consumers according to their correlations with sensory attributes projected on preference spaces. *Food Quality and Preference,* 19: 71-78.

Carter, L. 2005: South Africa. Rooibos tea. TED case studies No. 777. <www.america.edu/ted/riobos.htm> [Accessed 23/05/2007].

Cavalli-Sforza, L.L., and M. Feldman. 1981. *Cultural transmission and evolution. A quantitative approach.* Princeton: Princeton University Press.

Chadare, F.J., D.P. Gayet, P. Azokpota, M.J.R. Nout, A.R. Linneman, J.D. Hounhouigan, and M.A.J.S. Van Boekel. 2010. Three traditional fermented baobab foods from Benin, *mutchayan*, *dikouanyouri*, and *tayohounta*: preparation, properties and consumption. *Ecology of Food and Nutrition,* 49: 279–297.

Chadare, F.J., J.D. Hounhouigan, A.R. Linnemann, M.J.R. Nout, and M.A.J.S. Van Boekel. 2008. Indigenous knowledge and processing of *Adansonia digitata* - local food products in Benin. *Ecology of Food and Nutrition,* 47: 338–362.

Chapman, J. 2006. Focus on history of liqueurs. The Oxford Wine Company. <www.oxfordwine.co.uk/features/winter_06/liqueurs.html> [Accessed 09/03/2010].

Clanwilliam General Info. 2009. Rooibos tea tours. <http: <www.clanwilliam.inforooibostea.html> [Accessed 28/03/2009].

Coca Tea. 2009. Coca tea - the divine and magic plant of the Incas. <www.cocazone.co.za> [Accessed 01/ 07/2009].

Coetzee, G., I.J. Marx, M. Pengilly, V.S. Bushula, E. Joubert, and M. Bloom. 2008. Effect of rooibos and honeybush tea extracts against *Botrytis cinerea*. *South African Journal of Enology and Viticulture,* 29(1): 33-38.

Conservation of Agricultural Resources Act (CARA). 1983. Invasive species regulations of the Conservation of Agricultural Resources Act, (Act No.43 of 1983), Regulation 15 & 16. Pretoria: *Government Gazette.*

Cosmetic Web. 2008. African extracts: rooibos. <www.cosmeticweb.co.za> [Accessed 12/09/2008].

Cosmetic Workshop and Natures Goodness (CWNG). 2009. History of CWNG. <www.naturesgoodness.co.za> [Accessed 23/03/2009].

Crane, W. 2007. LED and the biodiversity economy: who benefits most? <www.khanyaaicdd.org/photo_root/publications/LED_Policybrief_7.pdf> [Accessed 13/03/2008].

Crouch, N.R., E. Douwesa, M.M. Wolfsond, G.F. Smith, and T.J. Edwards. 2008. South Africa's bioprospecting, access and benefit-sharing legislation: current realities, future complications, and a proposed alternative. *South African Journal of Science,* 104: 355-366.

Cruz, A. and J.M. Moreno. 2001. Seasonal course of total non-structural carbohydrates in the lignotuberous Mediterranean shrub, *Erica australis*. *Ecologia,* 128: 343-350.

Cunningham, A.B. and S.J. Pieser. 1991. Primary health care booklet. *Working Paper No: 75.* Pietermaritzburg: University of Natal.

Cunningham, A.B. and C.M. Shackleton. 2004. Use of fruits and seeds from indigenous and naturalised plant species. In Lawes, M.J., C.M. Shackleton, and B.G.S. Geach (Eds), *Indigenous Forests and Woodlands in South Africa: Policy, People and Practice*. Scottsville: University of KwaZulu-Natal Press.

Cupido, C. 2005. *Aspalathus linearis*. Compton Herbarium, Kirstenbosch. <plantzafrica.com/plantab/aspalathus.htm> [Accessed 22/02/2006].

De Beer, T. 2006. Polyphenols, ascorbate and antioxidant capacity of the Kei apple (*Doyvalis caffra)*. *MSc Nutrition Thesis*. School of Physiology, Nutrition, and Consumer Sciences. North-West University.

De Beer, D. and E. Joubert. 2007. Antioxidant potential and phenolic composition of bush tea (*Athrixia phylicoides*) extracts. *Poster presented at a Conference organised by the Indigenous Plant Use Forum (IPUF) held at the University of Johannesburg* (2-5/07/2007).

De Lange, H.C., W. Van Averbeke, and P.J.J. Van Vuuren. 2005. Human preference for and insect damage to six South African wild fruits. *African Entomology,* 13(1): 173-176.

De Nysschen, A.M., B.E. Van Wyk, F.R. Van Heerden, and A.L. Schutte. 1996. The major phenolic compounds in the leaves of *Cyclopia* species honeybush tea. *Biochemical and Systematic Ecology,* 24: 243-246.

Department of Agriculture (DA). 2005. Honeybush tea. <www.nda.agric.za/docs/Honeybush06.pdf> [Accessed 20/09/2006].

Department of Agriculture (DA). 2006a. *Economic review of national agriculture*. Publication of the National Department of Agriculture. <www.nda.gov.za> [Accessed 22/01/2007].

Department of Agriculture (DA). 2006b. *Agricultural statistics.* The National Department of Agriculture. Pretoria: Directorate Agricultural Statistics.

Department of Environmental Affairs and Tourism (DEAT). 2006. Types of Fynbos. <www.environment.gov.za> [Accessed 01/17/2007.

Department of Water Affairs and Forestry (DWAF). 2007. Category of the 47 protected tree species in South Africa. <www.dwaf.gov.za> [Accessed 10/07/2009].

Dillon, A. 1990. Fruit juice profiles. *Report 69*, CocaCola Foods.

Distell Annual Report. 2005. Amarula cream. <www.distell.co.za> [Accessed 01/04/2005].

Dharmanada, S. 2005. Honeybush – healthful beverage tea from South Africa. <www.itmonline.org/arts/honeybush.htm> [Accessed 29/01/2009].

Dovie, D.B.K., E.T.F. Witkowski, and C.M. Shackleton. 2008. Knowledge of plant resource use based on location, gender and generation. *Applied Geography,* 28: 331-322.

Du Plessis, P. 2004. Industry analysis – indigenous plant lipids sector. Natural Products Entreprise Programme IUCN (NPEP-IUCN-SA), Harare.

Du Preez, R.J. 2003. Lesser-known fruits of Africa. *Encyclopedia of Food Sciences and Nutrition:* 2800-2810.

Du Preez, R. 2007. Development of indigenous fruit species as commercial crops for South African resource poor farmers. Report TS 5710/30, ITSC, Nelspruit.

Du Preez, R.J., C.W. Matsha, and C.P. Welgemoed. 2003. Identification and domestication of selected indigenous fruits. *Paper presented at a Conference organised by the Indigenous Plant Use Forum (IPUF) held in Rustenburg* (7-10/06/2003).

Du Toit, J. and E. Joubert. 1999. Optimization of the fermentation parameters of honeybush tea (*Cyclopia*). *Journal of Food Quality,* 22: 241-256.

Du Toit, J., E. Joubert, and T.J. Britz. 1998. Honeybush tea - a rediscovered indigenous South African herbal tea. *Journal of Sustainable Agriculture,* 12: 67-84.

Edwards, H.G.M., D.W. Farwell, L.F.C. De Oliveira, J.M. Alia, M. Le Hyaric, and M.V. De Ameida. 2005. FT-Raman spectroscopic studies of guarana and some extracts. *Analytica Chemica Acta,* 532: 177–186.

Esoteric Oils. 2009. The world of fine and pure essential oils. <www.essentialoils.co.za/ximenia-oil.htm> [Accessed 09/12/2009].

Export Directory. 2004. *The official guide to South African perishable export products and export service providers.* <www.ppecb.com/PPECBCMS/News/.Export+Directory.htm> Singapore: Tien Wah Press Ltd.

Fabry, W., P. Okemo, and R. Ansorg. 1996. Activity of East African medicinal plants against *Helicobacter pyroli*. *Chemotherapy,* 42: 315-317.

Fayeola, C.O. and T.O. Akinwale. 2002. Utilization of kolanut and cocoa in beverage production. *Nutrition and Science,* 32(1): 21-23.

Food and Agricultural Organisation (FAO). 1983. Household food security and forestry analysis of socio-economic issues. *Community Forestry Notes*. Rome: FAO.

Foodcorp. 2010. Mageu number 1. <www.foodcorp.co.za/division_2/brands_div2.php?brandid=8 > [Accessed 4/11.2010].

Ferreira, A. 2009. Rooibos' bid for the gourmet table. <http://www.thetimes.co.za> [Accessed 31/03/2009].

Frances, M.A. and S. Mohammed. 2003. Relying on nature: wild foods in Northern Nigeria. *Ambio,* 32(1): 25-29.

Fukumasu, H., T.C. Da Silva, J.L. Avanzoa, C.E. De Limaa, I.S. Mackowiaka, A. Atrochib, S.H. De Souza, F.S. Morenoc, and M.L. Zaidan. 2006. Chemopreventive effects of *Paullinia cupana* Mart var. *sorbilis*, the guarana, on mouse hepatocarcinogenesis. *Cancer Letters,* 233: 158–164.

Gadaga, T.H., A.N. Mutukumira, J.A. Narvhus, and S.B. Feresu. 1999. A review of traditional fermented foods and beverages of Zimbabwe. *International Journal of Food Microbiology,* 53: 1-11.

Geldenhuys, C.J. 2004. Meeting the demand for *Ocutea bullata* bark. In Lawes, M.J., C.M. Shackleton, and B.G.S Geach (Eds), *Indigenous Forests and Woodlands in South Africa: Policy, People and Practice*. Scottsville: University of KwaZulu-Natal Press.

Gerhauser, C. 2005. Beer constituents as potential cancer chemopreventive agents. *European Journal of Cancer,* 41: 1941-1954.

Ghebremeskel, K., G. Williams, R.A. Brett, R. Burek, and L.S. Harbige. 1991. Nutrient composition of plants favoured by black rhinoceros (*Diceros bicornis*) in the wild. *Journal of Composition, Biochemistry and Physiology,* 98(A): 529-534.

Gin and Vodka Association. 2009. Gin history, development and origin. <www.ginvodka.org/history/ginHistory.asp> [Accessed 24/07/2009].

Global Invasive Species Programme (GISP). 2003. Invasive alien species in southen Africa: national reports & directory of resources. In Macdonald, I.A.W., J.K. Reason, C. Bright, L.E. Neville, G.W. Howards, S.J. Murphy, and G. Preston (Eds), *The Global Invasive Species Programme GISP*. National Botanical Institute, Kirstenbosch Gardens.

Govender, Y., M.R. Jury, A. Mthembu, S. Hatese, and E. Bulfoni. 2005. Socio-economic status and development potential for a rural community on the Maputaland Coast of South Africa. *The South African Geographical Journal,* 87: 37-42.

Goyvaerts, L. 2003. Marula brew: community brewing to benefit from biotechnology. <www.scienceinafrica> [Accessed 29/01/2009].

Green-A-Planet. 2009. *Vangueria infausta*. <www.greenaplant.co.za/wil-medlar.html> [Accessed 02/12/2009].

Gruenwald, J. 2009. Novel botanical ingredients for beverages. *Clinics in Dermatology,* 27: 210-216.

Guarano Tea. 2009. Guarana herb from Brazil. <www.articlesbase.com/health-articles/guarana-herb-from-brazil-1024479/html> [Accessed 11/09/2009].

Ham, C. 2004. Marulas more popular than apples (Box 21.1). In Lawes, M.J., C.M. Shackleton, and B.G.S Geach (Eds), *Indigenous Forests and Woodlands in South Africa: Policy, People and Practice*. Scottsville: University of KwaZulu-Natal Press.

Hansen, T. 2006. A sustainable production strategy for the rooibos tea industry. Commissioned by CapeNature (Greater Cederberg Biodiversity Corridor & SA Rooibos Council).

Hasler, C.M. 2002. Functional foods: benefits, concerns and challenges – a position paper from the American Council on Science and Health. American Society for Nutritional Sciences: 0022 3166/02:3772-3781.

Health and Fitness. 2007. Rooibos espresso. <www.health.iafrica.com> [Accessed 31/ 03/2009].

Henman, A.R. 1982. Guarana (*Paullinia cupana* var. *sorbilis*): ecological and social perspectives on an economic plant of the central Amazon Basin. *Journal of Ethnopharmacology,* 6: 311–338.

Holtzhauzen, L.C., E. Swart, and R. Van Rensburg. 1990. Propagation of the marula (*Sclerocarya birrea* subsp. *caffra*). *Acta Horticulturae,* 275: 323-334.

Hudaib, M., M. Mohammed, Y. Bustanji, R. Tayvem, M. Yousef, M. Abuirjeje, and T. Abuirjal. 2008. Ethnopharmacological survey of medicinal plants in Jordan, Mujib Nature Reserve and surrounding area. *Journal of Ethnopharmacology* 120:63-71.

Institute of Conservation and Natural History of the Soutpansberg (ICONS). 2002. Tree list of the Soutpansberg. Louis Trichardt: ICONS.

Institute of Soil, Climate, and Water (ISCW). 2009. Agrometerelogical data of selected areas of the Limpopo Province. ISCW, Agricultural Research Council (ARC), Arcadia Branch, Pretoria.

IPGRI-SAFORGEN Report, 2001. Review and appraisal on the status of indigenous fruits in eastern Africa. A Report prepared for IPGRI-SAFORGEN in the AFREA/FORNESSA framework. <www.bioversityinternational.org/saforgen/Review_and_Synthesis_of_Indigenous_Fruits_in_East_Africal.pdf> [ Accessed 01/12/2009].

Ismail, F. and T. Fakir. 2004. Trademarks or trade barriers? Indigenous knowledge and the flaws in the global IPR system. *International Journal of Social Economics,* 31(12): 173–194.

Joubert, E., F. Otto, S. Gruner, and B. Weireich. 2003. Reversed-phase HPLC determination of mangiferin, isomangiferin and hesperedin in *Cyclopia* and the effect of harvesting date on the phenolic composition of *C. genistoides*. *European Food Research and Technology,* 216: 270-273.

Joubert, E. 1988. Effect of batch extraction conditions on yield of soluble solids from rooibos tea. *International Journal of Food Science*, 23: 43-47.

Joubert, E., W.C.A. Gelderblom, A. Louw, and D. De Beer. 2008. South African herbal teas: *Aspalathus linearis, Cyclopia* spp. and *Athrixia phylicoides – a* review. *Journal of Ethnopharmacology,* 119: 376–412.

Karadeniz, F. and A. Eksi. 2002. Sugar composition of apple juices. *European Food Research and Technology,* 215: 145–148

Komane, M.B., E.I. Olivier, and A.M. Viljoen. 2008. *Trichilia emetica* – results of an ethnobotanical survey. *Paper presented at a Conference organised by the Indigenous Plant Use Forum held in Graaff Reinet, Eastern Cape Province (IPUF) (*7-10/07/2008).

Kuczkowski, K.M. 2009. Caffeine in pregnancy: a cause for concern? *Annales Françaises d'Anesthésie et de Réanimation*, 28(6): 605-607.

L'abbe, E.N., M. Steyn, and M. Loots. 2008. Life expectancy of the 20th century Venda: a compilation of skeletal and cemetery data. *Journal of Comparative Human Biology,* 59: 189-207.

Leakey, R. 1999. Potential for novel food products from agroforestry trees: a review. *Food Chemistry,* 66(1): 1-14.

Leakey, R., S. Shackleton, and P. Du Plessis. 2005. Domestication potential of marula (*Sclerocarya birrea* subs. *caffra*) in South Africa and Namibia: 1. Phenotypic variation in fruit traits. *Agroforestry Systems,* 64: 25-35.

Lee, E.J. and H.D. Jang. 2004. Antioxidant activity and protective effect on DNA strand scission of rooibos tea (*Aspalathus linearis*). *Biofactors,* 21: 285-292.

Limpopo State of the Environment Report (LSOER). 2005. State of the environment reports. <www.environment.gov.za/soer/reports/limpopo.html. > [Accessed 25/09/2010].

Luckow, T. and C. Delahunty. 2004. Consumer acceptance of orange juice containing functional ingredients. *Food Research International,* 37: 805-814.

Lues, J.F.R., B.K. Ikalafeng, M. Maharasoa, and K. Shale. 2009. Brewing and consumption practices of indigenous traditional beer in a typical South African semi-urban area. *Indilinga– African Journal of Indigenous Knowledge Systems,* 8(2): 163-174.

Mabogo, D.E.N. 1990. The ethnobotany of the Vhavenda. *MSc Botany Thesis*, University of Pretoria.

Maghembe, J.A., Y. Ntupanyama, and P.W. Chirwa. 1995. Improvement of indigenous fruit trees of miombo woodlands of southern Africa. ICRAF, Nairobi, Kenya.

Majhenič, I., M. Škerget, and Ž. Knez. 2007. Antioxidant and antimicrobial activity of guarana seed extracts. *Food Chemistry,* 104: 1258–1268.

Marnewick, J.L., W.C.A. Gelderblom, and E. Joubert. 2000. An investigation on the antimutagenic properties of South African herbal teas. *Mutations Research,* 471: 157–166.

Marnewick, J.L., E. Joubert, P. Swart, F. Van Der Westhuizen, and W.C.A. Gelderblom. 2003. Modulation of hepatic drug metabolyzing enzymes and oxidative status by green and black (*Camellia sinensis*), rooibos (*Aspalathus linearis*) and honeybush (*Cyclopia intermedia*) teas in rats. *Journal of Agricultural and Food Chemistry,* 51: 8113-8119.

Marnewick, J.L., W. Batenburg, P. Swart, E. Joubert, S. Swanevelder, and W.C.A. Gelderblom. 2004. *Ex vivo* modulation of chemical-induced mutagenesis by subcellular liver fractions of rats treated with rooibos tea (*Aspalathus linearis*) and honeybush (*Cyclopia intermedia*) as well as green and black (*Camellia sinensis)* teas. *Mutations Research,* 558: 145-154.

Maphosa, V. and P.J. Masika. 2007. A study of plants used in ethnoveterinary control of gastro-intestinal parasites of goats in the Eastern Cape Province, South Africa. *Paper presented at the Conference organised by the Indigenous Plant Use Forum (IPUF) held at the University of Johannesburg, Gauteng province* (2-5/07/2007).

Mashela, P.W. and N. Mollel. 2001. Farmer-identified indigenous fruit tree with suitable attributes for the semi-arid Northern Province of South Africa. *South African Journal of Agricultural Extension,* 30: 1-12.

Mashimbye, M.J., F.N. Mudau, T. Van Ree, and P. Soundy. 2006. A new flavonol from *Athrixia phylicoides* (Bush tea). *South African Journal of Chemistry,* 59: 1-2.

Mateke, S. 2003. Cultivation of native fruit trees of Kalahari Sandveld: Studies on the commercial potential, interactions between soil and biota in Kalahari sands of Southern Africa. Veld Products, Botswana.

Mathabe, M.C., R.V. Nikolova, N. Lall, and N.Z. Nyazema. 2006. Antibacterial activities of medicinal plants used for the treatment of diarrhoea in Limpopo Province, South Africa. *Journal of Ethnopharmacology,* 105: 286-293.

Matoti, B. 2007. Report: Honeybush tea.
<www.elseberg.com/economics.honeybush.html> [Accessed 28/01/2009].

McGaw, L.J. and J.N. Eloff. 2005. *Athrixia* bush tea: cytotoxicity and antioxidant activity. *Paper presented at a Conference organised by the Indigenous Plant Use Forum (IPUF) held at Rhodes University, Grahamstown, Eastern Cape province (27-30/06/2005)*.

McGaw, L.J. and J.N. Eloff. 2008. Ethnoveterinary use of southern African plants and scientific evaluation of their medicinal properties. *Journal of Ethnopharmacology,* 119: 559-574.

McGaw, L.J., V. Steenkamp, and J.N. Eloff. 2007a. Evaluation of *Athrixia* bush tea for cytotoxicity, antioxidant activity, caffeine content and presence of pyrrollizidine alkaloids. *Journal of Ethnopharmacology,* 110: 16-22.

McGaw, L.J., V. Steenkamp, and J.N. Eloff. 2007b. *In vitro* antihelminthic, antibacterial and cytotoxic effects of extracts from plants used in South African ethnoveterinary medicine. *The Veterinary Journal,* 173: 366-372.

Mebe, P.P., G.A. Cordell, and J.M. Pezzuto. 1998. Pentacyclic triterpenes and naphthoquinones from *Euclea divinorum*. *Phytochemistry,* 42(2): 311-313.

Meilgaard, M., G.V. Civille, and B.T. Carr. 1999. Sensory evaluation techniques. CRC Press LLC.

Mevy, J.P., J.M. Bessiere, S. Gref, G. Zombre, and J. Vian. 2006. Composition of the volatile oil from the leaves of *Ximenia americana*. *Biochemical Sytematics and Ecology,* 34(7): 549-553.

Meyer, T. 2010. Natural resources: land management. *Module 7.1: Environmental law for environmental managers.* University of the Northwest, Centre for Environmental Management.

Mitei, Y.C., J.C. Ngila, S.O. Yeboah, L. Wessjohann, and J. Schmidt. 2008. NMR, GC-MS and ESI-FTICR-MS profiling of fatty acids and triacylglycerols in some Botswana seed oils. *Journal of the American Oil Chemists Society,* 85: 1021-1032.

Mogotlane, I.D., F.N. Mudau, P.W. Mashela, and P. Soundy. 2006. Response of TAA concentration to nitrogen nutrition of bush tea (*Athrixia phylicoides*). *Poster presented at a Conference organised by the Indigenous Plant Use Forum (IPUF) held at the University of Botswana, Gaborone* (3-6/06/2006).

More, G., T.E. Tshikalange, N. Lall, F. Botha, and J.J.M. Meyer. 2008. Antimicrobial activity of medicinal plants against oral microorganisms. *Journal of Ethnopharmacology,* 119: 473-477.

Moshe, D. 2004. Household use of resources in the Hoedspruit district, Limpopo province. In Lawes, M.J., C.M. Shackleton, and B.G.S. Geach (Eds), *Indigenous Forests and Woodlands in South Africa: Policy, People and Practice*. Scottsville: University of KwaZulu-Natal Press.

Moskowits, H.R. 1999. On the intersection of products and concepts: opportunities for sensory analysis to improve the commercial development process. *Food Quality and Preference,* 10: 333-342.

Mothana, R.A., U. Lindequist, R. Gruenert, and P. Bednarski. 2009. Studies of the *in vitro* anticancer, antimicrobial, and antioxidant potentials of selected Yemeni medicinal plants from the island Sogotra. *BMC Complementary and Alternative Medicine,* doi: 10.1186/1472-6882-9-7.

Motlhanka, D.M.T., P. Motlhanka, and T. Selebatso. 2008. Edible indigenous wild fruits of eastern Botswana. *International Journal of Poultry Sciences,* 7: 457-460

Mudau, F.N., H.T. Hintsha, E. Araya, S. Du Toit, P. Soundy, and J. Olivier. 2007. Bush tea (*Athrixia phylicoides* DC) as an alternative herbal and medicinal plant in southern Africa: opportunity for commercialisation. *Medicinal and Aromatic Plant Science and Biotechnology,* 1(1): 70-73.

Muica, N. and D. Turnock. 1996. The potential for traditional food and drink products in Eastern Europe: Fruit processing – especially brandy ("*tuica*") distilling – in Romania. *Geojournal,* 38(2): 197-206.

Mwesigye, P.K. and T.O. Okurut. 1994. A survey of the production and consumption of traditional alcoholic beverages in Uganda. *Process Biochemistry,* 30(6): 497-501.

Nakano, M., Y. Itoh, T. Mizuno, and H. Nakashima. 1997. Polysaccharide from *Aspalathus linearis* with strong anti-HIV activity. *Bioscience, Biotechnology and Biochemistry,* 61: 267-271.

Nash, L.J. and C.H. Bornman. 1973. Constituents of ilala wine. *South African Journal of Science,* 69: 89-90.

National Environmental Management: Biodiversity Act (NEMBA). 2004. Invasive species regulations of the National Environmental Management: Biodiversity Act, (Act No.10 of 2004). Pretoria: Government Printer.

Nature Peru. 2007. Coca tea information tea. <www.natureperu.com/cocatea/index.php> [Accessed 03/08/2009].

Ndubani, P. and B. Hojer. 1999. Traditional healers and the treatment of sexually transmitted illnesses in rural Zambia. *Journal of Ethnopharmacology,* 67(1): 15-25.

Nel, E., T. Binns, and D. Bek. 2006. 'Alternative foods' and community-based development: rooibos tea production in South Africa's West Coast Mountains. *Applied Geography,* 1: 1–18.

Neven, D., J.T. Goliath, T. Reardon, and R. Hopkins. 2005. *Case studies of farmer organizations linked to dynamic markets in Southern Africa: the Haarlem and Ericaville Honeybush Producer Groups, South Africa.* USA: USAID and Michigan State University.

New Agriculturist. 2008. Marula - Africa's treasure tree. <www.new-ag.ino/06-5/focuson/focuson8.html> [Accessed 20/03/2009].

Niguez-Covarrubias, G.I., R.D. Teres, R. Sanjuan-Due, J. Anzaldo-Hern, and R.M. Rowell. 2001. Utilization of by-products from the tequila industry. Part 2: potential value of Agave tequilana Weber azul leaves. *Bioresource Technology,* 77: 101-108.

Nikolova, V., S. Petrova, V. Pavlova, A. Michailova, and T. Georgieva. 2007. Antioxidative effects of rooibos tea on workers occupationally exposed to lead. *Toxicology Letters,* 172: 120–121.

Nwonwu, F.O.C. 2006. The socio-cultural and economic relevance of the marula tree and its sustainable use in South Africa. *Africa Insight,* 36: 250-265.

Nyanga, L.K., M.J.R. Nout, T.H. Gadaga, T. Boekhout, and M.H. Zwietering. 2008. Traditional processing of masau fruits (*Ziziphus mauritiana*) in Zimbabwe. *Ecology of Food and Nutrition,* 47: 95–107.

Ogunleye, D.S. and F.S. Ibitoyi. 2003. Studies of antimicrobial activity and chemical constituents of *Ximenia americana*. *Tropical Journal of Pharmaceutical Research,* 2(2): 239-241.

Olivier, J. 2001. Strategies for the commercialization of bush tea (*Athrixia phylicoides*). Final Report, NRF Focus Area Project. GUN: 2048685.

Olivier, J. and A.E. De Jager. 2005. An ethnobotanical survey of *Athrixia phylicoides* and its uses. *Die Suid-Afrikaanse Tydskrifte vir Natuurwetenskap en Tegnologie,* 24(4): 139-147.

Olivier, J., I.T. Rampedi, and A.E. De Jager. 2003. Sustainable development of an indigenous South African tea: research outline. *Paper presented at the Conference organised by the Indigenous Plant Use Forum (IPUF) held in Rustenburg, Northwest province (*7-10/07/2003).

Olivier, J. and I.T. Rampedi. 2005. The *Athrixia phylicoides* research project: summary of research findings. *Poster presented at a Conference organised by the Indigenous Plant Use Forum (IPUF) held at Rhodes University, Grahamstown, Eastern Cape province (27-30/06/2005).*

Olivier, J. and I.T. Rampedi. 2008. Mountain tea: a new herbal tea from South Africa. *Journal of the Institute of Food Science and Technology,* 22(1): 47-49.

Olivier, J., I.T. Rampedi, E.A Symington, and T.S. Van Eeden. 2008. The nutritional composition of three South African teas: rooibos, honeybush, and *Athrixia phylicoides*. *Paper presented at a Conference organised by the Indigenous Plant Use Forum (IPUF)* held at Graaff Reinet, Eastern Cape Province (7-10/07/ 2008).

Olivier, J. and H.C. Rautenbach. 2002. The implementation of fog water collection systems in South Africa. *Atmospheric Research,* 64: 227-238.

Palgrave, M.C. 2002. *Trees of southern Africa*. Cape Town: Struik Publishers.

Peters, C.R. and B. Maguire. 1981. Wild plant foods of the Makapansgat area: a modern ecosystems analogue for *Australopithecus africanus* adaptations. *Journal of Human Evolution,* 10: 565-583.

Phytotrade. 2005. Supporting trade in natural products in the southern African region. <www.phytotrade.com> [Accessed 03/07/2005].

Piggot, J.R., M.R. Sheen, and S.G. Apostolidou. 1990. Consumer's perceptions of whiskies and other alcoholic beverages. *Food Quality and Preference,* 2: 177-185.

Platt, B.S. 1955. Some traditional alcoholic beverages and their importance in indigenous African communities. *Symposium Proceedings of the Nutrition Society,* 14: 115-124.

Pohjanheimo, T.A. and M.A. Sandell. 2009. Headspace volatiles contributing to flavour and consumer liking of wellness beverages. *Food Chemistry,* 115: 843-851.

Pohler, H. 2010. Caffeine intoxication and addiction. *The Journal for Nurse Practitioners,* 6(1): 49-52.

Prins, H. and J.A. Maghembe. 1994. Germination studies of fruit trees indigenous to Malawi. *Forest Ecology and Management,* 64: 111-125.

Putuka, N.D., D. Luseba, and G. Bouwer. 2006. Tick repellant activities of some plant extracts. *Paper presented at a Conference organised by the Indigenous Plant Use Forum (IPUF) held at Rhodes University, Grahamstown, Eastern Cape province (*3-6/07/ 2006).

Rampedi, I.T. and J. Olivier. 2005. The use and potential commercial development of *Athrixia phylicoides. Acta Academica,* 37(3): 165-182.

Rampedi , I.T. and J.Olivier. 2008. The development path of rooibos tea – a review of patterns and lessons learnt for the commercialization of other indigenous teas in South Africa. *International Journal of African Renaissance Studies,* 3(2): 5-20.

Reibel, J. 2003. South Africa: Increasing employment opportunities in Agriculture (AGRILINK ii) Projects. *3rd Quartely Report, FY'03 (01/04/ 2003-30/06/203)*, USAID. Enterprise Management & Innovation (Pty) Ltd.

Resano, H., A.L. Sanjuan, I. Cilla, P. Roncales, and L.M. Albisu. 2009. Sensory attributes that drive consumer acceptability of dry-cured ham and converegence with trained sensory data. *Meat Science,* 84: 344-351.

Research Centre Knowledge Base (RCKB). 2009. Non-probability sampling. <www.socialresearchmethods.net/kb/samp> [Accessed 24/4/2009].

Reyes-Garcia, V., J. Broesh, L. Calvert-Mir, N. Fuentes-Pelaez, T.W. McDade, S. Parsa, T. Huenca, S. Tanner, W.R. Leonard, and M.R. Martninez-Rodriques. 2009. Cultural transmission of ethnobotanical knowledge and skills: an empirical analysis from an Amerindian society. *Evolution and Human Behaviour,* 30: 274-285.

Reyes-Garcia, V., E. Kightly, I. Ruiz-Mallen, N. Fuentes-Pelaez, K. Demps, T. Huanca, and R. Martinez-Rodriquez. 2010. Schooling and local environmental knowledge: do they complement or substitute each other? *International Journal of Educational Development*, 30(3): 305-313

Richards, A.I. 1939. *Land, labour, and diet in Northern Rhodesia.* London: Oxford University Press.

Ritchfield, D. 2008. An investigation into the biological activity of rooibos (*Aspalathus linearis*). *MSc Biochemistry Thesis.* Department of Biochemistry, University of Stellenbosch.

Rodriquez-Saona, L.E., F.S. Fry, M.A. McLaughlin, and E.M. Calvery. 2001. Rapid analysis of sugars in fruit juices by FT-NIR spectroscopy. *Carbohydrate Research,* 336: 63-74.

Rolfes, R.S., K. Pinna, and E. Whitney. 2009. Understanding normal and clinical nutrition. US: Thomas Wardsworth.

Rooibos Innovations. 2010. The sophistication of café culture with extraordinary health properties. <www.rooibosinnovations.com/about_rooibos.htm> [Accessed 17/01/2010].

Rooibos Limited. 2010. The history of rooibos. <www. rooibosltd.co.za> [Accessed 20/03/2010].

Rouault, M. and Y. Richard. 2003. Intensity and spatial extension of drought in South Africa at different time scales. *Water SA,* 29(4): 489-500.

Rudnitskaya, A., I. Delgadillo, A. Legin, S.M. Rocha, A.M. Costa, and T. Simoes. 2007. Prediction of the port wine age using an electronic tongue. *Chemometrics and Intelligent Laboratory Systems,* 88: 125–131.

Ruffo, C.K., A. Birnie, and B. Tenghnas. 2002. Edible wild plants of Tanzania. Regional Land Management (RELMA) Report. Nairobi, Kenya.

SA Good News. 2008. SA's rooibos espresso wins at US Coffee espresso. <www.sagoodnews.co.za> [Accessed: 31/03/2009].

SA Year Book. 2008/09. South Africa. Government-Online <www.gov.za>

SABONET. 2009. *Invasive alien plants in southern Africa. Part 4: Eucalypts & Myrtles (Myrtaceae)*. Southern African Botanical Diversity Network: list of declared plants belonging to the Myrtaceae in South Africa.

Saka, J.D.K. and J.D. Msonthi. 1994. Nutritional value of edible fruits of indigenous wild trees in Malawi. *Forest Ecology and Management,* 64: 245-248.

Samie, A., C.L. Obi, P.O. Bessong, and I. Namrita. 2005. Activity profiles of fourteen selected medicinal plants from rural Venda communities in South Africa against fifteen clinical bacterial species. *African Journal of Biotechnology,* 4(12): 1443-1451.

Saul, M. 1981. Beer, sorghum and women: production for the market in rural Upper Volta. *Journal of the International African Institute,* 51(3): 746-764.

Scheijde, N. 2001. Developing indigenous wine. *Food Review* (News Update, January 2001).

Schmidt, T.E., M. Lotter, and W. McClelland. 2002. *Trees and shrubs of Mpumalanga and the Kruger National Park*. Johannesburg: Jacana Publishers.

Scholes, R.J. 2004. Woodlands of South Africa. In Lawes, M.J., C.M. Shackleton, and B.G.S. Geach (Eds), *Indigenous Forests and Woodlands in South Africa: Policy, People and Practice*. Scottsville: University of KwaZulu-Natal Press.

Schuster, M. 2005. *Essential winetasting*. London: Octopus Publishing Group.

Schwartz, H.M. 1956. Kaffircorn malting and brewing studies – the kaffir beer brewing industry in South Africa. *Journal of Science and Food Agriculture,* 7: 101-105.

Shackleton, S. 2004. Livelihood benefits from the local level commercialisation of savannah resources: a case study of the new and expanding trade in marula (*Sclerocarya birrea*) beer in Bushbuckridge, South Africa. *South African Journal of Science,* 100: 651-657.

Shackleton, S.E. and B.M. Campbell. 2007. The traditional broom trade in Bushbuckridge, South Africa: helping poor women cope with adversity. *Economic Botany,* 61(3): 256-268.

Shackleton, C.M., S.E. Shackleton, E. Buiten, and N. Bird. 2007. The importance of dry woodlands and forests in rural livelihoods and poverty alleviation in South Africa. *Forest Policy and Economics, 9*: 558– 577

Shackleton, S.E., C.M. Shackleton, T.R. Netshiluvhi, B.S. Geach, A. Balance, and D.H.K. Fairbanks. 2002. Use patterns and value of savanna resources in three rural villages in South Africa. *Economic Botany,* 56(2): 130-146.

Shackleton, S., C. Sullivan, T. Cunningham, R. Leakey, S. Laird, C. Lombard, M. Mander, T. Netshiluvhi, C. Shackleton, and R. Wynberg. 2001. An overview of current knowledge on *Sclerocarya birrea* (A. Rich.) Hochst. subsp. *caffra* (Sond.) with particular reference to its importance as a non-timber forest product (NTFP) in southern Africa. *Winners and Losers in Forest Product Commercialisation* Report ZF0140/R7795.

Shange, N.B., S.G. Shabalala, and A.R. Opoku. 2006. Anti-oxidant and DNA protecting properties of some *Rhoicissus* species-traditional Zulu medicinal plants. *Poster presented at a Conference organised by the Indigenous Plant Use Forum (IPUF) held at the University of Botswana, Gaborone* (3-6/07/2006).

Shava S., R. O'Donoghue, M.E. Krasny, and C. Zazu. 2009. Traditional food crops as a source of community resilience in Zimbabwe. *International Journal of African Renaissance Studies - Multi-, Inter- and Transdisciplinarity,* 4: 31-48.

Sikhakhane, J. 2008. *Awethu* thirsts for expansion. Sunday Times (Business Times). <btimes.co.za/97/1019/comp/comp3.htm> [Accessed 20/03/2008].

Snijman, P.W., S. Swanevelder, E. Joubert, I.R. Green, and W.C.A. Gelderblom. 2007. The antimutagenic activity of the major flavonoids of rooibos (*Aspalathus linearis*)-some dose-response effects on mutagen activation-flavonoid interactions. *Mutations Research,* 613: 111-123.

South African Bureau of Standards (SABS). 2007. Methods and techniques adopted by the South African Bureau of Standards. Brooklyn, Pretoria.

South African Weather Bureau (SAWB). 1986. Climate of South Africa – climate statistics up to 1984. Pretoria: Government Printer.

Sparg, S.G., J. Van Staden, and A.K. Jager. 2000. Efficiency of traditionally used South African plants against schistosomiasis. *Journal of Ethnopharmacology,* 73(1-2): 209-214.

Stasko, A., M. Polovka, V. Brezova, S. Biskupic, and F. Malik. 2006. Tokay wines as scavengers of free radical (an EPR study). *Food Chemistry,* 96: 185-196.

Statistics South Africa (Stats SA). (2001). Population census 2001 Data. <www.statssa.gov.za> [Accessed 20/03/2004].

Steenkamp, V. 2003. Traditional herbal remedies used by South African women for gynaecological complaints. *Journal of Ethnopharmacology,* 86: 97-108.

Steenkamp, V. and M.C. Gouws. 2003. Antiproliferative, antioxidant and antibacterial activity of herbal remedies used to treat prostrate disorders. *Paper presented at a Conference organised by the Indigenous Plant Use Forum (IPUF) held in Rustenburg, Northwest province (*7-10/07/2003).

Stubb, A. 2006. The European vodka wars. European voices. <www.alextubb.com/artikkelit/bw_vodka.pdf> [Accessed 28/07/2009]

Sullivan, C.A., D.P. O'Regan, and C.E.H. Wallingford. 2003. Winners and losers in forest product commercialization. *Final Report* R7795. Centre for Ecology and Hydrology. DFID Department for International Development.

Tapela, B.N. 2002. The Greater Groblersdal local municipality – Mpumalanga and Limpopo Provinces. An assessment of the local economic development and sustainability within the IDP for three projects. Tapela 41: Case Studies of Local Governance (UNDP).

Taylor, F.W., S.M. Mateke, and K.J. Butterworth. 1996. A holistic approach to the domestication and commercialization of non-timber forest products. In Leakey R.R.B., A.B. Temu, M, Melnyk, and P. Vantomme (Eds), *Domestication and commercialization of non-timber forest products in agroforestry products in agroforestry systems (8-22).* Rome: FAO.

Temple, J.L. 2009. Caffeine use in children: what we know, what we have left to learn, and why we should worry. *Neuroscience and Biobehavioral Reviews*, 33(6): 793-806.

Tourilla, H. and E. Monteleone. 2009. Sensory food science in the changing society: opportunities, needs, and challenges. *Trends in Food Science and Technology,* 20: 54-62.

Trotter, R.T. and M.H. Logan. 1986. Informant consensus: a new approach for identifying potentially effective medicinal plants. In N.L. Etkin, (Ed.). *Plants in Indigenous Medicine and Diet, Behavioural Approaches*. Bedford Hills, New York: Redgrave Publishing Company.

Tshikudu, P.P. 2005. Irrigation and dryland fruit production: opportunities and constraints faced by small-scale farmers in Venda, *MSc Thesis.* University of Pretoria.

Tshisikhawe, M.P. 2002. Trade of indigenous medicinal plants in the Northern Province, Venda region: their ethnobotanical importance and sustainable use. *MSc Thesis.* University of Venda.

Uganda Waragi, 2010. The spirit that binds us. <www.superbrandseastafrica.com/assets/Featured.../154-uganda-waragi.pdf> [Accessed 07/09/2010].

U S National Academy of Science. 2008. Dietary reference intakes (DRIs): recommended intakes for individuals. <www.fnic.nal.usda.gov> [Accessed 27/10/2009].

Van Der Bank, M., B.E. Van Wyk, and H. Van Der Bank. 1995. Biochemical genetic variation in four wild populations of *Aspalathus linearis* (Rooibos Tea). *Biochemical Systematics and Ecology,* 23(3): 257–262.

Van Heerden, F.R., B.E. Van Wyk, A.M. Viljoen, and P.A. Steenkamp. 2003. Phenolic variation in wild populations of *Aspalathus linearis* (rooibos tea). *Biochemical Systematics and Ecology,* 31: 885–895.

Vanisree, M., R.L. Alexandor-Lindo, D.L. De Witt, and M.G. Nair. 2008. Functional food components of *Antigonon leptopus* tea. *Food Chemistry,* 106: 487-492.

Van Wyk, B.E. 2008. A broad review of commercially important southern African medicinal plants. *Journal of Ethnopharmacology,* 119: 342–355.

Van Wyk, B.E. and M. Gericke, M. 2003. *Peoples plants.* Pretoria: Briza Publishers.

Van Wyk, B.E., B. Van Oudtshoorn, and N. Gericke. 1997. *Medicinal plants of South Africa*. Pretoria: Briza Publishers.

Van Wyk, B. and P. Van Wyk. 1997. *Field guide to trees of southern Africa*. Cape Town: Struik Publishers.

Venter, F.J. and J.A. Venter. 1996. *Making the most of indigenous trees*. Pretoria: Briza Publishers.

Venter, F.J., R.J. Sholes, and H. Eckhardt. 2003. The Kruger experience: ecology and management of savanna heterogeneity. <www.books.google.com> [Accesssed 12/02.2010].

Villegas, B., A. Tarrega, I. Carbonell, and E. Costell. 2009. Optimizing acceptability of new prebiotic low-fat milk beverages. *Food Quality and Preference,* 21: 234-242.

Von Gadow, A., E. Joubert, and C.F. Hansmann. 1997. Comparison of the antioxidant activity of *Aspalathus linearis* with green, oolong, and black tea. *Food Chemistry,* 60: 73-77.

Watson, L. 2002. US tastes the “cream of Africa’’.
<www.fin24.com/articles/default/display_article> [Accessed 20/03/2008].

Watson, H.K. and T.B. Dlamini. 2003. An assessment of the sustainability of the utilization of savanna products in Botswana. *South African Geographical Journal,* 85: 3-10.

Wehmeyer, A.S. 1966. The nutrient composition of some edible wild fruits found in the Transvaal. *S.A. Medical Journal* (Supplement to the *South African Journal of Nutrition*), 104: 1102-1104.

Wehmeyer, A.S. 1986. Edible wild plants of southern Africa: data on the nutrient contents of over 300 species. NFRI Report. <www.researchspace/csir.co.za/dspace/handle/10204/2337> [Accessed 02/12/2009].

Wilson, N.L.W. 2005. Cape natural tea products and the U.S. market: rooibos rebels ready to raid. *Review of Agricultural Economics,* 27(1): 139–148.

Wright, R. and M. Stein. 2005. Snowball sampling. *Encyclopedia of Social Measurement,* 3: 495-509.

Wu, C.D. and Wei, G.X. 2002. Tea as a functional food for oral health. *Nutrition,* 18: 443-444.

Wyatt-Minter, S. 2009. Miracle rooibos. <www.al4women/beauty/annique-rooibos-products.html> [Accessed 06/03/2009].

## PERSONAL COMMUNICATIONS AND OBSERVATIONS

De Jager K. and R.J. Du Preez. 2008. *Personal communications*.

Gundula, 2008. *Personal communications*.

Olivier, J. 2010. *Personal communications.*

Parsons, A. 2007. *Personal communications.*

Rampedi, I.T. 2006. *Personal observations*.

Red Cedar. 2007. *Personal communications*.

## SOURCES OF WEB-BASED IMAGES

Marula brewing process. <www.scienceinafrica>

Amarula cream liqueur, "Magnificent Seven Series". <www.giftworld.co.za/IMAGES/Amatin.jpg>

Fruits of (*Englerophytum magalismontanum*) species. <www.metafro.be/prelude/view country=ZA>

Branches of the brown ivory (*Berchemia discolor*). < www.aluka.org>

Ripe fruitsof the red milkwood (*Mimusops zeyheri*). <www.bidorbuy.co.za/item/17905407/*Mimusops zy*>

Kei apple with fruits in different stages of ripening. < www.forums.vietbao.com>

The magic quarry (*Euclea divinorum*) tree. <www.parks-sa.co.za>

*Athrixia phylicoides* species. <www.plantzafrica.com>

## APPENDIX A

## QUESTIONNAIRRE (BEVERAGE-MAKING INDIGENOUS PLANTS)

**Survey: Indigenous Plant-Based Beverages**

**GUN: 201 3321 (National Research Foundation)**

**University of South Africa**

**College of Agriculture and Environmental Sciences**

**Department of Environmental Sciences**

The research project deals with indigenous plant–based beverages in selected rural communities of the Limpopo province. Specific plant species involved are highlighted, collected and identified, with the assistance of the South African Biodiversity Institute (SANBI). Methods of preparing these beverages are documented while samples of specific beverages are collected for laboratory analyses.

We thank you for your participation.

## SECTION A: GENERAL INFORMATION

**Complete this section for each respondent interviewed, then make sure to attach copies of sections for plant records (Section B) for each plant collected, and for use records (Section C: beverage use).**

**1**. Name of Interviewer:

**2.** UNISA Fixed Contract No:

**3.** Geographical location of the survey: GPS Coordinates:

**4.** Name of village/town/settlement where survey is conducted:

**5.** Direction and distance from nearest large town/city (e.g., 12, 5 km NW of Gravelotte).

**6.** Name of Magisterial District where this settlement is located:

**7.** Date of interview (day, month, and year):

**8.** How long have you lived in the area specied above (i.e. point 4.)____________

## Biographical particulars of respondents

**9.** Name (only temporary:

______________________________________________

**10.** Specify ethnic group and language spoken:

| | North Sotho | Vhenda | Tsonga | Sesotho | Zulu | Xhosa | Other |
|---|---|---|---|---|---|---|---|
| Ethnic group | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Speak | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

**11.** Which other ethnic languages do you speak despite options specifed above?

______________________________________________

**12.** Specify gender (mark with an x)

Male [ 1 ] Female [ 2 ]

**13.** Age in years (if known, write age into appropriate block e.g., 29 in block 2; or if uncertain, mark with an x in the block which you think is closest to their age).

| | |
|---|---|
| 20-29 | 1 |
| 30-39 | 2 |
| 40-49 | 3 |
| 50-59 | 4 |
| 60-69 | 5 |
| 70-79 | 6 |
| 0ver 80 | 7 |

**14.** Specify present occupation of respondent (mark with an x; if unsure, describe at "other"

| | |
|---|---|
| Not working (e.g. housewife, unemployed) | 1 |
| Pensioner | 2 |
| Semi-skilled (e.g labourer, cleaner) | 3 |
| Professional (e.g teacher, nurse, lawyer) | 4 |
| Administrative (e.g clerical, manager) | 5 |
| Vendor | 6 |
| Own business (e.g Spaza) | 7 |
| Other (specify) | 8 |

**15.** Wait! Leave this point till after all the sections have been filled in, when the respondent is more relaxed. Do not ask this question directly, as the respondents may feel that they are being judged!

Find out what the highest level of education of the respondent is. (mark with an x, e.g. for Std 4, mark block 3, which is the block for Std 2 - 5)

| Grade | Code |
|---|---|
| No formal education | 1 |
| Grades 1 - 2, Std 1 | 2 |
| Std 2 – 5 | 3 |
| Std 6, 7, or 8 | 4 |
| Std 9 or 10 or equivalent | 5 |
| Std 10 and 1 or 2 years further education | 6 |
| Std 10 and 3 years further education | 7 |

## SECTION B: BOTANICAL DETAILS

Complete this section for **each** plant listed, then make sure to attach to Section A, along with other completed copies of sections B; and C and the plant specimen?

**NB!** Make sure that the correct specimen number (interviewer's name and unique collection no.) is filled in on this form, and that it also appears clearly on the plant specimen paper folder (in the plant press). Also make arrangements with the person interviewed for the collection of the fresh plant material for biological identification at the South African National Biodiversity Institute (SANBI).

**CROSS REFERENCING MATERIAL OR NUMBER**:

Date: (day, month and year):____________________________________________

**1.** Name of Interviewer____________________________________________
(Remember to supply code for cross-referencing)

**2.** Name of Respondent (in pencil) ___________________________________

**3.** Local ethnic name of specific plant used: _____________________________

**4.** COLLECTION NO. of voucher specimen (Unique Specimen No.)

____________________________________________________________

**5.** Specify names, locality and habitat in which the plant occurs_____________

**6.** Indicate locality, such as direction and distance from nearest landmark, or other description that will enable anybody to find the space even 10 years from now (e.g. halfway up the hill behind, 10 meters southeast of the kloof edge): Also complete the table below for habitat.

**7.** Draw a rough map to indicate exact position of specimen plant:

## Description of plant species

**8.** Specify plant type. (Mark appropriate with X).

| | |
|---|---|
| Tree | 1 |
| Shrub | 2 |
| Grass | 3 |
| Climber | 4 |
| Epiphyte or parasite | 5 |
| Succulent | 6 |
| Any, pls specify | 7 |

**9.** Specify flowering season. (Tick more than one box if necessary)

| | |
|---|---|
| Summer | 1 |
| Autumn | 2 |
| Winter | 3 |
| Spring | 4 |
| Any other time | 5 |

**10**. Specify fruiting season – or when can seeds be harvested? (Tick more than one box if necessary)

| | |
|---|---|
| Summer | 1 |
| Autumn | 2 |
| Winter | 3 |
| Spring | 4 |
| Any other time | 5 |

**11.** Specify whether or not the plant lose leaves in the dry season (winter)?__________________________

**12.** Specify any other particular features that distinguish the plant:

## Distribution and ecology

**13.** Specify the type of surrounding vegetation. Mark with an X.

| | |
|---|---|
| Open grassland | 1 |
| Wooded grassland | 2 |
| Bushveld / Savanna | 3 |
| Forest | 4 |
| Any other time | 5 |

**14.** Specify any human disturbance or cultural effects on the vegetation and habitat. Mark with an X.

| | |
|---|---|
| Undisturbed land | 1 |
| Cultivated land | 2 |
| Abandoned land | 3 |
| Planted pasture | 4 |
| Plantation | 5 |
| Garden | 6 |
| Side of road/railway | 7 |
| Heavily grazed | 8 |
| Recently burned | 9 |
| Disturbed in any other way (e.g. weeds, trampled or eroded) – Specify | 10 |

**15.** Indicate abundance at collection site. Mark with an X.

| | |
|---|---|
| Extremely rare | 1 |
| Rare | 2 |
| Very localised | 3 |
| Abundant | 4 |
| Other, specify | 5 |

**16.** Is plant becoming scarcer? Specify by marking with an X

Yes [ 1 ] No [ 2 ].

**17.** Briefly specify how the plant is harvested (harvesting methods)?

______________________________________________

**18.** If the plant is becoming scarcer, what are the causes? Mark with an X.

| | |
|---|---|
| Overgrazing | 1 |
| Deforestation | 2 |
| Over-utilization | 3 |
| Damage due to harvesting | 4 |
| Growth of informal settlements | 5 |
| Climate eg droughts or floods | 6 |
| Other, specify | 7 |

**19.** How is this plant be re-established after harvesting? Explain.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

**20.** How is the plant material collected / harvested? Mark with an X.

| | |
|---|---|
| By digging it out | 1 |
| By peeling off the bark | 2 |
| Cutting of branches | 3 |
| Picking fruit | 4 |
| Picking up fruit from ground | 5 |
| Picking leaves from plant | 6 |
| Any other method | 7 |

**21.** Specify any constraints or challenges associated with the harvesting of this plant species.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

## SECTION C: DETAIL OF USE AS BEVERAGE

**NB: Cross Reference Detail: (must be the same as on Section A, B, C)**

This section seeks information about a specific use (only as beverage) of an edible plant from respondents. Therefore, complete this section for use as beverage only. This use must be listed in Section A of the Questionnaire (in the table under point 5) and a voucher specimen (No) of the plant must be collected. If more than one use is investigated or beverage is made from this plant, more copies of this section can be filled in. Please make sure to attach to Section A, along with all other completed copies of Section B and C. Furthermore, each interviewer must make arrangements with the respondent being interviewed for the collection of a sample of the beverage for laboratory analyses.

**NB!** It is essential that the correct specimen number **(Interviewer's name and unique collection no. as shown on Section B)** is filled in on this form, and that it also appears clearly on the plant specimen paper folder.

**CROSS REFERENCING MATERIAL OR NUMBER**:

Date: (day, month and year):_____________________________________________

**1.** Name of Interviewer_____________________________________________

**2.** Name of Respondent_____________________________________________

**3.** Local name of specific plant used: ___________________________________

**4.** Collection number of Voucher Specimen (Unique Specimen No.)

____________________________________________________________

**5.** Other names which the plant may have.
(Write down all the names of the one edible beverage making-plant which the respondent describes):

## Details as Beverage-making Material (Uses)

**6.** What kind of traditional beverage is prepared from this plant? Please fill in **another one of these forms** if the plant is used for other different types of beverages.

(Tick one line only relevant to the use described in this questionnaire . If your answer is totally different, specify under "other")

| | |
|---|---|
| Traditional tea | 1 |
| Alcoholic beverage (e.g. Beer/wine) | 2 |
| Non- alcoholic juice | 3 |
| Other (specify) | 4 |

**7.** What is the local name of the beverage for which the plant is traditionally used?

**8.** Indicate the parts of the plant harvested that is/are used for the preparation of the particular beverage (tick the appropriate line/lines). If your answer is totally different, specify under "others".

| | |
|---|---|
| Root / Bulb | 1 |
| Stem | 2 |
| Bark | 3 |
| Leaves | 4 |
| Shoot (new growth) | 5 |
| Flowers | 6 |
| Fruit | 7 |
| Seeds | 8 |
| Other (specify, e.g. skin / cover of fruit): | 9 |

**9.** If fruit - is it also eaten fresh/raw. Mark with an X.

Fresh [ 1 ] Raw [ 2 ]

## Consumption aspects of beverage

**10.** When is the beverage usually consumed in the community during any 24 hour period? (Tick the appropriate line / lines. If your answer is totally different, specify under “other”

| | |
|---|---|
| Any time | 1 |
| Breakfast | 2 |
| Midmorning | 3 |
| Lunch | 4 |
| Afternoon | 5 |
| Supper | 6 |
| Before bed | 7 |
| Other (specify): | 8 |

**11.** In what type of community activities is this type of beverage consumed? Please mark with an X, in as many instances as possible.

| | |
|---|---|
| Weddings | 1 |
| Funerals | 2 |
| Rituals | 3 |
| Leisure time | 4 |
| Other, specify | 5 |

**12.** Is this beverage popular amongst those who consume it? Mark with an X.

Yes [ 1 ] No [ 2 ]

## Preparation methods and procedures

**13.** Briefly explain the procedure or process on how is this specific type of beverage made. In your explanation also list the ingredients. Indicate how long it takes for the beverage to be ready for consumption/ how do you know it is ready AND must it be drunk immediately?

**14.** Mention the type of people who usually consumes this indigenous beverage? Mark with an x.

| | |
|---|---|
| Anyone | 1 |
| Adults | 2 |
| Young children | 3 |
| Women only | 4 |
| Men only | 5 |
| Sick people | 6 |
| Old people | 7 |
| Other specify | 8 |

## Harvesting practices associated with specific beverage

**15.** When is the plant material harvested/collected (what season or time of year) for the purpose of making this type of beverage? (Tick the appropriate lines/ lines. If your answer is totally different, specify under "other"

| | |
|---|---|
| Spring | 1 |
| Summer | 2 |
| Autumn | 3 |
| Winter | 4 |
| All year | 5 |
| Other (specify) | 6 |

**16.** Who usually collects / harvests the plant material for making this type of beverage? (Tick the appropriate lines / lines. If your answer is totally different, specify under "other". Mark with an X.

| | |
|---|---|
| Anyone | 1 |
| Adults | 2 |
| Boys | 3 |
| Girls | 4 |
| Women only | 5 |
| Men only | 6 |
| Other (specify) | 7 |

**17.** How are people organized in collecting the plant material for the making of the beverage? Mark with an x. (Tick the appropriate line / lines. If your answer is totally different, specify under "other".

| | |
|---|---|
| One person only | 1 |
| Groups of people | 2 |
| Other (specify) | 3 |

**18.** Is this indigenous plant cultivated? Mark with an X. Yes [ 1 ] No [ 2 ]

**19.** How does one know that the plant is ready to be harvested / collected for making the beverage. Provide a brief description.

**20.** Can the rest of the plant continue to grow after harvesting? Mark with an X.

Yes [ 1 ] No [ 2 ]

**21.** (a) Can the plant be collected beforehand and kept/stored? Mark with an X.

Yes [ 1 ] No [ 2 ]

If yes, please explain how is this performed?.

## ADDITIONAL FIELD NOTES AND OTHER OBSERVATIONS

**APPENDIX B**

## MARKET SURVEY QUESTIONNAIRRE

### ESTIMATION OF MARKET DEVELOPMENT POTENTIAL

Provide name of beverage and also mark with X on relevant space.

| | |
|---|---|
| Fruit juice | 1 |
| Fruit beer | 2 |
| Liqueur | 3 |

## Section 1: General impressions (Appearance)

**1.** Do you like the colour of this beverager? Mark with an X in the space provided.

| | |
|---|---|
| Yes 1 | No 2 |

**2.** If NO, what colour will you prefer? Mark with an X in the space provided.

| | |
|---|---|
| Light yellow | 1 |
| Chocolate brown | 2 |
| Other, specify | 3 |

**3.** Is the degree of cloudiness in this beverage acceptable to you ? Mark with an X.

| | |
|---|---|
| Yes 1 | No 2 |

**4.** If NO, what will you prefer? Mark with an X.

| | |
|---|---|
| Clear / No floaties | 1 |
| Little turbidity | 2 |
| Other, specify | 3 |

## Section 2: Aroma / Smell

**Take your time to detect the smell of beverage. If possible, sniff at least twice.**

**1.** What prominent **smell or odour** will you associate with this beverage. Please mark with an X on descriptive terms.
Suggest relevant odours and you may also use the table below as guideline.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

| Sensory element | Main sensory notes | Shadows |
|---|---|---|
| Odour/ Smell | Alcoholic | Spicy; alcohol-like |
| | Aromatic<br><br>Fruity<br>Floral | Pleasant estery-odour-<br>Woody estery odour<br>Fruity shadow-apple, strawberry<br>Flower-based fragrance |
| | Cereal | Grainy<br>Malty |
| | Resinous<br>Nutty<br>Green<br>Grassy | Woody<br>Nutty<br>Green apples<br>Green grass |
| | Roasted caramel | Caramel, molasses<br>Licorice |
| | Rancid<br>Soapy<br>Fatty | Rancid<br>Oily<br>Butter-like |
| | Sulphury | Yeasty<br>Cooked vegetable<br>Eggs<br>Rubber |

**2.** Is there any other **secondary smell** in the background. Please specify it. ______________________

**3.** Upon tasting this beverage, by allowing the sample to touch all areas of your tongue, what **flavour** comes out? Mark with an X on all appropriate terms or suggest ones you think are relevant.

_____________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________

| Sensory element | Flavour note | Shadows & themes |
|---|---|---|
| Flavour/Mouthfeel | Mouthfeel | Warming sensation of alcohol<br>Astringence-dry rough feeling<br>Creamy<br>Smooth<br>Powdery |
| | Bitterness | Harsh<br>Too dry |
| | Fruity flavour | Watermelon<br>Guava<br>Citrus |
| | Acidic | Sourness<br>Sourmilk<br>Vinegar<br>Acidic |
| | Sweetness | Syrup-like |
| | Oxidised/stale | Papery<br>Leathery<br>Mouldy |

**4**. Kindly evaluate the **finish or after-taste** of this beverage. Mark with an X in appropriate space.

| | |
|---|---|
| Clean and pleasant 1 | Very unpleasant 2 |

## Section 3: Hedonic Scale: Product Acceptability

**1.** In order of increasing degree of likeness and preference please rank this beverage. Mark only once with an X on the appropriate score of the hedonic scale.

| Unit | Definition of acceptability and likeness |
|---|---|
| 9 | Like extremely |
| 8 | Like very much |
| 7 | Like moderately |
| 6 | Like slightly |
| 5 | Neither like nor dislike |
| 4 | Dislike slightly |
| 3 | Dislike moderately |
| 2 | Dislike very much |
| 1 | Dislike extremely |

**2.** Will you recommend this beer to someone you know? Mark with an X.

| | |
|---|---|
| Yes 1 | No 2 |

**3.** Will you buy this beverage if it is available in the supermarkets and bottle stores. Mark with an X.

| | |
|---|---|
| Yes 1 | No 2 |

**4.** What price are you willing to pay for 750ml of this beverage should it be available in the stores?

______________________________________________________________________

**5.** Any suggestions to improve the product make-up of this beverage.

______________________________________________________________________