Development and validation of a cultured meat neophobia scale: Industry implications for South Africa

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ABSTRACT

Interest in evaluating cultured meat neophobia is growing as the development of this product continues to progress. As the available evaluation tools have imprecise wording and fall short of providing critical information, this study endeavoured to develop a neophobia scale that captured product-specific nuances of cultured meat. The developed scale was tested using data collected in South Africa. Factor and correlation analyses were conducted to determine the dominant consumer concerns and the groups in society that would face the greatest psychological hinderances to adopting cultured meat. The study's findings show generally low neophobia in the South African market. Negative sentiment was dominated by meat quality concerns while health, food safety, social and cultural concerns, which normally form stronger objections to food acceptance, were low. The study predicts that market penetration would be hardest among older consumers, due to their relatively higher neophobia. However, if marketing efforts are targeted at addressing consumers' social concerns, marginal increases in acceptance may be experienced among meat-eaters, people reducing their meat consumption, household heads and consumers from high-income provinces. The study concludes that collaboration between the public and private sectors in the provision of legislation guiding food safety and the setting of quality standards will be key to addressing consumer concerns in the evolving protein supply market.

Introduction

There is increasing consumer criticism of animal agriculture, from both the environmental and animal welfare perspectives [36]. Further, high consumption of red meat has been linked to adverse effects on human health, including an increased risk of cancer and cardiovascular diseases [8]. Although some studies, such as Lescinsky et al. [19], have provided evidence suggesting an insufficiency in evidence of significant health-risks associated with meat consumption, a significant number of protein and technology innovations have been introduced to facilitate a reduction in the consumption of conventional

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meat. In tandem with efforts reduce meal sizes (the first driver of consumption's environmental footprint), this is being done with the goal of improving sustainable production and developing meat substitutes. One such item is cultured meat, or meat grown from cell cultures in a laboratory using tissue-engineering techniques [29]. Although there are debates on the actual amount of land-use gains, energy savings and emissions reductions that can result from the wide-spread production of cultured meat, there is broad concessions that it will result in some environmental gains [10]. Currently however, there is limited understanding of consumer willingness-to-accept this technology if it becomes commercially available in low and middle-income countries.

Despite the potential environmental and health benefits of food technologies, public acceptance can be low, and there is a high rate of associated market failure because of public perceptions and concerns of unknown or innovative products [23]. In some cases, this rejection can be caused by a phenomenon that is called, food neophobia, a term describing a range of emotions, opinions and attitudes about different aspects of a food product that a consumer finds concerning, which can lead to aversive behaviour. Hence, a certain level of cognitive dissonance [11] can exist around new food products as; on one hand, these new items have the potential to fill a need that has not been met before, but they also have the potential to cause discomfort or even perceived harm. Schosler et al. [30] and Mäkiniemi and Vainio [21] explain that consumers experience the same underlying psychological tension resulting from conflicting beliefs, values, or attitudes regarding cultured meat. More specifically, consumers are unsure if cultured meat will adequately fulfil the key motives, attributes and beliefs around meat consumption (The 4Ns). That is, people eat meat because it is: *necessary* (it provides rich store of nutrients that required for growth), *nice* (it has a desirable taste, texture and flavour), *natural* (it is authentic, and gives a sense of trust, transparency and control), and *normal* (it is a widely accepted food and is also used to show status in society) [27]. Potential consumers of cultured meat are unsure if their sensory expectations will be met by the quality of the newly introduced product. Secondly, they are not sure if they can trust that the product will not have negative externalities (side effects) that they cannot control. Lastly, the introduction of cultured meat also raises questions on whether they would have conflicts in their social, cultural and economic lives.

Pliner and Hobden [28] developed a food neophobia scale that has been extensively used in the measurement of consumer sentiment towards novel foods. However, this scale has been criticised for being a blunt tool for the measurement of food neophobia [23], providing imprecise questioning [24], providing a weak fit on diverse datasets ([15]; Han et al., 2010), providing inadequate diversity in the type of aspects questioned [24], and providing weak external validity [6,26,38]. Hence, this has necessitated the development of scales that can capture the different nuances presented by products and differences in societies in which they are introduced [26]. For cultured meat specifically, a 19-item evaluation scale was developed by Bryant and Barnett [3]. Similar to the general neophobia scale, its largest weakness is the imprecise nature of its questions. Specifically, item 2 (Cultured meat is likely to look, taste, smell, and feel the same as conventional meat) fails to provide indications on the precise sensory aspect(s) that is/are of greatest concern to consumers, item 7 (Cultured meat is unnatural) and item 10 (The idea of cultured meat is disgusting) fail to unpack the complex terms (i.e., disgust and unnaturalness) while item 16 (Others would disapprove of me eating cultured meat) fails to identify the reference groups in society that may be associated with the greatest neophobia. Hence, while the scale has proven to provide better measurement when compared to the previously used general food neophobia scale (see [14]), it does not provide information that would be useful in identifying the main product attributes that producers should focus on improving or the demographic groups to avoid or target for successful product acceptance. This study aims to develop a cultured meat neophobia scale that captures the succinct issues that influence meat consumption stipulated in the 4Ns that would affect the product's acceptance. The scale is tested on data was collected in South Africa to determine its validity.

Previous studies have found that consumers generally find unease with the unnaturalness of cultured meat [25,31,35,37]. The main issues found in these cultured meat consumer evaluation studies were its possible health-related and social effects [8,9,17,40], quality issues [12,34], ethical issues [18,37], and the potential economic implications [39]. From these previous findings we attempt to incorporate the consumer issues found above in the previous literature into a cultured meat neophobia scale.

South Africa is an ideal medium for validating a cultured meat neophobia scale because of the central role that the livestock industry plays in the economy and the social and cultural lives of its people. Hence, the introduction of cultured meat could be both welfare enhancing (given the large meat consumption in the country) and problematic due to the potential disruption to key areas in the economy. In monetary terms, the livestock industry contributed 48% to the gross value of the agriculture sector and was equivalent to R317 billion in 2021 [7]. Livestock constitutes the primary form and store of wealth for the rural poor and meat holds strong symbolism in the African tradition and culture. As the South African people tend to hold onto traditions, the possible cross-sectorial disruption associated with the introduction of cultured meat could result in low adoption rates. Currently, heated debates on how best to preserve consumers' interests in the face of a rise in market interest in meat alternatives are underway in South Africa. Opposing views of the best way to preserve the consumers' welfare have resulted in the Johannesburg High Court interdicting the Department of Agriculture Land Reform and Rural Development's instruction to seize all faux meat from South Africa's retail and restaurants (Daniel, 2022). To avoid similar indecision on how to handle cultured meat when it arrives on South Africa's market shelves, studies such as this must provide a better understanding consumer sentiment towards cultured meat.

This study is both timely and relevant in South Africa as cultured meat's non-commercial production has already begun domestically. Bloomberg [2] reported that a South African company, Mogale Meat Co, reported success of producing Africa's first cell-based chicken and is now developing a range of game meats (springbok, wildebeest and impala). Some local ven-

dors have already indicated a keenness to introduce the product to their menus [32]. Hence, this study seeks to capture the thoughts of South African consumers and determine what are, if any, the concerns they may have around cultured meat.

Methodology

The data for this study were collected using an online survey in May 2022. The data were collected by a third-party data collecting company Dynata, which recruited a pool of respondents for the study. After dropping incomplete survey responses and those responses that did not meet the quality check criteria adopted in the study, a sample of 658 respondents was acquired for data analysis. This sample size was adequately large as it yields an acceptable marginal error of +/- 3.9% when calculated in Eq. (1) below.

$$\text{Margin of Error} = Z * \sqrt{((p * (1-p))/n)} \tag{1}$$

where Z^* is the Z^*-value at a confidence level of 95%, p is the sample proportion and n is the sample size.

Strict ethical standards were observed as the survey participants' responses were kept private and untraceable to their individual identities. Respondents' identity was protected. Ethical clearance was granted by the University of Arkansas. The survey was administered through and managed via Qualtrics.

The survey questionnaire had three sections. The first section inquired about the respondents' socioeconomic attributes, the second asked about various meat consumption preferences and decision-making, and the last enquired about their opinions on cultured meat. Section 3 provided each respondent with 20 opinion statements (scale items) that indicated various concerns or elements of neophobia that consumers could have about the introduction of cultured meat in the market. The scale items were organised into five categories that grouped (1) social and cultural, (2) economic, (3) quality, (4) health and safety, and (5) ethical concerns. These areas of concerns have been investigated individually or in-part in past studies [4,8,17,39], however, the classification into a complete set of five specific areas of concerns is done for the first time in this study and forms the current study's contribution to literature. Survey respondents were requested to determine whether they strongly agreed/disagreed, agreed/disagreed or were impartial to each concern that was indicated in each statement. Each response was measured using a Likert scale where strongly disagree = 1, disagree = 2, neither agree nor disagree = 3, somewhat agree = 4 and strongly agree = 5.

The cultured meat neophobia scale was developed using a three-step approach adopted from Cox and Evans [6]. It included the assessment of the face or content validity, convergent validity and predictive validity of the scale. The face validity involved an evaluation of the content of the perception statements (items) making up the scale. The analyses in this stage included a calculation of the average score on each scale item and the average score of each concern category (average consumers' sentiment). The former indicated how strongly the consumers felt about each item, while the latter provided information on which elements of neophobia dominated the negative consumer sentiment. The congruency in the perception measured in each concern category was also measured. Factor analysis was carried out in this stage to determine the market sentiment and to particularly identify dominating concern factors in cultured meat neophobia.

The fundamental idea of factor analysis is to lessen the width of a set of data that comprises of a large number of variables that are interrelated, while retaining the distinction existing in the data [20]. This was done by transforming the original data into a set of new variables that are uncorrelated but summarise the variation in the data into fewer variables that are called factors, composite components or indices. The transformation is expressed as:

$$\text{Factor}_i = a_{i1}X_1 + a_{i2}X_2 + \ldots + a_{in}X_n \tag{2}$$

where i is the number of principal components ranging from $1\ldots n$; $a_{i1} \ldots a_{in}$ = the component loadings; and X_1 to X_n are items in neophobia scale.

The maximum likelihood method in confirmatory factor analytic techniques with varimax rotation was used. The two techniques were selected as they ensure that the extracted factors or components are uncorrelated. The Kaiser criterion [16] of retaining a factor with an eigenvalue of above 1 was utilised. Factor loadings above 0.5 were accepted.

Convergent and discriminant validity were assessed by computing the average variance extracted (AVE) and this was calculated by summing up all squared standardised factor loadings and dividing by the number of items in a factor. According to Hair et al. [13], an AVE of higher than 0.5 is indicative of acceptable convergent validity and implies that items that are indicators of a specific construct share sufficient variance. Four more tests were conducted to ensure analytical robustness. First, the Cronbach's alpha internal consistency test, was used to determine whether there was a statistically significant amount of correlation in the items (opinion statements) to justify the development of a composite variable. A further two tests, the Kaiser-Meyer-Olkin (KMO) value and the Bartlett's test of sphericity, were performed to test the internal validity of the scale. For the Barlett's test, a p-value lower than 0.5 is considered acceptable, while a value over 0.5 is considered as being robust for the KMO. Lastly, the average measures intra-class correlations for single measures and the 20 items were calculated. This was done to measure the reliability of the scale. The predictive ability of the scale was assessed using the level of correlation between the survey respondents' willingness to try cultured meat and the different derived neophobia factors. Pearson analytical estimation was utilised to predict the market segments or groups in society that would hold significantly higher/lower levels of concerns in the different categories. Similar to Verneau et al. [38], a p-value was used to indicate the significance of the correlation analyses results. These results were interpreted at levels 1% (p-value<0.01), 5% (p-value<0.05) and 10% (p-value<0.10) levels of confidence.

Table 1
Results of the content validity assessment of the cultured meat neophobia scale.

Items	Item score	Standard deviation	Category mean score	Cronbach's Alpha
Meat quality concerns				
I am concerned that cultured meat will not taste as good as conventional meat	3.40	1.241	3.47	0.805
I am concerned that cultured meat will not have the same texture as conventional meat	3.50	1.124		
I am concerned that cultured meat will not be as juicy as conventional meat	3.52	1.213		
I am concerned about the storage requirements for cultured meat	3.42	1.246		
Health and safety concerns				
I am not confident that cultured meat will be antibiotic free	3.32	1.184	3.15	0.789
Consuming cultured meat may result in long-term negative effects on one's health	3.35	1.198		
There could be long-term side-effects associated with the consumption of cultured meat	3.45	1.171		
I am sceptical of the health claims made about cultured meat	3.47	1.141		
I worry about the government's ability to protect consumers' rights when cultured meat is available on the market	2.17	0.977		
Ethical concerns				
Switching to eating cultured meat will not contribute much to the fate of the environment	3.05	1.192	3.30	-0.376
*Eating cultured meat will have a positive impact on animal welfare	1.45	1.046		
Social and cultural concerns				
I am worried that my family will not accept cultured meat	3.24	1.371	2.99	0.738
My friends will judge me for eating cultured meat	2.60	1.320		
I will probably be the only one amongst my colleagues that eats cultured meat	3.03	1.313		
I feel that I identify more with conventional meat than cultured meat	3.66	1.171		
My religion discourages me from eating cultured meat	2.44	1.367		
Economic concerns				
The introduction of cultured meat will not help avoid food shortage problems	3.25	1.235	3.23	0.733
A switch to eating cultured meat will cause increased unemployment	3.05	1.196		
The introduction of cultured meat will have a negative impact on conventional meat producers	3.45	1.170		
The introduction of cultured meat will cause unforeseen negative effects on the economy	3.17	1.093		

Note: The asterisk (*) indicates scores for statements that did not indicate a negative perception (concern) for the introduction of cultured meat that were switched around to ensure consistency in the calculation of respondents' perceptions.

Results and discussion

Descriptive statistics

The average survey respondent was a 37-year-old, middle income-earner (R151 000 – R630 000), who had a household of 4, had never been involved in agriculture, was not a vegetarian/vegan and had a university degree or diploma. Most respondents (83.9%) were breadwinners (bought all or most of the groceries in their households). Women made up 56% of the sample and 44% were men. Most of the respondents (44.3%) were from Gauteng Province while 13.5% and 11,1% were from Western Cape and KwaZulu Natal provinces, respectively. Respondents from the Limpopo and Eastern Cape provinces made up 9% and 8% of the sample, respectively. The remaining four provinces (Northern Cape, Mpumalanga, North West, Free State) made up the remaining tenth of the survey sample. The distribution of the sample roughly matched the distribution of economic activity across the country and hence provided approximate representation of the expected level of demand for cultured meat across South Africa. With regards to the racial distribution, the survey sample was dominated by people of African descent (classified as Black) who made up almost two-thirds of the sample (63.4%). Almost a fifth (19.3%) of the sample was made up of people classified as White while the coloured community (classified as mixed race) represented 12% of the sample. The race and gender distribution was in line with national population distribution, however, there was an overrepresentation of the educated population relative to the South African population [33]. When asked about their familiarity with cultured meat, the majority of the study participants (42.6%) indicated that they had heard about cultured meat and knew what the term meant, 35.9% reported that they had heard about cultured meat but did not know what the term meant and just over a fifth of the respondents (21.5%) had never heard about cultured meat before being provided information about it in this study.

Empirical results

Content validity

Table 1 shows the items that made up the cultured meat neophobia scale. It also shows the five categories in which the concern statements were grouped. As shown by the different item scores, respondents held different levels of concern for the different aspects raised in the statements. These scores ranged from 1.45 to 3.66. The average scores for the concern categories indicate that the respondents were most concerned about meat quality (mean = 3.47) and were least concerned about social and cultural aspects (mean = 2.99). Economic concerns were second highest category for the individuals, with a category mean score of 3.23 while ethical concerns (mean = 3.30) and health and safety concerns (mean = 3.15) were

Table 2
Factor analysis results.

Factor	Description	Item	Factor loadings
1	Meat Quality Concerns	I am concerned that cultured meat will not be as juicy as conventional meat	0.808
		I am concerned that cultured meat will not have the same texture as conventional meat	0.791
		I am concerned that cultured meat will not taste as good as conventional meat	0.785
		I am concerned about the storage requirements for cultured meat	0.573
		There could be long-term side-effects associated with the consumption of cultured meat	0.511
2	Economic Concerns	The introduction of cultured meat will cause unforeseen negative effects on the economy	0.774
		The introduction of cultured meat will have a negative impact on conventional meat producers	0.742
		A switch to eating cultured meat will cause increased unemployment	0.730
3	Ethical, Health and Safety Concerns	Switching to eating cultured meat will not contribute much to the fate of the environment	0.668
		Consuming cultured meat may result in long-term negative effects on one's health	0.586
		I am sceptical of the health claims made about cultured meat	0.528
		There could be long-term side-effects associated with the consumption of cultured meat	0.516
4	Social and Cultural Concerns	My friends will judge me for eating cultured meat	0.804
		I will probably be the only one amongst my colleagues that eats cultured meat	0.696
		I am worried that my family will not accept cultured meat	0.577
		My religion discourages me from eating cultured meat	0.559

ranked third and fourth, respectively. There was a high level of correlation among the items in most of the concern categories, as shown by the majority of Cronbach's alpha values that were above 0.7. As shown by these values, there was more agreement in respondents' sentiments on meat quality (alpha = 0.805) and health and safety (alpha = 0.789) aspects than on social and cultural (alpha = 0.738) and economic (alpha = 0.733) aspects. These results show high correlation between the scale items in these four categories. On the other hand, the Cronbach's alpha value for the ethical concerns' category (-0.376) was low indicating the difference in opinion on the levels of concern that should be attributed to the aspects questioned. As shown by the markedly different item scores, respondents were concerned about the possible negative effect that cultured meat may have on the environment (item score = 3.05) and thought there were minimal risks to animal welfare (item score = 1.45).

Factor analysis results

According to the Kaiser criterion, a 4-factor solution was appropriate, with one predominant factor (with an eigenvalue of 6.501) and three less dominant factors (with eigenvalues of 1.785, 1.223 and 1.104, respectively). Factor 1 accounted for the majority of the variation in the data (32.50%) and centred on the sample's meat quality concerns. Concerns about cultured meat's juiciness, texture and taste had the highest factor loadings. These were 0.808, 0.791 and 0.785, respectively. These results concur with those acquired by Szejda et al. [34], which indicated that meat quality was the most important product attribute for consumer acceptance of cultured meat in South Africa. The result also reinforces those reported by Verbeke et al. [37], Mancini and Antonioli [22], Gómez-Luciano et al. [12] and Bryant and Barnett [3] which were carried out in other countries. Albeit, these studies placed meat quality in the top three of the most important factors and not as the most important attribute.

The sensory orientation of the respondents was further emphasised by the association between the concern for meat quality with weaker health and safety objections (concern for any unpleasant eating experience or negative side effects resulting from consumption of cultured meat). In past studies that are conducted elsewhere in the world [3,14], stronger objections to cultured meat acceptance, such as risk of harm or danger to the body and environment, are often dominate market sentiment. As shown in Table 2, these are captured in Factor 3. This finding indicates that cultured meat may face lower rejection in South Africa than in previously sampled countries.

The second factor represented society's economic concerns and accounted for 8.927% of the variation in the data. This factor showed that the respondents were concerned about possible negative effects on the economy (factor loading = 0.774), farmers livelihoods (factor loading = 0.742) and employment (factor loading = 0.730). This was an expected result because it reflected the key role that livestock industry plays in the agricultural economy across South Africa. This result is also in agreement with previous research as the results presented by Gómez-Luciano et al. [12] show that the perceived economic concern or importance is generally higher in developing countries (Brazil and the Dominican Republic) than the developing countries (the United Kingdom and Spain). This is in line with expectations, as developed countries have a large economic contribution from agriculture and would be concerned about the possible negative effects if the industry is disrupted.

Factor 4 indicated society's social and cultural concerns. This result is in agreement with most studies [5,8,17,37,40] which predict that social and cultural concerns are likely to arise with the introduction of cultured meat to the market. However, the level of concern indicated in this study contradicts the findings reported by Bekker et al. [1] had showed that consumers in African countries were more likely to experience high social and cultural concerns about cultured meat. Interestingly, respondents in the current study's concerns were driven by uncertainty about the acceptance by their peers and reference groups (weaker reasons or food rejection) and not religion and culture which can be considered strong indicators

Table 3

Correlation with the willingness to try cultured meat and derived neophobia factors.

Derived neophobia factors	Correlation
Meat quality concerns	-0.202***
	(0.000)
Economic concerns	-0.103**
	(0.008)
Ethical, Health and Safety concerns	-0.107**
	(0.006)
Social and cultural concerns	-0.071*
	(0.067)

Note: P-values are in parentheses.

*,** and *** indicate correlation coefficients that is significant at the 10%, 5%, and 1% levels, respectively

Table 4

Demographic groups with relatively higher cultured meat neophobia.

	Age	Low Familiarity	African Descent	Education	Income	Number of Children
Meat quality concerns	0.079**	0.210***	-0.011	0.033	0.035	-0.028
	(0.043)	(0.000)	(0.769)	(0.399)	(0.374)	(0.470)
Economic concerns	0.034	-0.029	0.039	0.081**	0.025	-0.037
	(0.388)	(0.449)	(0.317)	(0.037)	(0.528)	(0.348)
Ethical, Health and Safety concerns	0.010	-0.058	0.080**	0.073*	-0.032	0.026
	(0.806)	(0.136)	(0.040)	(0.061)	(0.419)	(0.506)
Social and cultural concerns	-0.029	-0.085**	0.024	0.158***	0.092**	0.109**
	(0.451	(0.029)	(0.536)	(0.000)	(0.018)	(0.005)

Note: p-value in parenthesis.

*, ** and *** indicate correlations that is significant at 10%, 5% and 1% levels, respectively

of non-adoption also ranked lowest in Factor 4. This shows a relatively low level of rejection that cultured meat is likely to face in this society.

Internal validity and convergent validity

The average variance extracted (AVE) from Factor 1 (Meat quality concerns) was 3.609 while that of the factor measuring economic concerns (Factor 2) was 2.880. The AVE for the factor (Factor 3) measuring ethical, health and safety concerns was 3.791 and that of the Factor 4 (which measured social and cultural concerns) was 2.737. As these AVE figures were higher than the 0.5 threshold, this implies that items in the factors shared sufficient variance in common and were suitable indicators of each specific construct. This indicates a high level of convergence. A Cronbach's alpha of 0.871 was acquired when the correlation in all the scale items was analysed. This result indicated significant levels of internal consistency and that all the indicators reliably measured the same latent perception variable. The KMO analysis yielded a p-value of 0.904, while the Bartlett's test of sphericity produced a p-value of 0.000. These results indicated that there was a sufficient measure of sampling adequacy and correlation in the matrix of consumers' concern indicators to justify the use of a data reduction procedure. Hence, it showed that the items included in the cultured meat neophobia scale were of an adequate number to provide robust results. The average measures intra-class correlations for the single measure (0.243) and the average measures (0.871) of the 20-item scale showed that all correlations were significantly greater than zero and were significant at 1% level ($p < 0.001$). These results further confirm the reliability of the scale.

Predictive validity

The results shown in Table 3, confirmed the predictive ability of the cultured meat neophobia scale. This is indicated by the highly statistically significant correlation between the derived factors and consumers' willingness to try cultured meat. As shown, the correlation between meat quality concerns had the greatest negative correlation with the willingness to try the product, while the concerns about social and cultural concerns had the lowest correlation with the willingness to try cultured meat. These results imply that the neophobia around cultured meat is more associated with worries about possible meat quality compromises than any other risk factor. Although the study found the correlations statistically significant, the actual measures of correlation were small and this induces a limitation on the predictive ability of the developed scale. While this indicates a relatively weak practical relationship between the derived indices and willingness to try cultured meat, these are comparable to those reported in Bryant and Barnett [3] (Corr = 0.305) and Hamlin et al. [14] (Corr = 0.302) that investigated cultured meat neophobia. Similar to food neophobia scales that have been developed in the past, these coefficients and their statistical significance should be interpreted with caution in practice.

Table 4 highlights the statistically significant positive correlations between the four different cultured meat neophobia factors and various socioeconomic characteristics in the sample. These results indicate the market segments that would be relatively difficult to penetrate and gives the reasons for possible failure cultured meat acceptance. Positive correlations were

Table 5
Demographic groups with relatively lower cultured meat neophobia.

	No Agricultural background	Residing in Developed Province	People reducing meat consumption	Meat eaters (Non-vegan & non-vegetarians)	Breadwinners (Household members responsible for purchase of food)
Quality concerns	-0.058	-0.011	-0.007	0.038	-0.073
	(0.137)	(0.787)	(.864)	(0.332)	(0.061)
Economic concerns	-0.047	-0.133***	-0.082**	-0.024	-0.056
	(0.225)	(0.000)	(0.036)	(0.539)	(0.153)
Ethical, Health and Safety concerns	-0.098**	-0.075*	-0.083**	-0.100**	-0.054
	(0.012)	(0.053)	(0.034)	(0.011)	(0.164)
Social and cultural concerns	-0.069	-0.031	-0.124**	-0.125**	-0.116**
	(0.077)	(0.450)	(0.001)	(0.001)	(0.003)

Note: p-value in parentheses.
*,** and *** indicates correlation that is significant at 10%, 5% and 1% levels, respectively

found between meat quality concerns and age and low product familiarity. This means that the elderly and people who do not know much about the product are likely to find it difficult to accept cultured meat due to meat quality concerns. These results indicate the unsuitability of elderly members of society as target market for cultured meat. It also indicates the need for consumer education for successful acceptance. However, as indicated by the negative correlation between social and cultural concerns (Factor 4) and product familiarity, an increase in knowledge of cultured meat is also likely to result in an increase in social and cultural concerns. This result warns of the need to continue with marketing campaigns the promote the social acceptance of cultured meat after consumer education is completed.

The results show that economic concerns were significantly correlated with higher achievement in education. This means that the more educated an individual was, the more sceptical they were to the potential economic disruption that could result from the cultured meat production. People of African descent as well as highly educated people were more likely to cite ethical, health and safety concerns as reasons to reject cultured meat than people from other races and less educated people. The factor measuring social and cultural concerns was correlated with higher levels of education, higher income levels and larger number of children in households. This means that individuals who were highly educated, earned relatively high incomes and those that had a large number of children were more likely to struggle to accept the product because of social and cultural reasons. The results emphasise the need for collaboration between product developers and food safety management policy, as these will be critical in addressing the health and safety concerns that significant affect the two important demographic groups in the country (Africans and educated individuals). They also indicate that the marketing campaigns that indicate job creation may be used to encourage acceptance among the educated people in society. In general, the results indicate a key role that advertising cultured meat as a family product can play in overcoming neophobia as most of the demographic groups indicate social concerns as significant reservations to cultured meat acceptance. However, the lower correlation value may indicate that one should expect a limited response of any marketing efforts to change consumer actions.

As shown in Table 5, people living in the high-income provinces (Gauteng, Western Cape and KwaZulu Natal) as well as individuals who stated they were reducing their meat consumption had relatively lower economic concerns about cultured meat. This was an expected result because these groups of people are relatively less reliant on the livestock industry for employment and hence would not face significantly high direct economic risk with the introduction of cultured meat to the market. The results show that ethical, health and safety concerns were significantly lower among respondents that ate meat, had never been involved in farming, resided in developed provinces and those that were reducing their meat consumption. As shown by meat-eaters, those reducing meat consumption and breadwinners had low social and cultural concerns. These results indicate the early adopters of cultured meat. Notably, none of the possible early adopters' market segments had relatively lower concerns with the main factor of neophobia (meat quality). Taking this into account, as well as the low coefficients of the correlations, it implies that these results point to areas that can make minor changes to cultured meats' acceptance. They emphasise the need for a product that will satisfy consumer sensory expectation as the demographic groups seem not be compromised in this regard.

Conclusion

In this study, we demonstrated that an in-depth investigation into the concept of cultured meat neophobia is possible and necessary for better understanding of the acceptance of cultured meat and possible hinderances to its success. Study's results indicate that the scale developed for this purpose is valid and is useful for overcoming the shortcomings of the available tools. This conclusion is draw beacuse shown by the findings are important in identifying the product attributes that should take priority in product development, identifying the possible early adopters and non-adopters and identifying possible elements to include in market penetration campaigns. The results also caution against the possible hurdles in growing the initial market as the returns to advertising are likely to be moderate.

We also conclude by weighing-in on the current debates on how to preserve the welfare of consumers in South Africa amidst the changes occurring in the protein supply market. As shown by the results, South African consumers are not apprehensive of the introduction of cultured meat but have moderate concerns. Hence, there is need for the development of legislation, quality guidance and health and safety protocols that would ensure a reduction in the technical hinderances towards the entrance of meat alternatives. It would advisable that such institutional structures be developed for the cultured meat market ahead of time. The results do not support a complete removal of faux meat in the market, which was attempted in 2022. We recommend the collaboration between the private and public sectors to shaping the evolving industry, as this will also be critical for success in delivering consumer value.

We acknowledge some limitations in the study and suggest areas of further investigation. Firstly, there is need for external validation of the developed scale through test-retest analyses using data collected from other regions of the world. This is necessary as it will confirm the applicability of the scale and the stability of the developed categories in different contexts. Secondly, predictive testing could also be improved in future studies by determining the correlation between the derived indices and consumers' willingness to purchase or consume on a regular basis instead of the willingness to try (taste) cultured meat as was done in this study. Thirdly, there is a need to test the scale against actual behaviour i.e. consumption of cultured meat. This is important because perceptions are context specific and they are most likely to change when the product is consumed. Lastly, this study did not compare the performance of the developed scale with past scales. This should be probed in future studies as it will contribute to the academic fields that analyse neophobia. Other investigations in this field could also include adaptation of the scale to the measurement of other novel products.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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