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The coexistence of psychological drivers and deterrents of consumers' willingness to try cultured meat hamburger patties: evidence from South Africa

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Abstract

The widespread consumption of alternative meat products, such as plant-based alternatives in the hamburger patty market, has provided insights into the potential of commercially produced cultured meat. Evidence from previous alternative meat studies shows mixed results on whether experience with commercially available alternative protein will help to overcome or compound consumers' concerns about cultured meat. This study investigates the effect that South African consumers' implicit perceptions developed by experience with and from attitudes about novel products and perceptions about the product could influence their acceptance of cultured meat. South African consumers' perceptions were estimated using opinion statements, and the level of agreement was ranked on a Likert scale. Composite indices were extracted from these data, which were regressed against consumers' willingness to try cultured meat burger patties. Results suggest that the implicit perceptions (worldviews) promoted both neophobic and neophilic attitudes, while explicit (product-specific) perceptions indicated that concerns of anticipated social, cultural and economic disruptions may drive non-adoption. The study's results suggest targeted marketing approaches that can utilise implicit perceptions to promote consumer adoption. Other results indicated the areas of concern that should be addressed to facilitate acceptance and the population groups that could be targeted as early adopters. These results contribute to a better understanding of the potential market for cultured meat in the world's eighth-largest per capita beef consumer and provide insights into drivers and deterrents of cultured meat in an environment that struggles with food security.

Keywords: Neophobia, Meat consumption, Disgust, Lab-grown meat, Alternative protein sources, Consumer food behaviour, Attitudes/beliefs

Introduction

Globally, consumer acceptance of alternative protein in the burger patty market has increased rapidly in the past decade (Asioli et al. 2022). This trend has been partially driven by consumers' increasing desire to create a more sustainable food production system, which can contribute to a lower environmental footprint (Quevedo-Silva and

Pereira 2022). As conventionally produced burger patties continue to cede market share to plant-based protein alternatives (Ang et al. 2023), questions are beginning to arise on the effect that introducing cultured meat[1] could have on the livestock industry and its supporting stakeholders. The Italian government has acted on these concerns by developing legislation that would prevent the production of cultured meat production, as it is perceived as a product that threatens the country's food heritage and agricultural industries (Holland 2023). Conversely, the United States of America's Food and Drug Administration has approved the commercial production of cultured meat, and efforts to allow commercial production are being pursued (Chasani 2023). Currently, only Singapore and Israel produce cultured meat commercially (Future Meat 2021; The Guardian 2020). The possibility of producing cultured meat patties that are affordable is increasing as food scientists have managed to decrease the cost of production from $325,000 USD (Fountain 2013) to $11.36 USD for a 100 g of in vitro beef (Flaws 2019) and $4.00 USD for a 100 g of in vitro chicken breasts (Terazono 2021). However, market penetration in South Africa is unknown as forecasts on the antecedents for consumer acceptance of cultured meat remain limited.

Competing theories have been adopted as credible guides for forecasting consumers' future responses to introducing cultured meat to the commercial food sector. Neo-classical economics predicts that food preferences will be driven by rational behaviour that results from a cognitive process guided by utility maximisation (Cembalo et al. 2012). However, given the incomplete information (due to lack of commercial availability) regarding cultured meat's pricing, taste and potential health risks, this theory's predictions could be sub-optimal as the rationality of consumers will be limited. Other theories, such as the theory of planned behaviour (Ajzen 1991), which predicts consumers' attitudes, beliefs and emotions as direct and indirect antecedents of both intention and behaviour, have been used. As attitudes are often unstable because an individual can hold both positive and negative attitudes about different aspects of cultured meat (Wilks et al. 2019), the omnivore's paradox (Fischler 1988) has been applied. This philosophy describes people's simultaneous aversion and attraction to new food products. It represents the coexisting presence of demand driven by the curiosity for novelty (neophilia) and by caution, at times aversion, concerning the new or the unknown (neophobia) with regard to food (Verneau et al. 2014; Starowich 2020). This study aims to adopt this theory and apply it in predicting the factors that could affect South African consumers' acceptance of cultured meat burger patties. The study aims to determine the drivers and deterrents of cultured meat burger patty acceptance in South Africa. This is done as consumers tend to hold ambivalent attitudes towards novel food products as expressed in a concurrent desire to adopt novel foods with a higher ethical value, accompanied by a desire to face low or no health, economic, social and quality risks and compromises. It is envisaged that this information will assist cultured meat companies looking to expand market penetration and, ultimately, market share and inform policymakers, the livestock industry and its supporting stakeholders about the potential disruption in the conventional protein market.

[1] Cultured meat is a newly developed food product consisting of muscle tissue grown from an animal's stem cells within a laboratory environment. It is produced using animal stem cells using reverse engineering techniques (Post 2014).

A limited but fast-growing number of studies have investigated the effect of the cognitive process on consumers' willingness to try, consume or purchase cultured meat if made commercially available. The majority of previous studies estimate the effect of consumer psychology using consumers' higher-order values pertaining to life, such as worldviews or cultures (Lewisch and Riefler 2022; Wilks et al. 2019), personality traits (Piochi et al. 2022; Rombach et al. 2022; Hwang et al. 2020) and perceptions of novel products (Lin-Hi et al. 2022; Quevedo-Silva and Pereira 2022). Other studies (Hamlin et al. 2022; Bryant and Barnett 2020) have focused less on using implicit perceptions by using product-specific (explicit) perceptions calculated using cultured meat neophobia scales. Some studies (Li et al. 2023; Hamlin et al. 2022; Bekker et al. 2021; Gomez Luciano et al. 2019) have investigated the concurrent effect of consumer implicit and explicit perceptions of cultured meat on intended behaviour. Such analytical approaches are valuable because they are more comprehensive as they capture the influence of both aspects (implicit and explicit perceptions) on consumers' intended behaviour. This is important because the variables measuring consumers' implicit attitudes capture the heuristics that can guide initial judgement when information is scarce, while the explicit variables take into account the detailed information and are considered to result in contextualised and somewhat rational behavioural responses (De Koning et al. 2020; Gawronski and Bodenhausen 2006). Hence, the current study's analysis provides information on the possible marketing effort that could prime consumers and the continual marketing effort that should be undertaken to encourage long-term consumers of cultured meat. Examples of studies that have investigated the concurrent effect of implicit and explicit perceptions are Bekker et al. (2017) and Lewisch and Riefler (2022), who confirmed that both implicit and explicit variables have a part to play in influencing intended behaviour with regard to cultured meat; with the former assisting in formulating the latter. As cultured meat enters the commercial food market and credence information becomes available on cultured meat, consumers can make product-specific perceptions that interact with higher-order values in influencing intended behaviour. Li et al. (2023), Hamlin et al. (2022), Bekker et al. (2021) and Gomez Luciano et al. (2019) investigated the concurrent effect of implicit and explicit consumer perceptions of cultured beef. However, these studies have yielded mixed results, which are contrary to theory, as the implicit perceptions were found to have an insignificant effect on planned behaviour. Consequently, this warrants further research on the antecedents of consumer acceptance of cultured meat's acceptance.

This study uses data collected from South Africa in its analysis. South Africa presents a unique context for consumer research because of the high acceptance of meat analogues in its burger patty market. First, South Africa is the first African country to host two of the world's largest alternative meat companies (Impossible Foods and Beyond Meat) that dominate the plant-based burger patty landscape (Szejda et al. 2021). Burger patties from these two franchises have found a place in numerous South African fast-food restaurant chains, supermarkets, and other food entities. Second, hamburgers make a good medium of study in South Africa because they are one of the most popular food-away-from-home meals across the country (Stowe et al. 2020). Third, similar to other developing countries, South Africa is likely to continue experiencing consumption and demographic trends (e.g. high urbanisation rates, growth in the demand for meat and a

rise in demand for convenience foods) that could promote cultured meat acceptance and ultimate adoption. Lastly, success in the non-commercial production of cultured meat has been reported in South Africa (Stark 2022). Therefore, the information provided in this study may assist industry stakeholders and policy-makers in preparing for a future that may not be too distant (Szejda et al. 2021; Siegrist and Hartmann 2020). Given the market potential, high beef consumption per capita and persistent food insecurity issues driven by climate change, a better understanding of drivers and deterrents of cultured meat is warranted in South Africa.

The rest of the manuscript is organised as follows: Section "Methodology" describes the research methodology, section "Results and discussion" reports and discusses the results, and section "Conclusion" concludes the paper.

Methodology

Data for this study were collected in May 2022. Dynata, a private company maintaining a nationally representative sample of South African residents, recruited the respondents. Participation was anonymous and voluntary, and participants could withdraw without prejudice. University of Arkansas IRB approval (protocol #2202386371) was granted for ethical clearance on March 28, 2022. Each respondent was 18 or older, and consent was acquired before the survey commenced. A total of 956 individuals attempted the survey. The sample was reduced to 658 after responses that did not meet the quality criteria (passing an attention check question and answering all the opinion questions) were removed. This was found to provide adequate representation, given South Africa's population of 59.39 million people; this sample size is consistent with a marginal error of $\pm 3.2\%$.[2]

The survey was administered through and managed via Qualtrics and consisted of three sections. Section one solicited information on the respondents' socio-economic attributes. This included their race, education, gender, income, residential location, age, marital status, and household size. Section two inquired about various meat consumption preferences and decision-making about household shopping, while the last enquired about their opinions on consumers' perceptions of cultured meat. The perceptions were divided into implicit perception (consumers' higher-order values pertaining to life, such as worldviews or cultures, personality traits and perceptions of novel products) (Wilks et al. 2019) and explicit perception (product-specific beliefs, views and thoughts) (Bryant and Barret 2020). The study investigated three worldviews. These described their view of (1) Science's role in the food industry, (2) their level of responsibility in promoting responsible consumption, and (3) their tolerance for change or unfamiliar things. These worldviews were adopted from Wilks et al. (2019) and categorized as: (1) Attitude towards food Science and Technology (Trust vs. Distrust) (2) Level of communitarianism (Altruism vs egoism) (3) Tolerance (liberalism vs. illiberalism). According to Vidigal et al. (2015), worldviews facilitate the development of neophobic or neophilic personalities that enable the acceptance/rejection of new food products such as cultured meat.

[2]

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

where Z' is the Z^*-value at a confidence level of 95%, p is the sample proportion, and $\boldsymbol{n}$ is the sample size.

Table 1 Opinion statements indicating explicit and implicit perceptions of cultured meat

Indicators of the explicit perceptions of cultured meat	Indicators of the implicit perceptions of cultured meat
Meat quality concerns	*Conspiratorial ideation (Trust vs. Distrust in food Science and technology)*
I am concerned that cultured meat will not taste as good as conventional meat	The benefits of new food technologies are often grossly overstated
I am concerned that cultured meat will not have the same texture as conventional meat	Society should not depend heavily on new food technologies to solve its food problem
I am concerned that cultured meat will not be as juicy as conventional meat	New food technologies may have long-term negative effects on the environment
I am concerned about the storage requirements for cultured meat	
Health and safety concerns	*Communitarianism (Altruism vs egoism)*
I am not confident that cultured meat will be antibiotic-free	Efforts to improve environmentally friendly products should be made up by the government and not by consumers
Consuming cultured meat may result in long-term adverse effects on one's health	I will not change my consumption decisions unless everyone is forced to change their consumption decisions
There could be long-term side effects associated with the consumption of cultured meat	
I am sceptical of the health claims made about cultured meat	
I worry about the government's ability to protect consumers' rights when cultured meat is available on the market	
Ethical concerns	*Tolerance (liberalism vs. illiberalism)*
Switching to eating cultured meat will not contribute much to the fate of the environment	I know many people who have embraced a vegetarian/vegan lifestyle
Social and cultural concerns	I do not mind eating food that my peers deem socially unacceptable
I am worried that my family will not accept cultured meat	
My friends will judge me for eating cultured meat	My culture encourages me to eat conventional meat
I will probably be the only one among my colleagues that eats cultured meat	
I feel that I identify more with conventional meat than cultured meat	
My religion discourages me from eating cultured meat	
Economic concerns The introduction of cultured meat will not help avoid food shortage problems	
A switch to eating cultured meat will cause increased unemployment	
The introduction of cultured meat will have a negative impact on conventional meat producers	
The introduction of cultured meat will cause unforeseen negative effects on the economy	

Similar to Wilks et al. (2019), the questions enquiring about consumers' worldviews were extracted from Pliner and Hobden (1992). For estimating the explicit perceptions of cultured meat, opinion statements were organized into five categories that grouped (1) social and cultural, (2) economic, (3) quality, (4) health and safety, and (5) ethical concerns. These categories of concerns were constructed following a review of existing literature. Table 1 below shows the opinion statements asked in the survey that served as indicators of these categories of consumer psychology.

Responses to statements in Table 1 were elicited using a 5-point Likert Scale, calibrated as Strongly disagree = 1, Disagree = 2, Neither agree nor disagree = 3, Somewhat agree = 4 and Strongly agree = 5. Principal component analysis was then carried out on each group of opinion statements to draw a set of components or indices indicating the participants' dominant worldviews or perceptions of cultured meat. The Maximum Likelihood method in confirmatory factor analysis was utilised. This is a data dimension-reducing method that allows for the assessment of the fit between observed data and an a priori conceptualised, theoretically grounded model that specifies the hypothesised causal relations between latent factors and their observed indicator variables (Mueller and Hancock 2001). It does so by capturing the variance in the underlying data variables. Statistical Package for Social Sciences (SPSS) was used for data analysis. Varimax rotation was used to ensure that the derived components were uncorrelated. The average variance extracted (AVE) was used to confirm that the indicators of specific constructs share sufficient variance. During the extraction of the principal components (PCs), the Kaiser criterion (Kaiser 1970) of retaining factors with an eigenvalue of above one was utilised. Herewith, factor loadings above 0.5 were accepted and reported. The adequacy of the correlation between the opinion statements was measured using the Cronbach's alpha internal consistency test. The study aimed to acquire a score above 0.7, following Hair et al. (2013). The Kaiser–Meyer–Olkin (KMO) value was used to measure the sampling adequacy for the overall set of opinion statements. Following Hair et al. (2013), the acceptance threshold was set at 0.5. Bartlett's test of sphericity was performed to test the variance in the analysed questions. A p value lower than 0.5 was considered acceptable.

The extracted PCs were regressed with other socio-economic factors as determinants of the willingness to try cultured meat burger patties. A hierarchical linear regression approach, first identifying the consumer psychology indicators and then the socio-economic predictors, was used. Given the order nature of the dependent variable, as shown in Table 2, an ordinal logit model could have been run, but there was no statistically significant difference between the categories created in the ordered variable. Hence, the model failed the goodness of fit test. As such, we explored clear delineations (No) vs. (unsure, yes-probably, and yes-definitely). Given that Neophobia focuses on the rejection of a product, we classified those who said they would definitely not or probably not willing to try vs. those who were unsure or said they would probably try. As such, the binary methodology lent itself well to hypothesis testing. The dependent variable was measured as a binary variable, so the binary logistic model was utilised. A binary variable also had the advantage of ensuring comparison with past studies' findings. This model is expressed in *Eq.* 1.

$$\gamma_i = \text{Prob}(Y_i = 1) = F\left(\beta' X_i\right)_{\text{coni}} = 1, 2, \ldots n \tag{1}$$

where Yi is a binary variable coded as 1 = willing to try cultured meat and 0 = unsure or not willing to try cultured meat[3]; Xi is a vector of the explanatory variables; β' is a vector of parameters to be estimated, and F is a known function.

Table 2 describes the variables included in the regression model.

[3] The respondents were asked, "Are you willing to try cultured meat?". The study participants responded No, definitely not = 1; No, probably not = 2; Unsure = 3; Yes, probably = 4 or Yes, definitely.

Table 2 Variable descriptions and prior expectations

Variables	Type of variable	Description	Expected sign
Dependent variable			
Willingness to try cultured meat	Dummy	1 indicates a willingness to try cultured meat; 0 otherwise	
Explanatory variables			
Concern for cultured meat's quality	Continuous	Composite index derived from perception data. It measures consumers' concerns about the meat's quality of cultured meat	–
Concern for economic risk associated with cultured meat	Continuous	Composite index derived from perception data. It measures consumers' concerns about the economic risk associated with cultured meat	–
Health, food safety and ethical concerns surrounding cultured meat	Continuous	Composite index derived from perception data. It measures consumers' concern about the meat's quality	–
Concern for social and cultural acceptability of cultured meat	Continuous	Composite index derived from perception data. It measures the health, food safety and ethical concerns surrounding cultured meat	–
Distrust for Science and Egoism	Continuous	Composite index derived from perception data. It indicates the level of distrust for Science and egoism measured in the sample	±
Liberalism	Continuous	Composite index derived from perception data. It indicates the level of liberalism measured in the sample	±
Male	Dummy	1 indicates a male respondent; 0 otherwise	±
Age	Continuous	Age measured in years after birth	±
Burger consumption	Dummy	1 indicates a respondent who eats burgers regularly; 0 otherwise	±
Reducing meat consumption	Dummy	1 indicates a respondent who is planning to reduce meat consumption; 0 otherwise	±
Faux meat consumption	Dummy	1 indicates a respondent who eats meat alternatives (faux meat); 0 otherwise	±
Less knowledge of cultured meat	Dummy	1 indicates a respondent who stated that they did not have much knowledge about cultured meat (faux meat); 0 otherwise	±
Naming of faux meat	Dummy	1 indicates a preference for a non-meat-related name to be developed for faux meat; 0 otherwise	±
Residential location	Dummy	1 indicates a respondent who resides in the developed provinces (Gauteng, Western Cape and KwaZulu Natal); 0 otherwise	+

Results and discussion

Sample description

The average age of a survey respondent was 35.98, and the same sample was predominantly (55.69%) women (Table 3). The majority of the respondents were from Gauteng (44.31%), KwaZulu Natal (13.51%) and Western Cape (11.08%). The remaining six provinces accounted for less than 10% of the sample each. About sixty-three per cent

Table 3 Representativeness of the survey sample

Characteristic	Sample (*N* = 658)	Sample (Percentage)	National census (Percentage)	Δ**
Gender				
Male	290	44.16	50.76	− 6.6
Female	367	55.69	49.24	6.45
Other	1	0.15		
Province				
Gauteng	292	44.31	26.6	17.71
Limpopo	61	9.26	9.8	− 0.54
Mpumalanga	27	4.10	7.8	− 3.7
North West	25	3.79	6.9	− 3.11
Northern Cape	15	2.28	2.2	0.08
Free State	23	3.49	4.8	− 1.31
Eastern Cape	54	8.19	11.0	− 2.81
Western Cape	73	11.08	11.9	− 0.82
KwaZulu Natal	89	13.51	19.0	− 5.49
Racial classification				
Black/African	418	63.43	80.2	− 16.77
White	131	19.88	8.4	11.48
Coloured	80	12.14	8.8	3.34
Indian/Asian	2	4.55	2.5	2.05

StatsSA (2022) data for national census

Δ** Difference between subsample and population

(63.43%) of the respondents were of African descent, 19.88% were white, 4.25% were coloured, and 0.30% were Indian. One in every ten respondents was either vegetarian or vegan. As shown in Table 3, the survey overrepresented the female demographic group and Gauteng province while underrepresenting the black/African demographic group.

As shown in Table 4, about 40% of the respondents were well educated with a 3-year degree or better, 27.03% had received some form of vocational training, and the remaining 31.96% had attained a secondary school certificate or less. Most (26.61%) of the sample respondents fell under the middle-income bracket (R54 345–R863 906), where 20.82%, 29.48%, 16.10% and 6.99% were classified as low emerging, emerging, realised and upper middle class. Most of the respondents (54.71%) reported no intention to change their current meat consumption patterns, while 20.67% said they wanted to increase their consumption. About a quarter (24.62%) of the respondents had plans to reduce their meat consumption in the succeeding 12 months. Most respondents (58.44%) reported buying burger patties a few times (1–3) a month.

When asked about their knowledge of cultured meat, the majority of the study participants (42.6%) indicated that they had heard about cultured meat, 35.9% reported that they had heard about cultured meat but did not know what the term meant, and 21.5% of the respondents had never heard about cultured meat prior to this study. As shown in Fig. 1, 35.31% of the respondents said they were very willing; the majority said they would probably try it, 15.83% were unsure, while the remainder were either against the idea (5.02%) or strongly against (5.78%) the idea of trying it.

Table 4 Demographic characteristics of the sample

Characteristic	Sample (*N* = 658)	Percentage
Vegan/Vegetarian		
Yes	65	9.87
No	593	90.13
The highest education level competed		
No formal education	1	0.15
Primary school	1	0.15
Secondary school	208	31.66
Diploma (Vocational training)	178	27.09
3–4 Year degree	208	31.66
Masters' degree	53	8.07
PhD	8	1.22
Income		
R0–R54 344 (poor)	123	18.69
R54 345–R151 727 (low emerging	137	20.82
R151 728–R363 930 (emerging middle class)	194	29.49
R363 931–R631 120 (Realised middle class)	106	16.11
R631 121–R863 906 (Upper middle class)	46	6.99
R863 907–R1 329 844 (Emerging affluent)	38	5.77
R1 329 845 + (Affluent)	14	2.13
The intention of changing meat consumption in the next 12 months		
Increase	136	20.67
Maintain	360	54.71
Decrease	162	24.62
Frequency of buying burger patties		
Daily	18	2.74
2–3 times per week	102	15.53
Once a week	112	17.05
2–3 times a month	210	31.96
Once a month	174	26.48
2–3 times a year	31	4.72
Never	10	1.52

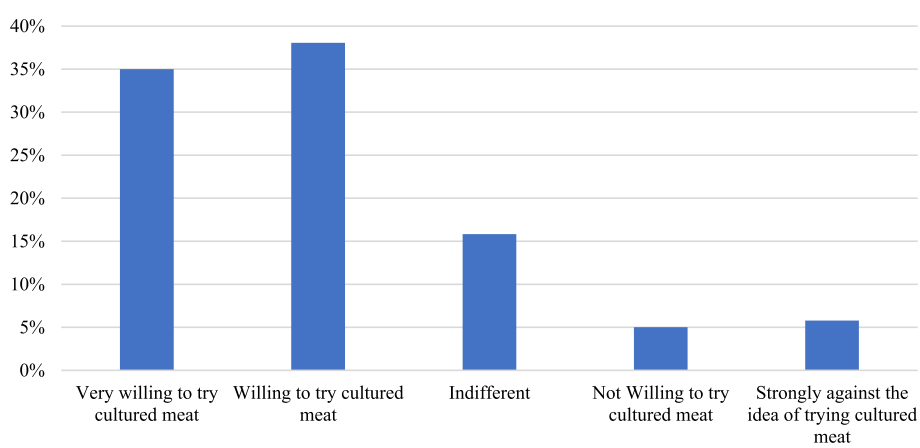

Fig. 1 Percentage of sample willing to try cultured meat

Table 5 Consumers' world views

Consumers' worldview and personality indicators	Factor loadings		Mean	SE
	PC 1 Distrust of Science and egoism (28.58%)	PC 2 Liberalism (14.02%)		
I will not change my consumption decisions unless everyone is forced to change their consumption decisions	0.681		3.11	1.39
New food technologies may have long-term negative effects on the environment	0.639		3.49	1.18
Efforts to improve environmentally friendly products should be made up by the government and not by consumers	0.562		2.92	1.37
The benefits of new food technologies are often grossly overstated	0.559		3.51	1.12
My culture encourages me to eat conventional meat	0.554		3.21	1.34
Society should not depend heavily on new food technologies to solve its food problem	0.533		3.58	1.21
*I do not mind eating food that my peers find socially unacceptable		0.783	3.96	1.11
*I know many people who have embraced a vegetarian/vegan lifestyle		0.631	3.68	1.25

Cronbach's alpha = 0.805

KMO = 0.769

Bartlett's test = 0.000

*Indicates statements indicating positive perceptions that were reverse coded during data analysis to ensure consistency in measuring a negative perception. This is done to ensure accurate results are obtained

Implicit and explicit attitudes towards cultured meat burger patties

The results in Table 5 show that the survey respondents' worldview was dominated by a strong distrust for Science and an unwillingness to promote responsible consumption in society actively. This is shown by the significant number of indicators in PC 1 showing negative perceptions of Science and Technology and egoism. This PC accounted for 28.58% of the perception data variation and had an eigenvalue of 2.286. This finding provides evidence of the scepticism towards Science reported by Wilks et al. (2019) and Lewisch and Riefler (2022). The results in PC1 also show that respondents would generally not choose to bear the costs of driving change required for sustainable lifestyles but believe that the government should coordinate efforts. The significant factor loadings in the opinion statements loaded on PC 2 also show a significant level of liberalism existed in the sample. This PC accounted for 14.02% of the variation in the sample's perceptions and an eigenvalue of 1.121.

Table 6 indicates the relative ranking of concerns consumers had around cultured meat. Respondents were primarily concerned about the quality of cultured meat. This is indicated by the high number of meat quality opinion statements with statistically significant loadings on PC 1. As shown in PC 2, economic concerns were the second highest concern. This PC accounted for 8.927% of the variation in the data on consumer perceptions and had an eigenvalue of 1.785. The third-highest PC represented the largest variety of consumer perceptions. This PC, with an eigenvalue of 1.223, represented consumers' ethical, health and safety concerns. The last PC represented social and cultural concerns. This PC had an eigenvalue of 1.104 and accounted for 5.679%.

Table 6 Consumers' concerns about cultured meat

Concerns statements	Factor loadings				Mean	SE
	PC 1 Meat quality (32.50%)	PC 2 Economic (8.927%)	PC 3 Ethical, Health and Safety (7.122%)	PC4 Social and Cultural (5.679%)		
I am concerned that cultured meat will not be as juicy as conventional meat	0.808				3.52	1.213
I am concerned that cultured meat will not have the same texture as conventional meat	0.791				3.50	1.124
I am concerned that cultured meat will not taste as good as conventional meat	0.785				3.40	1.241
I am concerned about the storage requirements for cultured meat	0.573				3.42	1.246
There could be long-term side effects associated with the consumption of cultured meat	0.511				3.45	1.171
The introduction of cultured meat will cause unforeseen negative effects on the economy		0.774			3.17	1.093
The introduction of cultured meat will have a negative impact on conventional meat producers		0.742			3.45	1.170
A switch to eating cultured meat will cause increased unemployment		0.730			3.05	1.196
Switching to eating cultured meat will not contribute much to the fate of the environment			0.668		3.05	1.192
Consuming cultured meat may result in long-term negative effects on one's health			0.586		3.35	1.198
I am sceptical of the health claims made about cultured meat			0.528		3.47	1.141
There could be long-term side effects associated with the consumption of cultured meat			0.516		3.45	1.171
My friends will judge me for eating cultured meat				0.804	2.60	1.320
I will probably be the only one amongst my colleagues that eats cultured meat				0.696	3.03	1.313
I am worried that my family will not accept cultured meat				0.577	3.24	1.371
My religion discourages me from eating cultured meat				0.559	2.44	1.367

Cronbach's alpha = 0.871

KMO = 0.904

Bartlett's test = 0.000

Determinants of consumer acceptance of cultured meat burger patties

The results in Table 7 show how consumers' product-specific implicit perceptions influenced consumers' willingness to try cultured meat burger patties. This finding is consistent with prior expectations as other studies (Lewisch and Riefler 2022; Wilks et al. 2019; Piochi et al. 2022; Quevedo-Silva and Pereira 2022; Rombach et al. 2022; Lin-Hi

Table 7 Personal and psychological antecedents of consumers' willingness to try cultured meat burger patties

Variables	ß	S.E	Wald	EXP (ß)
Concern for cultured meat's quality	− 0.223*	0.111	4.013	0.800
Concern for economic risk associated with cultured meat	− 0.305**	0.115	6.987	0.737
Health, food safety and ethical concerns surrounding cultured meat	− 0.253**	0.114	4.956	0.776
Concern for social and cultural acceptability of cultured meat	− 0.395***	0.115	11.841	0.674
Distrust in Science and egoism	− 0.310**	0.125	6.181	0.733
Liberalism	0.244**	0.112	4.730	1.276
Male	− 0.380*	0.212	3.224	0.684
Age	− 0.019**	0.009	4.859	0.981
Burger consumption	2.035***	0.522	15.226	7.654
Reducing meat consumption	− 0.393**	0.163	5.827	0.675
Faux meat consumption	0.322	0.216	2.233	1.380
Less knowledge of cultured meat	− 0.665***	0.138	23.176	0.514
Naming of faux meat	− 0.486**	0.208	5.433	0.615
Residential location	− 0.038	0.040	0.921	0.963
Constant	3.405***	0.935	13.256	30.104
Nagelkerke *R*-squared	0.279			
− 2 Log likelihood	623.995			
Observations	658			

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

The variables "income", "education level", and "vegan" had no statistically significant influence on the dependent variable

et al. 2022; Van Loo et al. 2020; Hwang et al. 2020) also found that consumers often rely on preconceived attitudes from experiences with related products and high-order values to assist in making decisions on novel food products. However, Table 6 shows that the omnivore paradox is exhibited in the results as consumers' worldviews had a mixed effect on their willingness to try cultured meat. On the one hand, consumers' egoism and distrust in Science were found to deter the consumers' willingness to try cultured meat (ß = -0.310; p value = 0.013). On the other hand, consumers' liberalism (ß = − 0.030; p value = 0.244) positively influenced their willingness to try cultured meat. According to Rombach et al. (2022), the negative relationship with Science is born out of the need for self-preservation and is often driven by experience or evidence of negative externalities (negative side effects) of scientific products. This result is consistent with the findings reported by Zhang et al. (2020), Shaw and Iomaire (2019) and Wilks and Phillips (2017), which highlight distrust in food scientists and food safety authorities as potential barriers to consumer acceptance of cultured meat. Wilks et al. (2019) explain the positive relationship between liberalism and consumers' propensity to accept cultured meat due to food curiosity. The results reported here support those that were reported by Rombach et al. (2022), Piochi et al. (2022), Arora et al. (2020), Grasso et al. (2019) and Bryant et al. (2019a, b), who found that having a liberal mindset, predicted cultured meat acceptance. As this is the case in this study, it can be recommended that marketing efforts be directed towards positioning cultured meat as a commonly consumed product instead of a Scientific innovation. This could reduce the concern of the possible failure that is associated with Scientific experiments. Bryant and Dillard (2019) suggest refraining from advertising cultured meat as a high-tech product that is accompanied

by pictures of test tubes and Petri dishes as is portrayed in the media, but towards one that is more mundane. Interestingly, when comparing the size of the influence of the two worldviews in Table 6, the results indicate that consumers' neophilic attitudes (liberalism) had a stronger influence than their neophobic attitudes (distrust in Science and egoism). Such a finding may predict a larger probability for consumers' acceptance of cultured meat as opposed to product than rejection tendency.

The results in Table 7 also indicate that the composite indices that measured consumers' product-specific perceptions were significantly associated with the consumers' willingness to try cultured meat. This means that cultured meat neophobia was a significant deterrent to trying cultured meat. The social and cultural concerns (ß = − 0.395; p value = 0.000) had the strongest influence. This was followed by the concern for possible economic disruptions (ß = − 0.305; p value = 0.008) and the health, food safety and ethical concerns (ß = − 0.395; p value = 0.000), which were second and third, respectively. Quality concerns (ß = − 0.223; p value = 0.045) were the lowest hindrance to trying cultured meat among the four explicit consumer perception variables. The order of influence of product-specific perceptions is different from those reported in past studies. De Oliveira Padilha et al. (2022) found that consumers' willingness to try cultured meat in their research was affected by their perception of the meat quality was higher than the health-risk perception. The estimated level of influence is also markedly different as the former was reported to have a coefficient of 2.003 and the latter 1.709, while all coefficients in the current study have values below 0.5. None of the interaction terms between the implicit and explicit attitudes yielded any statistically significant results.

It is also interesting to note that matters found to be least concerning in the principal component analysis (social and cultural concerns) in Table 5 were found to have the strongest negative effect on consumers' willingness to try cultured meat. This finding indicates how sensitive consumers can be when considering novel food products. This finding agrees with results reported by Bekker et al. (2017), who showed that consumers in African countries were more likely to reject cultured meat for social and cultural reasons. Koch et al. (2018) also explain that social and cultural concerns are far-reaching in some communities because violation of social norms can cause moral disgust and lead to consumers' subsequent rejection of food products. Meat quality concerns, the biggest concerns in the principal component analysis (Table 6), were among the lowest deterrents to consumers' willingness to try cultured meat. These findings indicate that consumers are willing to overlook matters they consider most concerning and eat cultured meat. The high level of receptiveness by the consumers is also demonstrated by the fact that health and safety concerns, which often make up the most significant objections to consumer acceptance in past studies from elsewhere in the world, were the lowest in this study.

The results on consumer implicit and explicit perceptions highlight the opportunities that can be utilised and the pitfalls that can be avoided when trying to gather acceptance and momentum for cultured meat in the hamburger industry. For the implicit indicators, the fact that consumers had a domineering distrust of Science while also holding egoistic views indicates that the possible marketing that appeals to an altruistic nature in people may not be a very effective marketing approach in this market. Perhaps product value, which indicates a more direct benefit to the individual, would assist in providing

more successful marketing penetration opportunities. Hamlin et al. (2022) also recommend using messages that are targeted at influencing consumers' immediate needs. This recommendation is similar to one given by Asioli et al. (2022), who advocated for marketing messages that indicate societal and personal benefits.

The results of the control variables were in line with prior expectations. As shown by the results in Table 6, survey participants who generally ate burgers were more willing to try cultured meat burgers than vegan/vegetarian counterparts, while individuals with less knowledge about cultured meat were less willing to try it. The results indicate that segmenting the South African market and developing targeted marketing efforts could be possible. This is because there were significant negative correlations between the willingness to try cultured meat and being male (ß = − 0.380; p value = 0.073), older (ß = − 0.019; p value = 0.027) and planning to reduce meat consumption (ß = − 0.393; p value = 0.016). Hence, the target markets for cultured meat hamburger patties could be: (1) females, (2) younger consumers and (3) individuals not planning to reduce meat consumption (meat lovers). These results agree with past studies that also found that females (Hwang et al. 2020; Shaw and Mac Con Iomaire 2019; Zhang et al. 2020), younger consumers (Lin-Hi et al. 2022; Piochi et al. 2022; Zhang et al. 2020), and those who a higher in attachment to meat (Bryant et al. 2019a, b; Arora et al. 2020; Wilks et al. 2019) were relatively more likely to try cultured meat. As expected, the preference for a non-meat-related name to be developed for faux meat was less willing to try cultured meat. This indicates that consumers who have a disdain for cultured meat are the ones who would have issues with the naming of the product.

Conclusion

This study investigated the antecedents of consumers' willingness to try burger patties made from cultured meat in South Africa. It took a particular interest in psychological factors and examined implicit and explicit consumer perceptions. This advanced consumer research on cultured meat as it allowed a separation between the effect of consumers' heuristics and product-specific attitudes while analysing their possible concurrent impact. The study's results provided information that could assist in developing marketing campaigns that could lead to cultured meat burger patty adoption. Two key implications of the study's findings are as follows: (1) messages that highlight cultured meat as a symbol of freedom of choice and inclusiveness could potentially encourage adoption, and (2) marketing messages indicating social acceptance are likely to encourage longer-term acceptance. Taken altogether, the results indicate that tactful marketing will be required to work around the neophobic attitudes and the product-specific perceptions present opportunities that could help consumers overcome their neophobia. As the findings gave a general indication of consumers' openness to cultured meat burger patties, we recommend that policies be implemented to both facilitate the evolution of the protein supply industry and safeguard consumer welfare.

We want to acknowledge some limitations of this study. First, the sample used was not representative of the distribution of the demographic characteristics of South Africa. Although an adequate representation was achieved in the recruitment, high attrition, which occurred during data cleaning, resulted in the over-representation of more developed provinces. This made the sample more representative of the economically active

population than the demographic spread of consumers. Second, the study's results failed to find the influence of interaction between implicit and explicit perceptions. This can be investigated in future studies as this is consistent with theory and could provide insights into using this information in marketing. These terms' lack of significant influence indicates the consumers did not conflate their concerns about cultured meat with neophobic attitudes. Such a state of affairs may be present in other communities. Future studies can also investigate how the symbolism of freedom determined in this study can be used as a possible successful marketing theme for cultured meat. Lastly, the study used binary variables to measure willingness to try cultured meat. Although this was ensured in comparison with past studies' findings, information was lost. We recommend that future studies use variables with even more categories in this variable's measurement.

Abbreviations

AVE Average variance extracted
KMO Kaiser–Meyer–Olkin
PC Principal components

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Author contributions
CT was involved in the study's conceptualization, data collection, data analysis and writing of the manuscript. LN was involved in the study's conceptualization, data collection and writing of the manuscript.

Availability of data and materials
Data are available on request.

Declarations

Competing interests
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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