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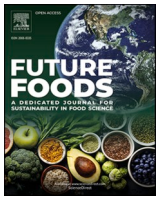

The effects of information and naming restriction on South African consumer preferences for farm-raised meat and meat alternatives

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ABSTRACT

High meat consumption in South Africa is driven by population growth, increased income, and urbanization. However, high meat production raises environmental and societal concerns, highlighting the need to shift toward more sustainable protein sources to reduce these impacts. This study examines consumer preferences for plant-based, insect-based, and cultured meat as alternatives, alongside the effects of environmental and health information and naming restrictions on these preferences. A food choice experiment was administered on 1013 urban South African food shoppers to assess preferences for three alternative burger patties relative to farm-raised beef patties. Respondents were randomly assigned to treatments varying by health, environmental, and product naming information. Results indicate that farm-raised beef captures approximately 96 % of the market share within our sample of urban food shoppers. Naming restrictions do not significantly affect beef demand but increase the market share for plant-based and cultured alternatives. Health information leads to slightly higher preferences for plant-based options than environmental information. Preference for insect-based alternatives remains low, likely due to an aversion to insects. These findings enhance understanding of consumer preferences for alternative meat products and naming restrictions, informing policies aimed at reducing the environmental and societal impacts of livestock production in South Africa.

1. Introduction

Global population growth, urbanization, and rising disposable income have led to increased meat consumption worldwide (Milford et al., 2019; OECD/FAO, 2021; Parlasca and Qaim, 2022; Ratnasiri and Bandara, 2017). This phenomenon is also observed in South Africa, an emerging economy with growing meat demand (OECD/FAO, 2021). From 2003 to 2016, meat consumption in South Africa increased by 54 %, and a further 23 % increase is projected by 2028 (Bureau for Food and Agricultural Policy, 2020; Delport et al., 2017), making the country an increasingly important market for meat producers. In the meantime, the trend of South African consumers shifting towards meatier diets has significant implications: it stresses the food system amid food insecurity (OECD/FAO, 2020); and it raises environmental and health concerns (OECD/FAO, 2021; Parlasca and Qaim, 2022; Stubbs et al., 2018).

Livestock meat production, especially beef production, is resource-intensive and contributes to increased greenhouse gas (GHG) emissions, land and water usage, and energy consumption (OECD/FAO, 2021; Stubbs et al., 2018). Livestock production consumes substantial natural resources (Asem-Hiablie et al., 2019) and accounts for 14.5 % of the global GHG emissions (Gerber et al., 2013). In South Africa, livestock production contributes to approximately 5.5 % of GHG emissions, with beef cattle responsible for approximately 4.5 % of the overall emission burden (Stevens, 2022).

Moreover, meat production raises societal concerns regarding food safety and health issues (Godfray et al., 2018). For example, consumption of red and processed meat is linked to obesity, cardiovascular disease, diabetes, and colon cancer (Godfray et al., 2018; Kennedy et al., 2024). In South Africa, 28.8 % of adults are obese, and heart disease is prevalent (OECD/FAO, 2020; Smith et al., 2023). Consequently, dietary guidelines recommend reducing meat consumption (Fischer and Garnett, 2016; Willett et al., 2019) with the South African guidelines advising to limit red meat to 80–90 g per day or no >560 g per week per capita (Schonfeldt et al., 2013).

Transitioning to a diet with fewer animal proteins can address environmental and health issues (Ortega et al. 2022). Edible insects as well as plant-based and cultured meat alternatives, compared to farm-raised meat, may significantly reduce land and water use, lower

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GHG emissions, provide better health outcomes, and enhance food security (Godfray et al., 2018; Ortega et al., 2022; Willet et al., 2019). The production and adoption of these alternatives can supplement farm-raised beef (Chriki and Hocquette, 2020). Alternative meat options such as insect protein, plant-based meat, and cultured meat are gaining attention (Mosca et al., 2025; Onwezen et al., 2021). South Africa's meat alternatives market is projected to grow by approximately 37 % from 2019 to 2028 (Racz, 2024). Meat-like insect-based and plant-based burger patties have been developed to replicate the texture, taste, and appearance of farm-raised beef (Tsvakirai et al., 2023). Insect-based patties are available in select outlets, whereas plant-based patties are widely available in large grocery stores and fast-food outlets (Madubela, 2023). Cultured meat is still in its early stages of development and has not yet entered the South African market.

This study assesses the effects of health and environmental information and naming restrictions on South African consumers' WTP for beef burger patties and their alternatives (insect-based patties, plant-based patties, and cultured beef patties). Our study enhances the literature on consumer preferences and naming of alternative meat products in three ways. First, we examine South African consumer preferences for beef alternatives, including insect-based options, using a discrete choice experiment. While substantial evidence exists on meat alternative preferences in developed countries, there is limited research on developing economies such as South Africa. To the best of our knowledge, at the time this research was conducted, only two studies have evaluated South African consumers' preferences for meat alternatives, focusing solely on plant-based and cultured options (Szejda, 2021; Tsvakirai et al., 2023). Similar to plant-based and cultured meat alternatives, insect-based alternatives offer both health and environmental benefits, and increased adoption could contribute to alleviating food insecurity and pollution. Thus, understanding how beneficial information influences consumer preferences for insect-based alternatives, and comparing these effects to plant-based and cultured options is crucial. While our sample is not nationally representative, the findings offer insights into how a specific group of urban food shoppers responds to information and labeling policies concerning meat alternatives.

Second, we estimate the effects of both health and environmental information on consumers' WTP for the three meat alternatives and simulate market shares at different price points. While Tsvakirai et al. (2023) also estimated WTP and market share, only environmental information was provided to the consumers, and the market share was derived from a fixed price point. Our study provides additional insights into the effectiveness of health information on consumers' WTP, and how it compares with environmental information. Moreover, simulating market share at different combinations of price points allows us to examine different market scenarios when the relative prices of product alternatives change. The results can help inform price-related marketing strategies to promote these novel products and increase their adoption.

Finally, we examine the effect of the naming restriction on consumers' preferences for meat alternatives in South Africa. This focus is particularly relevant given recent regulatory debates and legal decisions over the use of "meaty" terms for plant-based and cultured products. These naming policies warrant careful, evidence-based evaluation, as they may influence consumer perceptions and purchasing behavior. Understanding these effects is essential not only for researchers studying food labeling and consumer acceptance, but also for marketers navigating how to position novel protein products in evolving regulatory environments. Our study builds on DeMuth et al. (2023), who examined U.S. consumer preferences for plant-based and cultured alternatives. We extend this work by analyzing the South African context, which includes different regulatory dynamics and cultural considerations, and by incorporating insect-based alternatives. Moreover, while DeMuth et al. (2023) focused on mean WTP values, our study offers a broader view by examining the full distribution of consumers' WTP, providing insights into heterogeneous responses to naming restrictions.

2. Background and research hypotheses

2.1. Meat alternatives in perspective

Insect-based food refers to insect species used for human consumption, both whole and as ingredients in processed food products, such as burger patties, pasta, and/or snacks (Mancini and Antonioli, 2022). Insects possess a substantial protein content and supply of minerals, making them a nutritious food source (Conway et al., 2024). Studies indicate that insects have the lowest acceptance among alternative proteins owing to food neophobia and disgust (Demartini et al., 2024; Heijnk et al., 2023; Mancini et al., 2019; Onwezen et al., 2021; Verbeke, 2015). Consumers are more willing to eat insects in processed forms, such as insect-fortified burgers, than in unprocessed forms (Hartmann et al., 2015; Kornher et al., 2019; Mosca et al., 2025; van Huis and Rumpold, 2023). Entomophagy (the consumption of insects) has long been practiced in South Africa, where insects form part of some traditional diets (Hlongwane et al., 2021). In South Africa, certain cultural practices and rural livelihoods support insect consumption, mainly in rural areas (Hlongwane et al., 2021; Makhado et al., 2014). Familiarity with alternative food options has been shown to influence food choices and the decision to replace meat with alternatives (Chia et al., 2024; Demartini et al., 2024; Heijnk et al., 2023; Hoek et al., 2011). Thus, familiarity with eating insects and a willingness to reduce meat consumption are expected to increase the acceptance of insect-based burgers as alternatives to meat. However, many educated, middle- to upper-class urban South Africans from these insect-eating cultures have adopted Western diets and have reduced their insect consumption (Imathiu, 2020). The findings of this study will shed light on the opinion of consuming insect-based burger patties among urban consumers.

Plant-based food refers to food products derived from plants (Flint et al., 2023), whereas plant-based meat alternatives refer to "commercially available food products derived from plants that are designed to mimic the preparation methods, sensorial qualities, and nutritional profile of meat-equivalents" (Flint et al., 2023). These alternatives often use proteins derived from wheat, soy, or peas (Santo et al., 2020). Plant-based foods generally offer health benefits because of their low saturated fat content and energy density (Viroli et al., 2023). However, Hu et al. (2019) warned that highly processed plant-based meats might lack some health benefits present in less processed plant proteins such as lentils or beans. The nutritional content of plant-based meat varies in protein, saturated fat, minerals, and fiber (Harnack et al., 2021). The plant-based protein market is expected to reach USD 162 billion by 2030, representing 7.7 % of the global protein market (Bloomberg, 2021). South Africa's plant-based meat sales are projected to grow by 6.5 % annually, accounting for more than half of Africa's market share in the global forecast (Reuters, 2022). This growth is driven by the availability of alternative plant-based meat products in major South African grocery stores (Madubela, 2023). Numerous studies have examined consumer perceptions of plant-based meat (Bryant, 2019; Faber et al., 2020; Heijnk et al., 2023; Pohjolainen et al., 2015; Vainio, 2019), and one South African study showed that 59 % of the respondents were highly willing to purchase plant-based meat alternatives (Szejda et al., 2021).

Cultured meat (also called cultivated or lab-grown meat) refers to real animal meat produced under laboratory conditions by introducing muscle tissue from donor bovine animals into a culture medium, where they proliferate under controlled conditions and develop into muscle fibers (Post, 2012). As the technology surrounding the development of cultured meat is precise, it is expected that cultured meat will be healthier and more nutritious than conventional meat (Stout et al., 2020). Although cultured meat caters to a meat-centric diet, much remains uncertain about its acceptance (Bryant and Barnett, 2018). Several studies in Europe, the U.S., Asia, India and China found consumers willing to accept cultured meat as an alternative (e.g., Bryant et al., 2019; Chia et al., 2024; Demartini et al., 2024; Heijnk et al., 2023;

Melios et al., 2025; Van Loo et al., 2020; Verbeke et al., 2015; Wilks and Phillips, 2017). Similarly, in South Africa, survey results have shown that about 53 % of consumers were willing to purchase cultured meat alternatives (Szejda et al., 2021), and that consumers were willing to pay 10.8 % more than the price of farm-raised meat for cultured meat alternatives (Tsvakirai et al., 2023). These findings allude to the market potential of cultured meat alternatives in South Africa.

2.2. Impact of information and product naming on consumer preferences

To enhance consumer acceptance of meat alternatives developed through new technologies, studies have recommended informing consumers about the health and environmental benefits of these products (Hocquette et al., 2015; Siegrist and Harmann, 2023; Verbeke et al., 2015). For instance, 24 % of Belgian consumers initially showed a willingness to try cultured meat, but this increased to 43 % after learning about its environmental benefits (Verbeke et al., 2015). Thus, providing environmental and technological information can encourage consumers to try meat alternatives without reducing the demand for conventional meat (Ortega et al., 2022; Van Loo et al., 2020). In South Africa, health benefits are linked to a higher intention to purchase meat alternatives (Szejda et al., 2021), and environmental benefits can expand the market share of these products (Tsvakirai et al., 2023). Overall, consumers' acceptance of meat alternatives depends on their knowledge of these products, highlighting the need for informative communication (Zhang et al., 2020).

While the provision of beneficial information could potentially increase South African consumers' acceptance of meat alternatives, regulatory challenges remain when it comes to how these products should be named. The naming of products refers to the name (or label) given to a product, which can affect how the product is viewed, evaluated and even consumed (Bryant and Barnett, 2019). Several product names exist for alternative meat products, such as plant-based, veggie, vegan, meatless, lab-grown, cultured, animal-free, and clean meat (Friedrich, 2019; Sucapane et al., 2021). The variety of names for meat alternative products has led to debates on whether to restrict the use of the word "meat" to products harvested from live animals only. The purpose of naming restrictions in terms of the use of meat-related terms for non-animal products is to prevent consumer confusion and to protect traditional meat producers from free-riding on farm-raised meat advertising (Agricultural Product Standards, 2022; DeMuth et al., 2023).

In 2022, South Africa's Department of Agriculture, Land Reform and Rural Development imposed naming restrictions on meat alternatives such that "meaty" terms (e.g., burger, sausage, beef, nugget, or mince) were reserved for processed meat products only (Agricultural Product Standards, 2022; Southey, 2022). This decision was partly overturned in 2024 when the Johannesburg High Court ruled that certain "meaty" terms (e.g. sausage, burger and steak) can be used for alternative meat products (Racz, 2024). Similarly, in France, a ban on using 21 'meaty' terms for plant-based products was overturned in 2024 by the European Union Court of Justice, allowing terms like 'steak' and 'sausage' to be used again (Ingredients Network, 2024). Although a recent academic study showed minimal evidence that restricting "meat" in product naming affects consumer choices (DeMuth et al., 2023), other studies have found naming to be effective in changing consumers' perceptions of meat alternatives (e.g., Bryant and Barnett, 2019; Kunst and Hohle, 2016; Sucapane et al., 2021). However, most of these studies are from developed economies such as the U.S., leaving a gap in understanding how consumers in emerging economies interpret alternative meat product names. Considering the market potential of meat alternatives in South Africa (Racz, 2024), it is crucial to investigate the impact of this regulatory change on consumer preferences. Our study provides empirical insights into how such restrictions may influence consumer preferences, offering evidence to inform both marketers aiming to position alternative proteins effectively and policymakers evaluating the potential effects of naming regulations on consumer behavior and market development.

2.3. Research hypotheses

Our analysis was guided by research hypotheses formulated based on previous studies and an understanding of the South African market. Given South Africa's high per capita beef consumption and growth in plant-based food sales, we hypothesize that South Africans will prefer farm-raised meat, but will also show significant acceptance of alternative meat products (Hypothesis 1). Health concerns are the primary drivers for consuming alternative proteins over farm-raised meat (Unilever, 2024; Verbeke, 2015; Verbeke et al., 2015; Zhang et al., 2024). Research indicates that health benefits are more important to individuals than environmental benefits (de Boer and Aiking, 2021; Szejda et al., 2021). Therefore, we expect that marketing and policy efforts highlighting health benefits will likely increase demand for alternative proteins, followed by environmental benefits (Hypothesis 2). Our final hypothesis concerns the naming of beef alternatives. While naming restrictions did not change the perceptions of farm-raised beef's nutritional content, they positively influenced perceptions of alternative meat options (DeMuth et al., 2023). Therefore, naming may affect consumer preferences for farm-raised meat versus meat alternatives (Hypothesis 3). These hypotheses aim to enhance our understanding of consumer preferences and demand for alternative meat products and their naming restrictions, aiding policy development to mitigate the negative impacts of livestock production in South Africa.

3. Method

3.1. Participants and measurement

A survey questionnaire was developed to obtain data on South African consumer preferences and the demand for beef product alternatives. The different meat alternatives were clearly defined before respondents answered any questions on the particular product type. The ethics committee of the academic institution granted ethical clearance for the study (protocol no EMS1048/24). Data were collected over a two-month period (May to June 2024) using an online paid-for consumer panel through Qualtrics. The 20-minute survey was conducted in English, and the questionnaire was programmed, pretested, and administered using the Qualtrics XM platform. The panel was recruited according to the target population specifications which consisted of primary food shoppers aged 18 years and older across urban South Africa. The online panel ensured a gender-balanced and age-balanced sample across the age groups 18–34 years, 35–54 years and 55+ years. Other socio-demographic questions included race, household size, monthly income and province. It is important to note that our sample is not representative of the broader South African or urban population. Respondents were limited to individuals with internet access, potentially skewing the sample toward more educated, higher-income, and tech-savvy individuals. The study also focuses on urban residents, excluding rural consumers who may differ in food purchasing habits and exposure to meat alternatives. Findings should therefore be interpreted as descriptive of this sample rather than generalizable to the national or urban population.

Dietary habits were measured ranging from the full-time meat eaters to those who ate no meat or products of animal origin.[1] Respondents were also asked to indicate their likelihood of purchasing each type of meat alternative on a scale from 1 (I will definitely not buy) to 7 (I will definitely buy), assuming that the products were available on the market. To further ensure the quality of the data, speeders (responses completed in less than half of the median duration) or respondents who straight-lined through the survey were excluded. In total, 1013 valid

[1] Dietary question and full response options are presented in Appendix A.

observations were obtained.

Consumer preferences for burger patties were elicited using a discrete choice experiment, which is a widely used tool in food product preference and demand analyses. Burger patties were chosen as the product of interest because of their widespread popularity and familiarity among South African consumers (Tsvakirai et al., 2023), making them an ideal vehicle for assessing preferences and WTP for alternative protein sources. Beef was chosen over other types of meat since it is the most-consumed red meat in South Africa (Directorate Statistics and Economic Analysis, 2023), and its negative impact on the environment is more pronounced (OECD/FAO, 2021; Stubbs et al., 2018). Importantly, burger patties are commonly offered in both traditional (farm-raised) beef and meat alternative forms, allowing for a direct comparison of consumer preferences across different protein types in a familiar and accessible format.

The survey process for the respondents unfolded as follows. Once they passed the screening requirements, respondents were asked several questions on each of the meat alternatives as well as questions on farm-raised beef (e.g. preference and knowledge of these meat types). This was followed by product descriptions and the choice experiment. The choice experiment featured 12 questions, with each scenario displayed on an individual page, and each participant answering all 12 simulated shopping scenarios. To mitigate ordering effects, the order of the choice questions was randomized, as was the order of each alternative within each choice question.

In each choice question, participants were asked to choose among four types of burger patties and a no-purchase option. The four product alternatives included farm-raised beef and insect-based, plant-based, and cultivated meat burger patties. These products were offered at four different price levels in South African Rands (ZAR): 40, 90, 140, and 190 Rands per 450 g. The corresponding price of each alternative in each choice question was generated based on orthogonal main effects fractional factorial design to ensure that the price vector and product alternatives were not correlated. The goal was to know which burger patties (if any) participants would be most likely to buy at the given price level. To reduce hypothetical bias, a cheap talk script was employed (Cummings and Taylor, 1999). Specifically, consumers were cautioned against the tendency to exaggerate their willingness to pay and were instructed to make their decisions as they would in an actual shopping scenario.

To elicit the effect of information and naming restrictions on consumers' food choices, participants were randomly assigned to the control group or one of the three treatment groups. Using a between-subjects design, participants in Treatment 1 and 2 received environmental information and health information prior to doing the choice tasks, respectively. Participants in treatment group 3 received choice questions different from the other three groups, where the word "burger" was removed from the alternative products. An example choice question for each group is presented in Fig. 1. The environmental information and health information provided to participants are presented in Appendix B, and the choice experiment procedure, including the cheap talk script, is detailed in Appendix C.

3.2. Preference modelling

To understand how consumers make choices among different products, we use a modelling approach grounded in economic theory. In simple terms, this method estimates how much value consumers place on different products based on the trade-offs revealed in their choices. Because individual preferences vary, we use a flexible model that accounts for these differences, allowing for more realistic assessment of consumer behavior.

Building on the foundational principles of Consumer Theory (Lancaster, 1966) and Random Utility Theory (McFadden, 1973), we conceptualize product alternatives in a discrete choice experiment as composed of a set of attributes. Consumers derive utility from each attribute and choose the alternative with the highest perceived utility. In our study, the utility that consumer i derives from beef product alternative j is expressed as:

$$U_{ij} = \beta_j + \sigma\, Price_{ij} + \varepsilon_{ij}$$

where β_j is an alternative-specific constant that captures the utility of product alternative j relative to the no-purchase option, σ is the marginal utility of money (proxied by the price coefficient), and $Price_{ij}$ is the price of alternative j offered to consumer i. The error term ε_{ij} follows a Gumbel (extreme value type I) distribution.

To account for preference heterogeneity and the repeated nature of consumer choices, we employed a random parameter logit (RPL) model to estimate consumers' WTP. This approach is commonly used in consumer preference research because it captures individual-level variation and avoids the restrictive assumptions of simpler models. While the multinomial logit model (MNL) is commonly employed as a baseline model for WTP estimation, its key MNL assumptions, such as the independence of irrelevant alternatives, are inconsistent with consumer food choice behavior. In particular, MNL treats all 12 choices made by the same respondent as statistically independent events, and assumes homogenous preferences for meat alternatives. In contrast, the RPL model addresses these constraints by accommodating unobserved preference heterogeneity, making it better suited for our analysis.

Operationalizing RPL requires certain specifications, namely, to specify the distribution of random coefficients. For model identification purposes, the coefficients of the product alternatives are specified to be normally distributed to allow for positive and negative consumer preferences for the product alternatives. The price coefficients are constrained to follow a constrained one-sided triangular distribution to align with the economic principle of a positive marginal utility of income and downward-sloping demand, and are supported by prior research on meat alternatives (i.e., Ortega et al., 2022; Van Loo et al., 2020).

To estimate the RPL model and obtain individual-specific preference coefficients, we used simulated maximum likelihood estimation with 1000 Halton draws to enhance the efficiency and accuracy of the estimation (Bhat, 2003; Train, 2009) .[2] Willingness to pay values are calculated as - β_j /σ and statistical significance is established using the Krinsky and Robb (1986) method. For deriving WTP standard errors, the Krinsky and Robb (1986) procedure serves as a well-established methodology that offers an advantage over the Delta method by relaxing the assumption of symmetric WTP distributions. This approach demonstrates particular robustness in RPL frameworks involving non-linear WTP estimations (Hole, 2007). Finally, we performed the Kolmogorov–Smirnov (K-S) test (Smirnov 1939) to evaluate differences in preference distributions, providing a comprehensive assessment of distributional differences beyond mean comparisons (Botelho and Pinto, 2002; Matthews et al., 2017) .[3] The predicted market share for each product was computed using the RPL probability equations and evaluated at different product prices, as in Ortega et al. (2022).

4. Results

4.1. Sample characteristics

The socio-demographic characteristics and diet composition of the

[2] The use of 1,000 Halton draws effectively addresses simulation bias in models with multiple random parameters while maintaining computational efficiency compared to traditional pseudo-random draw methods (Bhat, 2003; Train, 2009).

[3] Unlike tests focusing solely on mean equality, the K-S test evaluates differences in both the central tendency and distributional shape, while remaining free from normality assumptions (Brouwer and Spaninks, 1999; Matthews et al., 2017).

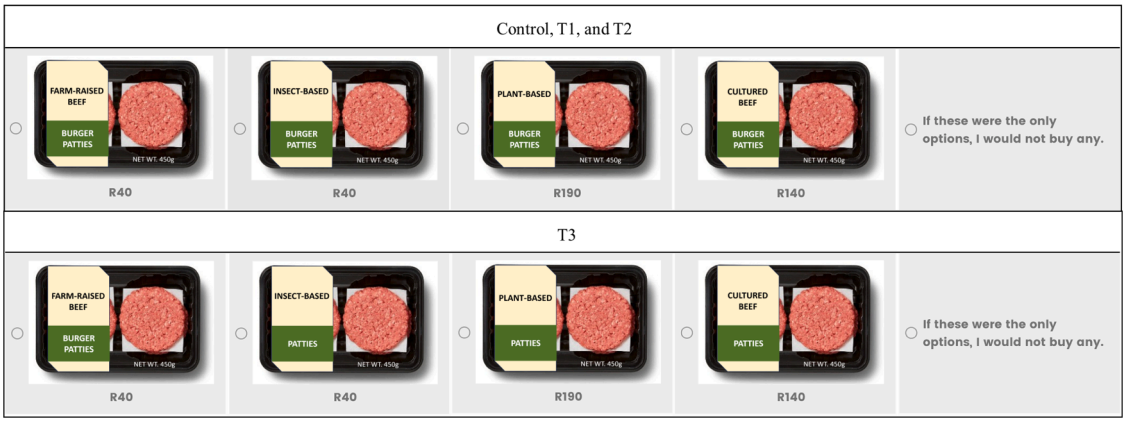

Fig. 1. Example choice task for the control group, environmental information treatment group (T1), health information treatment group (T2), and naming restriction treatment group (T3).

full sample by treatment group are shown in Table 1. As per the quota set for the sample, the gender distribution was even between the gender groups, with an average age of 45.4 years. Approximately 44.5 % of the respondents identified as Black African, and >60 % had an educational level of university degree or above. The average household size was 3.8 persons, and approximately three-quarters of the consumers in our sample had a monthly household income below ZAR 40,000. The vast majority of respondents reported living in urban areas (92.3 %). The three most represented provinces were Gauteng (46 %), Western Cape (21.9 %), and KwaZulu-Natal (11.5 %). Finally, most respondents had a diet that included red meat, with full-time meat eaters comprising 83.3 % of our sample. We emphasize that this study did not intend to mirror the South African population because it included only food shoppers and urban consumers. Overall, each treatment group had characteristics similar to those of the full sample, with no significant differences in socio-demographic characteristics and dietary habits across the treatment groups.

4.2. Model results and WTP values by treatment

The results of the RPL model for the control and treatment groups are presented in Table 2. The parameter estimates for the four product alternatives reflected the relative appeal of each product compared to the "no purchase" option. The price coefficient had the expected negative sign for all treatments. Farm-raised beef emerged as the preferred product in the control group, followed by cultured beef, plant-based, and insect-based alternatives. The standard deviations of the random parameters showed notable variability in consumer preferences within the sample. Willingness to pay estimates revealed that participants in the control group were, on average, willing to pay ZAR 196 for 450 g of farm-raised beef, ZAR 83 for cultured beef, ZAR 77 for plant-based beef, and ZAR −33 for insect-based alternatives (Table 3). An insignificant negative WTP value (p-value 0.065) for the insect-based alternative in the control group suggested that consumers were unwilling to pay to purchase this product. Overall, these findings support Hypothesis 1 stating that consumers prefer traditional beef to alternative proteins, with a high degree of acceptance of beef alternatives, particularly cultured and plant-based beef.

Examining the effects of information treatments, findings showed support for Hypothesis 2 in that both the environment and health information affect consumer WTP in different ways. Information on the environmental benefits of beef alternatives increased consumers' WTP for all three products. The average WTP increased by ZAR 40 for plant-based alternatives and by ZAR 34 for cultured beef. Our study provided further evidence that environmental information has a positive impact on consumers' WTP for insect-based products, which was increased by ZAR 71. However, this high increase of ZAR 71 should be seen in context, as the WTP after the increase is still lower than the other two meat alternatives, given the negative WTP for the insect-based alternative (ZAR −33) before the environmental treatment. This low overall WTP is supported by previous studies claiming that, while cultured, plant-based, and/or insect-based alternatives are considered sustainable food resources with a positive influence on the environment, insect-based food has the lowest acceptance level among consumers (Ardoin and Prinyawiwatkul, 2021; Chia et al., 2024; Demartini et al., 2024; Onwezen et al., 2021). Information on the health benefits of the beef alternatives, on the other hand, increased only the mean and distribution of plant-based beef, and by ZAR 63.

When comparing the impact of naming restrictions on consumer WTP for the product alternatives, we found slight changes in mean WTP values (Table 3), but significant differences in the distribution of WTP for all products compared to the control group (Table 4). In particular, these findings suggest that restricting the use of meaty terms would lead to a decrease in WTP for farm-raised products and an increase in WTP for beef alternatives, which confirms Hypothesis 3 related to the effectiveness of naming restrictions. While the effect sizes of the mean WTP values were small, the significant differences in the underlying WTP distributions suggested heterogeneous preferences for prices between consumers in the naming restriction and control groups. This highlights the importance of looking beyond mean WTP values to gain a clearer understanding of the impact of naming restrictions.

For the insect-based alternative, the lack of a substantial mean effect may initially suggest a minimal impact of naming restrictions on WTP, but the significant distributional shift ($p < 0.001$) showed varied consumer responses, with some favoring insect-based alternatives more than others. Similarly, for plant-based and cultured meat alternatives, slight increases in the mean WTP values and significant distributional differences indicated that naming restrictions do not uniformly increase preferences.

4.3. Simulated market shares

We simulated unconditional market shares based on our model results using five pricing scenarios (Fig. 2). These simulations illustrate potential demand shifts within our sample but are not predictive of broader market behavior. Given the non-representative nature of the sample, the scenarios should be interpreted as indicative rather than conclusive for South African urban consumers. In Scenario 1, prices of farm-raised beef were set to ZAR 90, insect-based ZAR 140, plant-based ZAR 140, and cultured beef at ZAR 190. In this scenario, the price levels reflected the current expected pricing differentials across products in the marketplace, which captured relatively high product development costs. Scenarios 2–5 depicted situations with different price points for alternative products in the market. For example, in Scenario 2, the price of

Table 1
Descriptive statistics of the sample.

	Control	T1-Environment information	T2-Health information	T3-Naming restriction	Overall
Male (%)	51.3	49.8	50.5	48.7	50.1
Age (years)	44.3 (16.0)	45.6 (15.7)	45.6 (15.7)	45.9 (15.7)	45.4 (15.8)
Household size (no.)	3.7 (1.8)	3.6 (1.8)	3.8 (1.9)	3.8 (2.1)	3.7 (1.9)
Educational level (%)					
University degrees (diplomas, degrees, post-graduate degrees)	62.0	63.4	61.1	62.5	62.2
Below university degree/others	37.9	36.5	38.8	37.5	37.7
Monthly household income (%)					
<ZAR15,001	30.6	26.1	31.7	30.6	29.8
ZAR15,001-ZAR40,000	45.5	46.9	43.1	43.1	44.7
ZAR40,001-ZAR61,000	14.9	14.0	13.3	15.3	14.4
>ZAR61,001	8.8	12.8	11.7	10.8	11.0
Race (%)					
Black	45.2	45.3	43.5	43.9	44.5
White	36.7	38.9	40.7	38.7	38.8
Others	18.0	15.6	15.6	17.3	16.6
Area (%)					
Urban	92.3	90.7	93.3	92.7	92.3
Rural	7.6	9.2	6.6	7.2	7.7
N	261	249	255	248	1013
Region (%)					
Cape provinces	29.5	28.5	32.5	30.6	30.3
KwaZulu-Natal (KZN)	14.1	10.4	9.4	11.6	11.4
Gauteng	43.6	50.6	45.1	44.7	46.0
Others	12.6	10.4	12.9	12.9	12.2
Dietary habit (%)					
Full-time meat eater	84.6	84.3	83.1	81.0	83.3
Flexitarian	13.0	12.0	12.9	14.5	13.1
Others	2.3	3.6	3.9	4.4	3.5
N	261	249	255	248	1013

Note: 1. Standard deviations are shown in parentheses. 2. We conducted F-tests and Pearson Chi-square tests to test the null hypothesis of indifference in variables across treatments. All p-values were insignificant, suggesting that there was no significant difference in characteristics across treatments. 3. T1/2/3 = Treatment 1/2/3. 4. ZAR = South African Rand.

Table 2
Random parameter logit estimates by treatment.

	Control		T1- Environment Information		T2- Health Information		T3- Naming Restriction	
Mean	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Farm-raised	7.718***	0.324	6.372***	0.292	6.604***	0.313	7.417***	0.382
Insect-based	−1.291*	0.700	1.208***	0.382	−1.532**	0.720	0.245	0.382
Plant-based	3.033***	0.309	3.706***	0.291	4.491***	0.273	3.932***	0.262
Cultured	3.270***	0.313	3.728***	0.276	2.451***	0.261	4.368***	0.409
Price	−0.039***	0.002	−0.032***	0.002	−0.032***	0.002	−0.041***	0.002
Standard Deviation								
Farm-raised	2.329***	0.178	2.757***	0.246	2.439***	0.151	4.52***	0.394
Insect-based	5.069***	0.560	3.276***	0.347	4.108***	0.523	3.92***	0.429
Plant-based	3.614***	0.383	2.668***	0.257	2.646***	0.200	3.718***	0.291
Cultured	3.381***	0.222	3.044***	0.272	3.349***	0.305	3.794***	0.344
Price	0.039***	0.002	0.032***	0.002	0.032***	0.002	0.041***	0.002
LL	−2261		−2613		−2659		−2236	
AIC/n	1.45		1.76		1.74		1.51	
No. Choices	3132		2988		3060		2979	
No. Observations	261		249		255		248	

Note: 1. ***, **, * indicate statistical significance at 1 %, 5 % and 10 % levels, respectively. 2. T1/2/3 = Treatment 1/2/3. 3. Coef. = Coefficient. 4. S.E. = Standard Error. 5. LL = Log-likelihood. 6. AIC = Akaike Information Criterion.

Table 3
Willingness to pay estimates by treatment (ZAR/450 g).

	Control ($n = 261$)		T1- Environment Info. ($n = 249$)		T2- Health Info. ($n = 255$)		T3- Naming Restriction ($n = 248$)	
Product	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Farm-raised	195.94***	7.24	200.34***	9.55	205***	6.99	182.64***	6.8
Insect-based	−32.78*	17.76	37.97***	11.66	−47.55**	21.89	6.04	9.4
Plant-based	76.99***	7.49	116.52***	9.73	139.44***	6.4	96.84***	5.93
Cultured	83.04***	6.76	117.2***	8.23	76.08***	7.72	107.56***	7.27

Note: 1. ***, **, * indicate statistical significance at 1 %, 5 % and 10 % levels, respectively. 2. ZAR = South African Rands. 3. T1/2/3 = Treatment 1/2/3. 4. Coef. = Coefficient. 5. S.E. = Standard Error.

Table 4
Kolmogorov-Smirnov (K-S) test p-value (treatment compared to control).

	T1- Environment Info.	T2- Health Info.	T3- Naming Restriction
Farm-raised	0.163	0.162	<0.001
Insect-based	<0.001	0.107	<0.001
Plant-based	0.042	<0.001	<0.001
Cultured	<0.001	0.530	0.015

the insect-based alternative decreased to the level of farm-raised beef, whereas the prices for plant-based and cultured beef remained unchanged. Scenario 5 reflected a situation in which the prices of all meat alternatives reached parity with farm-raised beef prices.

4.4. Determinants of consumers' conditional WTP

The determinants of consumers' conditional WTP were estimated using ordinary least squares (OLS) regression. The factors under consideration included dietary habits and socio-demographic characteristics. The socio-demographic characteristics were gender, age, educational level, household size, household monthly income, race, and geography. In this analysis, we pooled the control, environmental information, and health information treatment groups. The naming restriction group was excluded because the product names in the choice experiment were different from those in the other three groups and were not comparable in the pooled analysis. The regression results for the determinants of the conditional WTP for each product alternative are presented in Table 5.

Overall, the information treatments did not affect consumers' WTP for farm-raised beef burger patties but were effective in increasing consumers' WTP for meat alternatives. Environmental information was found to have a larger effect on insect-based and cultured products than health information, whereas the opposite was true for plant-based products. Specifically, for insect-based products, environmental information increased consumers' WTP by ZAR 96, and health information increased consumers' WTP by ZAR 46. Similarly, environmental information increased consumers' WTP for cultured products by ZAR 52, but health information did not have a significant positive effect. On the other hand, for plant-based products, health information increased consumers' WTP by ZAR 53, which was larger than the ZAR 40 increase provided by environmental information.

Despite the significant treatment effects, none of the controlled socio-demographic and dietary habit variables were significant. This is similar to Szejda et al. (2021), who found that socio-demographic characteristics are limited in explaining South African consumers' intentions to purchase meat alternatives. To gain additional insights, we conducted a subgroup analysis by categorizing consumers into early adopters and non-early adopters, following Szejda et al. (2021). Early adopters were consumers with relatively high intentions to purchase meat alternatives and who rated 5 or higher on the 7-point likelihood scale. Those who rated 4 or lower were considered non-early adopters.[4] Among the 765 respondents in our subgroup analysis, 165 (22 %) were considered early adopters of insect-based alternatives, 393 (51 %) were considered early adopters of plant-based alternatives, and 265 (35 %) were considered early adopters of cultured alternatives, respectively.

The results of subgroup OLS regression analyses are shown in Table 6. Interestingly, treatment information was effective only in increasing non-early adopters' WTP for insect-based and cultured alternatives. Specifically, environmental information increased non-early adopters' WTP for insect-based and cultured alternatives by ZAR 97 and ZAR 52, respectively, and health information increased non-early adopters' WTP for insect-based alternatives by ZAR 58. However, for plant-based alternatives, different information treatments were effective for different groups of consumers. While environmental information increased early adopters' WTP by ZAR 61, health information increased non-early adopters' WTP by ZAR 54.

Besides the information treatments, a few socio-demographic characteristics, such as educational level, dietary habits, and income helped to explain consumers' WTP for meat alternatives in the subsample analysis. For example, early adopters of insect-based alternatives with a university degree were willing to pay ZAR 125 more than early adopters of insect-based alternatives without a university degree. One possible explanation is that consumers with a higher educational level are more exposed to new technology, and are thus more accepting and willing to pay a higher price for novel food products, which was also reported in previous studies (Bryant and Barnett, 2018; Onwezen et al., 2021). While the results of our subsample analysis provided implications on the target consumers based on certain socio-demographic characteristics and their purchase intention, socio-demographic characteristics, in general, remained weak predictors of South African consumers' WTP for meat alternatives.

5. Discussion and implications

5.1. Demand for meat alternatives

This study examined the preferences of South African urban food shoppers for farm-raised beef and alternative proteins with a particular focus on health and environmental information, and naming restrictions. While the findings provide useful insights, they should not be generalized beyond the sampled urban South African consumers due to the absence of representative data for this population. For our sample, the results showed that farm-raised beef remains the preferred choice, with consumers consistently showing the highest WTP for farm-raised meat across all treatments. This finding is consistent with other studies showing that most consumers prefer conventionally produced beef to plant-based or cultured meat (Grasso et al., 2019; Heijnk et al., 2023; Onwezen et al., 2021; Slade, 2018; Van Loo et al., 2020), and reflects the current situation in which South Africans eat twice the amount of meat recommended, with 84 % eating meat almost daily (Unilever, 2024). Whilst there is a clear preference for farm-raised beef, there is an emerging acceptance of alternative proteins, especially plant-based proteins and cultured meat, suggesting a viable market if appropriately positioned. South Africa leads in plant-based alternatives in Africa, with 74 % being locally produced (Moonaisur et al., 2023), making them readily available, thereby supporting consumer preferences (Szejda et al., 2021). Thus, there are opportunities to introduce more plant-based options in retail outlets and restaurants, and to increase demand by communicating these options to consumers seeking a variety of plant proteins. The findings show demand for cultured meat, which supports its development and commercialization. Although two companies currently use cell-cultivated meat production in South Africa (Grobler, 2023), cultured meat may only become commercially available in five to ten years owing to high production costs and regulatory approvals (South African Veterinary Council, 2023). Given the status of meat in South African culture (Magano et al., 2023), marketers can perhaps position cultured meat as a premium option. Alternatively, subsidies could make plant-based and cultured products more price-competitive with farm-raised meat, thus addressing the price sensitivity noted in this study. In addition, industry regulations are required for cultured meat classification (Bloomberg, 2022).

The results show that insect-based alternatives face significant consumer resistance from this urban food shopper sample to the point where consumers would require compensation to consider these products. This finding concurs with other findings, indicating that disgust or aversion towards insect-based food affects consumer preferences and adoption of

[4] Respondents were asked "on a scale from 1 to 7, how likely are you to buy the following in the future, assuming the products are available on the market?" with 1 indicating "definitely not buy" and 7 indicating "definitely buy."

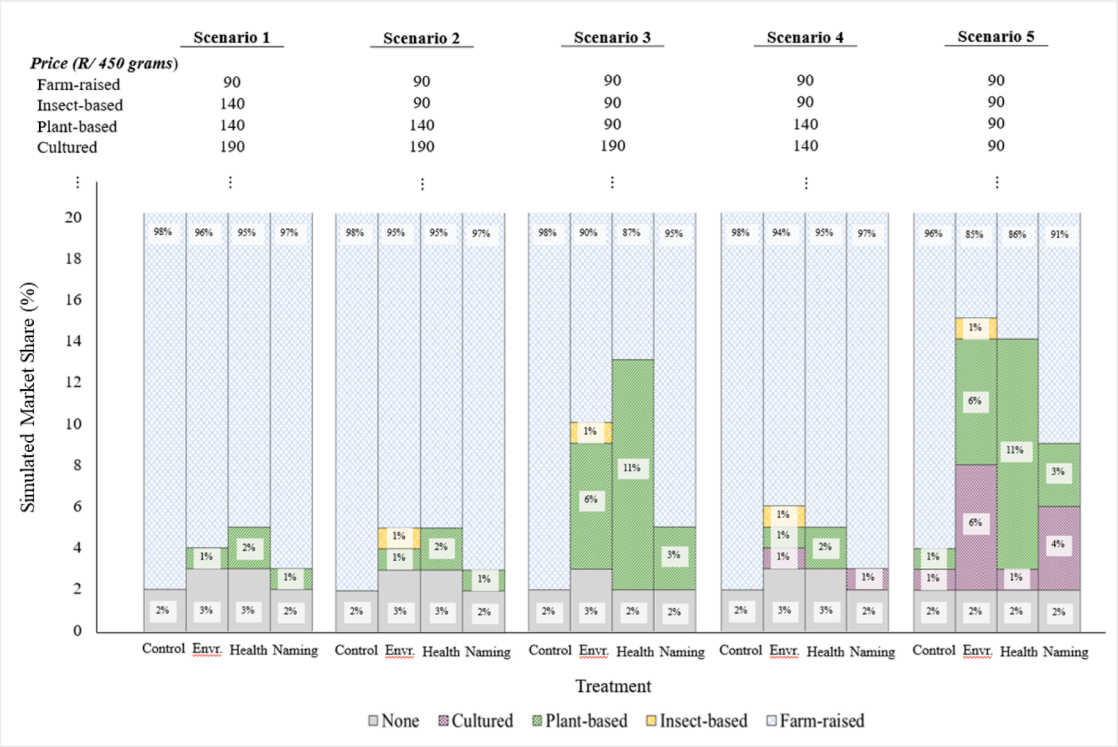

Fig. 2. Simulated market share by treatment under five price scenarios.

innovative, especially insect-based, food products (Chia et al., 2024; Heijnk et al., 2023; Lucas et al., 2025; Mosca et al., 2025; Siddiqui et al., 2022; Siegrist and Hartmann, 2020; Verbeke, 2015; Siegrist et al., 2013). While edible insects are part of traditional diets of specific cultures in rural areas of South Africa (AfricaLive Editor, 2020; Ntengento, 2022), many urban consumers from these cultures have changed to Western diets (Hlongwane et al., 2021). Also, many South Africans question the lack of food standards and safety regulations of these insects, mainly sold informally (Hlongwane et al., 2021), and view them as disease carriers (AfricaLive Editor, 2020), which may further explain consumer resistance. This highlights the need for marketers to address the sensory and cultural barriers to insect consumption in their strategies, and for policymakers to establish food safety standards for insect-based products.

Organizations have been criticized for not promoting insect consumption culture in South Africa, leading to an unfamiliarity with the benefits of edible insects (Hoek et al., 2011). Campaigns should address consumer resistance by gradually normalizing insect-based food by highlighting its benefits for nutrition, sustainability and food security (Conway et al., 2024; Lucas et al., 2025; Mosca et al., 2025). Modernizing insect products, as is done in Japan with cricket crackers and chocolate cricket bars (Numata, 2023), could further this goal. With South Africa hosting approximately 250 edible insect species (van Huis, 2003), commercialization could address food insecurity and promote acceptance through modernization. Consumer education, together with sensory exposure through tastings and bundling with familiar foods, could help to shift consumer demand for insect-based food options. Legislation can also contribute to the acceptance of insect-based meat by incorporating edible insects into the Meat Safety Act as an essential step in including edible insects in economic development strategies (Ntengento, 2022). Government policies can also help to shift demand through sustainability labeling, subsidies and even public procurement at, for example, hospitals and schools.

5.2. Demand based on environmental information

The provision of information, particularly regarding environmental benefits, plays a crucial role in shaping consumer preference for meat alternatives. In our sample, environmental information had a pronounced effect on increasing WTP for all alternative proteins, including insect-based meat products, demonstrating the effectiveness of environmental messaging in appealing to sustainability-conscious consumers. These findings are similar to those of Van Loo et al. (2020) and Tsvakirai et al. (2023), who found that environmental benefits are effective in increasing consumers' WTP for plant-based and cultured beef alternatives. The effect on insect-based meat specifically is supported by a study by Sogari et al. (2016), who reported that perceived environmental benefits are an important factor that motivates future consumption of insects. The highest WTP increase was for insect-based alternatives, suggesting that the demand for these products can be changed through environmental arguments. Marketers could create educational campaigns that emphasize environmental benefits such as

Table 5
Full sample regression results of the determinants of consumers' conditional WTP for farm-raised beef burger patties and alternatives.

	Farm-raised	Insect-based	Plant-based	Cultured
Treatments				
Environmental information (T1)	10.72	96.29***	39.84**	52.32***
	(17.61)	(19.15)	(18.82)	(17.39)
Health information (T2)	11.76	46.29**	52.72***	20.83
	(17.79)	(20.35)	(17.86)	(18.31)
Controls				
Socio-demographic	Yes	Yes	Yes	Yes
Dietary habit	Yes	Yes	Yes	Yes
Observations	765	765	765	765
R-squared	0.022	0.046	0.033	0.030

Note: 1. ***, **, * indicate statistical significance at 1 %, 5 % and 10 % levels, respectively. 2. Robust standard errors are in parentheses.

Table 6
Subsample regression results of the determinants of consumers' conditional WTP for beef burger patty alternatives.

	Insect-based		Plant-based		Cultured	
	Early adopters (1)	Non-early adopters (2)	Early adopters (1)	Non-early adopters (2)	Early adopters (1)	Non-early adopters (2)
Treatments						
Environ. info. (T1)	86.52	97.01***	60.78**	21.38	48.97	52.23***
	(55.28)	(19.22)	(29.52)	(23.71)	(34.01)	(19.64)
Health info. (T2)	13.17	57.78**	44.43*	54.47**	−1.98	29.98
	(53.63)	(22.69)	(26.85)	(24.91)	(34.79)	(21.87)
Controls						
Male	42.25	10.19	12.59	−7.54	−7.58	−14.33
	(51.47)	(19.36)	(23.68)	(24.80)	(29.10)	(20.33)
Age	−0.75	0.51	0.12	−0.83	−0.07	−0.04
	(1.63)	(0.88)	(1.07)	(0.89)	(1.42)	(0.73)
Household size	3.55	−1.07	−1.54	−2.37	−5.06	8.19
	(10.91)	(4.43)	(6.20)	(4.83)	(6.26)	(5.89)
University degree	125.16**	6.65	16.92	−22.83	−10.16	15.46
	(51.45)	(19.69)	(26.30)	(21.49)	(33.85)	(20.08)
Monthly income ZAR 15,001 to 40,000	−110.46	−5.26	−36.79	−8.89	−4.76	−55.14**
	(70.17)	(22.70)	(36.93)	(22.89)	(39.67)	(24.38)
Monthly income ZAR 40,001 to 61,000	5.22	32.93	−15.96	8.69	10.45	−62.84**
	(98.83)	(32.54)	(49.58)	(28.82)	(66.30)	(29.58)
Monthly income higher than ZAR 61,000	−77.20	30.22	−55.92	47.74	44.12	−42.80
	(86.90)	(41.12)	(42.55)	(51.31)	(50.88)	(39.39)
Race_black	−18.94	6.42	24.98	−28.62	−24.16	5.65
	(53.14)	(30.59)	(24.63)	(34.49)	(39.00)	(28.37)
Race_white	−85.51	−24.37	27.25	−41.88	6.32	13.84
	(70.39)	(25.96)	(30.17)	(30.39)	(48.98)	(23.47)
Urban	−112.04	33.07	11.21	−24.11	−27.05	−2.30
	(111.95)	(26.26)	(40.98)	(41.03)	(64.63)	(39.55)
Region_Cape	37.99	14.59	−15.87	−28.29	−45.24	−22.72
	(45.20)	(29.53)	(38.69)	(30.41)	(43.91)	(30.57)
Region_Gauteng	89.79*	−9.75	21.57	14.35	20.65	−13.63
	(51.18)	(26.88)	(41.23)	(30.59)	(46.95)	(28.26)
Region_KZN	122.96	−7.83	86.95*	−21.86	39.63	2.60
	(100.85)	(33.24)	(50.79)	(35.07)	(61.49)	(38.15)
Diet_full-time	−248.82	55.94*	1.43	−240.11	56.91	−59.77
	(157.89)	(31.94)	(37.50)	(210.31)	(70.88)	(74.02)
Diet_flex	−311.77*	118.28**	18.38	−219.47	84.71	−4.42
	(160.38)	(48.36)	(44.06)	(214.84)	(78.34)	(81.71)
Constant	295.10	−137.40*	99.23	501.57**	162.22	197.46*
	(236.19)	(79.07)	(72.87)	(231.25)	(125.77)	(108.56)
Observations	165	600	393	372	265	500
R-squared	0.172	0.056	0.050	0.075	0.048	0.044

Note: 1. ***, **, * indicates statistical significance at 1 %, 5 %, and 10 % level, respectively. 2. Robust standard errors are in parentheses. 3. The base group of each characteristic is as follows: for gender, the base group is female. For educational level, the base group is respondents without a university degree. For income, the base group is respondents with monthly income below ZAR15,000. For race, the base group is respondents who do not identify as either black or white. For area, the base group is rural area. For region, the base group is respondents living in Free State, Northwest, Mpumalanga, or Limpopo. For dietary habit, the base group is respondents who do not consume red meat.

protein content and sustainability, while addressing sensory and cultural barriers to insect consumption. In addition, social norming techniques can encourage shifts in behavior by convincing consumers that "most people choose sustainable food" or by using endorsements from environmental advocates (Higgs, 2015).

Environmental narratives also strongly appeal to plant-based and culture-meat alternatives, suggesting their importance in market expansion. Implementing pricing strategies (such as bundle pricing) or premium positioning (such as 'gourmet' plant-based meat) could help to shift demand. The high standard deviations for consumer preferences reported in this study decrease with environmental information, indicating that this can unify consumer perceptions. Marketers and policymakers can promote alternative proteins by leveraging environmental messaging to reduce the reliance on farm-raised meat. Partnerships with fast-food chains and restaurants could also introduce these products to increase exposure and drive demand. Given that South Africa is a water-scarce country, and that Africa's population is predicted to double in 30 years (Madubela, 2023), educating consumers on the sustainability of meat alternatives is essential. Educational initiatives about how dietary decisions affect the environment can improve the perceptions and acceptance of alternative meat products.

5.3. Demand based on health information

Unlike environmental messaging, which influenced all the meat alternatives, health framing appears to work best for plant-based alternatives, suggesting that consumers associate plant-based meat more with wellness than other meat alternatives. This aligns with another South African study indicating that health considerations are more important for adopting plant-based (Szejda et al., 2021), and that

general health interest does not affect consumers' willingness to consume insects (Lombardi et al., 2019). Our findings also concur with international studies showing that WTP for meat alternatives favors plant-based proteins, likely due to their familiarity and market availability (Bryant et al., 2019; Chia et al., 2024; Demartini et al., 2024; Gómez-Luciano et al., 2019; Heijnk et al., 2023; Hoek et al., 2011; Wang et al., 2024). To drive demand for plant-based meat alternatives, marketers could focus on the dietary benefits of plant protein as part of nutrition-focused campaigns. Given South Africa's negative health forecasts, plant-based diets can mitigate risks such as diabetes and cardiovascular disease (Garland and de Villiers, 2022). Highlighting the lower saturated fat, fewer calories, and dietary fiber of plant-based products in messaging could expand the market. Content creation on social media, packaging, point-of-sale, or educational events can enhance plant-based preferences by building trust in the health benefits of plant-related products. In contrast, consumers showed resistance towards insect-based meat despite health framing, potentially due to biases or health concerns. Health-focused messaging proved to be less effective for cultured meat, likely because of concerns regarding its safety and unnaturalness. Regulations and educational initiatives could address ambiguity regarding the health and safety of insect-based and cultured meat. There is currently limited public knowledge of cultured and insect-based meat alternatives due to the limited availability of insect-based meat and the fact that cultured meat is not yet commercialized in South Africa. Findings on the provision of environmental and health information highlight the need for differentiated communication strategies to address specific consumer concerns about meat alternatives.

5.4. Demand based on naming restrictions

Our findings on naming restrictions for meat alternatives reveal important effects. While average WTP values for farm-raised beef and the alternatives did not shift significantly, the distributions of WTP suggest that naming restrictions can influence consumer perceptions. These findings are in line with other studies showing that product naming can influence consumer perceptions of meat alternatives (Bryant and Barnett, 2019; De Muth et al., 2023; Kunst and Hohle, 2016; Sucapane et al., 2021). Restricting the use of meaty terms like "burger" for alternative proteins may lower WTP for traditional beef products while enhancing consumer acceptance of alternatives, offering a low-cost intervention to shift market dynamics. The findings signal that farm-raised beef marketers should no longer assume that offering 'traditional meat' is sufficient to keep a demand but should consider highlighting other attributes such as quality of origin, authenticity and/or flavor as part of their offering. Meat alternative marketers do not have to focus on meaty terms to maintain appeal, but could emphasize attributes such as "clean protein" or "next generation meat".

For insect-based meat, naming restrictions may reduce negative associations for some, but may not universally enhance appeal. Marketers may need to segment the market for insect-based meat and customize messaging according to taste or safety for more adventurous or environmentally conscious consumers. The restricted use of meaty names appears to be particularly beneficial for plant-based and cultured meat. Here, product positioning can capitalize on the unique qualities of these meat alternatives to make them more appealing using names that highlight, for example, naturalness, innovation, or plant-forward values. Perhaps marketers should consider naming alternatives, such as plant proteins, veggie cutlets, or protein patties, to position plant-based meat alternatives as complementary rather than competitive with meat. This complementary positioning strategy can target consumers seeking a variety of protein sources, without increasing the resistance of traditional meat consumers.

The heterogeneous impact of naming restrictions uncovered in this study suggests that the key to managing demand shifts lies in understanding how different segments respond and leveraging those insights to optimize marketing, pricing, and policy strategies. Overall, the findings indicate that naming policies could shape consumer demand in ways that extend beyond simple price or product comparisons, emphasizing the importance of clear and accurate naming (labeling) for both regulatory bodies and marketers. The key takeaway is that naming effects are not uniform, opening segmentation opportunities for meat alternatives to shift demand in favor of sustainable food choices.

5.5. Market share simulations and demand

Market share simulations propose that farm-raised beef will probably continue to dominate the South African urban shopper market, even under favorable price and information conditions for alternatives. Even though the scenarios are exploratory and do not predict actual population behavior, they do help to identify strategies for shifting demand based on pricing dynamics. Under the baseline prices (Scenario 1), the urban shopper market shows strong loyalty to farm-raised meat. Thus, without price reductions, cultured and insect-based proteins will likely remain niche products rather than mainstream competitors to farm-raised beef. In contrast, broad price reductions for alternatives (Scenario 5) may significantly disrupt farm-raised dominance, which can lead to a reduction in market share from 98 % to 85 % in the presence of environmental information. This scenario is the most favorable for market expansion of alternative proteins, as price barriers are removed. The results also suggest that health and environmental information are effective at increasing consumers' WTP for meat alternatives. For example, when health information is present, market share shows a shift to plant-based (11 % market share) and cultured products (6 % share) over insect-based options (1 % share). Combined with messaging about health and/or environmental benefits, price reductions seem to be a powerful driver of substitution, suggesting that aggressive discounts for plant-based and cultured meat can drive market penetration.

The urban food shoppers in this sample show that barriers to insect-based products, such as familiarity and safety concerns, remain critical in unlocking their potential. To increase familiarity, marketers can consider mixing insect protein with traditional meat to serve as an intermediary step to shift demand. Another option to increase demand for insect-based alternatives with specific consumer segments, such as sustainability-conscious consumers, is to market insect-based alternatives as a high-performance, eco-friendly option. When respondents were asked if they had heard or read about each alternative before taking the survey, about 70 % reported 'yes' and understood the meaning of plant-based alternatives, but less than half of the respondents reported the same for insect-based and cultured alternatives. Since various edible insect species are available as a natural resource in South Africa, educational campaigns and innovative product formats could help mitigate these concerns and stimulate acceptance. In summary, the findings showed that price is a critical factor in consumer adoption of alternative proteins, but it is not the only determinant, and that demand shifts require a combination of affordability, consumer perception management, and regulatory support.

6. Conclusion, limitations, and future research

The consumers surveyed in this study, while geographically diverse, do not fully represent the South African population. Our sample primarily includes urban food consumers with internet access, which aligns with the demographic of shoppers of meat alternatives and is our target population. Future research employing random sampling techniques is recommended to assess the broader applicability of these findings. In addition, the types of plants and insect species were not specified in this study because our key contribution is the inclusion of insect-based alternatives in general. While some studies have explored consumers' preferences for different plant-based options (e.g., Tsvakirai et al., 2023; Van Loo et al., 2020), future research can also explore the acceptance of various insect species, as acceptance levels may differ. To strengthen the population-level relevance of our findings, studies employing random sampling techniques are needed. This is particularly important given that willingness-to-pay and simulated market shares estimated in this study are descriptive of our sample and should not be interpreted as being nationally representative or the wider urban population.

Although our results indicated a preference for plant-based and cultured meat, sensory evaluations will be important to conduct to confirm actual acceptance. Organoleptic tests could assess if the aversion to insect-based meat decreases when insects are less visible in processed form. This study focused on how environmental, health, and price information influenced meat consumption, but other factors, such as product type or brand familiarity, might also affect consumer preferences. As consumer acceptance is influenced by product nomenclature, further studies should explore suitable commercial descriptions for cultured meat and how naming options could impact consumer acceptance as highlighted by Asioli et al. (2022). Given the varied price preferences between naming restriction and control groups in this study, additional research should investigate factors explaining these differences, such as product knowledge or lifestyle. While we do not advocate for or against a specific regulatory approach, our results underscore the importance of evidence-based naming policies that balance clarity with market innovation. Naming restrictions can influence consumer preferences in varied ways, and these insights can help inform how alternative proteins are positioned by marketers and evaluated by policymakers.

In conclusion, the future success of alternative proteins in South Africa will depend on a combination of rigorous food safety standards and regulations, effective information campaigns, favorable pricing strategies, and transparent regulatory frameworks in product naming or labeling. While plant-based and cultured meats are poised for growth, the adoption of insect-based alternatives will require greater effort to familiarize consumers with their benefits and address the current barriers to acceptance. An important consideration is whether meat alternatives can be manufactured at a cost equal to or less than that of conventional farm-raised beef, while also matching its flavor and consistency. The ability to achieve comparable pricing and sensory qualities will be a key factor in the success of alternative meat products. Further research is necessary to explore how different consumer segments respond to these promotional strategies, and how market dynamics evolve as alternative proteins become more prevalent in the South African food system.

Ethical statement

This study received ethical review clearance from Michigan State University and was approved by MSU's IRB. *MSU Study ID: STUDY00010533.*

CRediT authorship contribution statement

Rejoice Tobias-Mamina: Writing – original draft, Methodology, Conceptualization. **Yolanda Jordaan:** Writing – original draft, Supervision, Methodology, Conceptualization. **Lin Lin:** Methodology, Formal analysis, Writing – original draft, Visualization, Investigation. **David L. Ortega:** Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization.

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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Appendix A. Dietary question

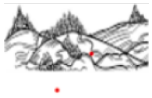
For dietary habit, respondents were asked "which of the following most closely resembles the diet that you regularly adopt?" and could choose from one of the following nine options adapted from De Backer and Hudders (2015):

(1). Full-time meat eater (eat red meat, fish, and chicken)
(2). Flexitarian (reduce meat intake, but eat meat now and then)
(3). Pollotarian (eat no red meat, but eat fish, chicken, and other poultry)
(4). Pescotarian (eat no red meat and chicken, but eat fish and shellfish)
(5). Macrobiotic consumer (eat unprocessed, organic, and locally grown foods, with a great overlap with foods consumed in a vegetarian diet, yet also include certain kinds of meat)
(6). Lacto-ovo vegetarian (eat no meat or fish, but eat eggs and dairy produce)
(7). Lacto-vegetarian (eat no meat, fish, or eggs, but eat dairy produce)
(8). Ovo-vegetarian (eat no meat, fish, or dairy produce, but eat eggs)
(9). Vegan (eat no meat and using no products of animal origin)

Appendix B. Environmental and health benefit information

Environmental Information

Insect-based, plant-based, and cultured meat alternatives can be more environmentally friendly. These alternatives use less water, land, and energy. Their production emits less greenhouse emissions, which are known to contribute to climate change. The table below shows the estimated reductions in environmental impact of each of the three alternative products compared to conventional meat.

	Plant-based	Cultured beef	Insect-based
Water 	99 % less	96 % less	80 % less
Land 	93 % less	99 % less	96 % less
Energy 	46 % less	45 % less	71 % less
Green House Gass emission 	90 % less	96 % less	85 % less

Health Information

Insect-based, plant-based, and cultured meat alternatives can be better for human health and reduce diet-related health problems. They can be created to have lower saturated fats and they also have more nutrients such as iron, and calcium. The table below shows the estimated health benefits of the three alternative products compared to conventional meat.

	Saturated fats	Calcium	Iron
Insect-based	Less saturated fats	More calcium	More iron
Plant-based	Less saturated fats	More calcium	More iron
Cultured-beef	Less saturated fats	More calcium	More iron

Note: While the source of information was not disclosed to participants, the information provided in the tables is rigorously supported by peer-reviewed studies. Previous studies have demonstrated that meat alternatives, including plant-based, insect-based and emerging cultured beef products are more environmentally friendly (e.g., Heller and Keoleian 2018; Liceaga, 2022; Oonincx and de Boer, 2012; Tuomisto and Teixeira de Mattos, 2011). These meat alternatives also surpass conventional beef in critical nutrients like iron, calcium and saturated fat (e.g., Heller and Keoleian 2018; Latunde-Dada, 2023; Liceaga, 2022; Lim et al., 2025; Mwangi et al., 2018; Payne et al., 2016; Rubio et al., 2020; Sirimungkararat et al., 2010; Swing et al., 2021; Van Loo et al., 2020). This information was synthesized and simplified into the table format to make it more accessible to respondents.

Appendix C. Choice experiment procedure

In the choice experiment, participants were first presented with an introduction to the experiment that included descriptions of the different product types:

"In the next section, we will present you with 12 shopping scenarios. In each of these scenarios (displayed on individual pages), we will ask you to choose between four types of burger patties that differ with respect to production method and price level. You can also select a no-buy option. For each question, we want to know which burger patties (if any) you would be most likely to buy. The types of burger patties presented are: a farm-raised beef burger patty; insect-based burger patty; plant-based burger patty; cultured beef burger patty. Please see the descriptions of these products and labels in the table below. All other characteristics of the burger patties that are not reported in the choice questions are similar across the products (taste, variety, etc.). The options are all the same quantity (450 g)."

Product	Description
Farm-raised beef	Farm-raised beef is regular beef that is produced from livestock.
Insect-based meat alternatives	Insect-based meat alternatives are meat substitutes made from proteins derived from edible insect species that are designed to look like, taste like, and cook like meat
Plant-based meat alternatives	Plant-based meat alternatives are meat substitutes made from edible plants that are designed to look like, taste like, and cook like meat
Cultured-beef	Cultured-beef is real meat produced in the laboratorty, outside of a living animal. Animal stem cells are cultured in a medium with nutrients and energy sources necessary for cell division and differentiation into muscle cells that create tissue to make meat that looks like, tastes like, and cook like meat

Following the introduction, participants in the environmental or health information treatment group would receive their respective information

treatment. Next, participants were presented with a cheap talk script that cautioned them against the tendency to exaggerate their willingness to pay and were instructed to make their decisions as they would in an actual shopping scenario. The cheap talk script provided in our survey is as follows:

"In similar surveys, researchers have found that individuals often state a higher willingness to pay than what they actually are willing to pay for the product. For instance, a recent study asked people whether they would buy a new food product similar to the one you are about to be asked about. This purchase was hypothetical (as it will be for you) in that no one actually had to pay money when they indicated a willingness to purchase. In this study, the majority of people said they would buy the new product, but in reality, when the product was available at a store and they had to pay for it, only a few people actually bought it. This difference is what we refer to as hypothetical bias. In the next few questions, it is important that you make each of your product selections like you would if you were actually facing these exact choices in a store. For example, buying a particular product means you would have less money available for other purchases. Please treat each question as an independent purchase, and please answer as honestly as possible and in a manner that reflects how you actually shop."

After the cheap talk script, participants moved on to the twelve choice tasks, with each choice task displayed on an individual page, and each participant answering all 12 choice tasks. Participants in the environmental and health information treatment groups were reminded of the benefits of meat alternatives. Specifically, participants in the environmental treatment group were asked: "Insect-based, plant-based, and cultured beef alternatives can be more environmentally friendly. These alternatives use less water, land, and energy. Their production emits less greenhouse emissions, which are known to contribute to climate change. Which burger option would you buy?" Participants in the health information treatment group were asked "Insect-based, plant-based, and cultured beef alternatives can be better for human health and reduce diet-related health problems. They can be created to have lower saturated fats and they also have more nutrients such as iron, and calcium. Which burger option would you buy?" Finally, participants in the control group and the naming restriction group were simply asked "Which product option would you buy?"

Below the question, participants would choose from one of the four products or the no-buy option, as presented in Fig. 1. While the product alternatives were the same throughout the twelve choice tasks, their price levels differed in each choice task. The different price levels were generated based on an orthogonal main effect design, with the full list of price levels displayed below.

	Product alternatives			
Choice task	Farm-raised	Insect-based	Plant-based	Cultured
1	190	190	190	190
2	90	90	40	40
3	190	40	140	90
4	140	190	90	40
5	190	140	40	140
6	40	140	40	190
7	140	90	140	140
8	90	140	190	40
9	40	40	190	140
10	140	40	90	90
11	40	190	140	90
12	90	90	90	190

Note: The price unit is ZAR/ 450 g.

Data availability

Data will be made available on request.

References

AfricaLive Editor, 2020. Putting Edible Insects on the Menu. Africalive.Net, 28 September. https://africalive.net/article/putting-edible-insects-on-the-menu/ (Accessed 18 March 2025).

Agricultural Product Standards, 2022. Illicit use of Product Names with Respect to Names Exclusively Prescribed for Processed Meat Products. Department of Agriculture, Land Reform and Rural Development, South Africa. https://biz-file.com/f/2206/Communique_to_the_stakeholders_of_meat_analogues_-_22__June2022.pdf.

Ardoin, R., Prinyawiwatkul, W., 2021. Consumer perceptions of insect consumption: a review of Western research since 2015. Int. J. Food Sci. Technol. 56 (10), 4942–4958. https://doi.org/10.1111/ijfs.15167.

Asem-Hiablie, S., Battagliese, T., Stackhouse-Lawson, K.R., Rotz, C.A., 2019. A life cycle assessment of the environmental impacts of a beef system in the USA. Int. J. Life Cycle Assess. 24, 441–455. https://doi.org/10.1007/s11367-018-1464-6.

Asioli, D., Bazzani, C., Nayga Jr, R.M., 2022. Are consumers willing to pay for in-vitro meat? An investigation of naming effects. J. Agric. Econ. 73 (2), 356–375. https://doi.org/10.1111/1477-9552.12467.

Bhat, C.R., 2003. Simulation estimation of mixed discrete choice models using randomized and scrambled Halton sequences. Transp. Res. B 37 (9), 837–855. https://doi.org/10.1016/S0191-2615(02)00090-5.

Bloomberg, 2021. Plant-Based Food Market to Hit $162 Billion in Next Decade. https://www.bloomberg.com/company/press/plant-based-foods-market-to-hit-162-billion-in-next-decade-projects-bloomberg-intelligence/# (Accessed 27 November 2024).

Bloomberg, 2022. Lab-grown wildebeest on the menu in South Africa. BusinessTech, 23 July. https://businesstech.co.za/news/trending/609990/lab-grown-wildebeest-on-the-menu-in-south-africa/ (Accessed 27 November 2024).

Botelho, A., Pinto, L.C., 2002. Hypothetical, real, and predicted real willingness to pay in open-ended surveys: experimental results. Appl. Econ. Lett. 9 (15), 993–996. https://doi.org/10.1080/13504850210148143.

Brouwer, R., Spaninks, F.A., 1999. The validity of environmental benefits transfer: further empirical testing. Environ. Resour. Econ. 14, 95–117. https://doi.org/10.1023/A:1008377604893.

Bryant, C.J., 2019. We can't keep meating like this: attitudes towards vegetarian and vegan diets in the United Kingdom. Sustainability 23 (11), 6844. https://doi.org/10.3390/su11236844.

Bryant, C.J., Barnett, J.C., 2018. Consumer acceptance of cultured meat: a systematic review. Meat Sci. 143, 8–17. https://doi.org/10.1016/j.meatsci.2018.04.008.

Bryant, C.J., Barnett, J.C., 2019. What's in a name? Consumer perceptions of in vitro meat under different names. Appetite 137, 104–113. https://doi.org/10.1016/j.appet.2019.02.021.

Bryant, C., Szejda, K., Parekh, N., Desphande, V., Tse, B., 2019. A survey of consumer perceptions of plant-based and clean meat in the USA, India, and China. Front. Sustain. Food Syst. 3 (11). https://doi.org/10.3389/fsufs.2019.00011.

Bureau for Food and Agricultural Policy, 2020. The South African Agricultural Baseline, BFAP Baseline Agricultural Outlook 2019-2028. https://www.bfap.co.za/wp-content/uploads/2020/04/Final-Baseline-2019.pdf (Accessed 28 November 2024).

Chia, A., Shou, Y., Wong, N.M.Y., Cameron-Smith, D., Sim, X., Van Dam, R.M., Chong, M. F.F., 2024. Complexity of consumer acceptance to alternative protein foods in a multiethnic Asian population: a comparison of plant-based meat alternatives, cultured meat, and insect-based products. Food Qual. Prefer. 114, 105102. https://doi.org/10.1016/j.foodqual.2024.105102.

Chriki, S., Hocquette, J.F., 2020. The myth of cultured meat: a review. Front. Nutr. 7. https://doi.org/10.3389/fnut.2020.00007.

Conway, A., Jaiswal, S., Jaiswal, A.K., 2024. The potential of edible insects as a safe, palatable, and sustainable food source in the European Union. Foods 13 (3), 387. https://doi.org/10.3390/foods13030387.

Cummings, R.G., Taylor, L.O., 1999. Unbiased value estimates for environmental goods: a cheap talk design for the contingent valuation method. Am. Econ. Rev. 89 (3), 649–665. http://www.jstor.org/stable/117038.

De Backer, C.J., Hudders, L., 2015. Meat morals: relationship between meat consumption consumer attitudes towards human and animal welfare and moral behavior. Meat Sci. 99, 68–74. https://doi.org/10.1016/j.meatsci.2014.08.011.

De Boer, J., Aiking, H., 2021. Exploring food consumers' motivations to fight both climate change and biodiversity loss: combining insights from behavior theory and eurobarometer data. Food Qual. Prefer. 94, 104304. https://doi.org/10.1016/j.foodqual.2021.104304.

Delport, M., Louw, M., Davids, T., Vermeulen, H., Meyer, F., 2017. Evaluating the demand for meat in South Africa: an econometric estimation of short term demand elasticities. Agrekon 56 (1), 13–27.

Demartini, E., Marescotti, M.E., Amato, M., Corradini, A., Verneau, F., Gaviglio, A., 2024. Acceptance of alternative meats among different dietarian styles: an explorative analysis in Italy. Food Qual. Prefer. 113, 105060. https://doi.org/10.1016/j.foodqual.2023.105060.

DeMuth, B., Malone, T., McFadden, B.R., Wolf, C.A., 2023. Choice effects associated with banning the word "meat" on alternative protein labels. Appl. Econ. Perspect. Policy 45 (1), 128–144. https://doi.org/10.1002/aepp.13070.

Directorate Statistics and Economic Analysis, 2023. South African Abstract of Agricultural Statistics. Department of Agriculture, Land Reform & Rural Development, South Africa. https://old.dalrrd.gov.za/Portals/0/Statistics%20and%20Economic%20Analysis/Statistical%20Information/Abstract%202023.pdf (Accessed 28 November 2024).

Faber, I., Castellanos-Feijoó, N.A., Van de Sompel, L., Davydova, A., Perez-Cueto, F.J., 2020. Attitudes and knowledge towards plant-based diets of young adults across four European countries. Exploratory survey. Appetite 145, 104498. https://doi.org/10.1016/j.appet.2019.104498.

Fischer, C.G., Garnett, T., 2016. Plates, Pyramids, Planet. Developments in National Healthy and Sustainable Dietary Guidelines: A State of Play Assessment. https://openknowledge.fao.org/server/api/core/bitstreams/4986aec2-a354-4497-8afc-94b562a53e53/content. (Accessed 12 November 2024).

Flint, M., Bowles, S., Lynn, A., Paxman, J.R., 2023. Novel plant-based meat alternatives: future opportunities and health considerations. Proc. Nutr. Soc. 82 (3), 370–385. https://doi.org/10.1017/S0029665123000034.

Friedrich, B., 2019. Clean Meat's Advantages Over Conventional Meat Are Many and Will Grow Over Time. Good Food Institute. https://gfi.org/blog/2019-02-19 (Accessed 11 November 2024).

Garland, M., de Villiers, A., 2022. Can Plant-Based Diets Make South Africa Healthier? News24. https://www.news24.com/life/wellness/diet/can-plant-based-diets-make-south-africa-healthier-20221013-2 (Accessed 28 November 2024).

Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkma, J., Falcucci, A., Tempio, G., 2013. Tackling Climate Change Through livestock: A global Assessment of Emissions and Mitigation Opportunities. Food and Agriculture Organization of the United Nations (FAO), Rome. https://www.fao.org/4/i3437e/i3437e.pdf (Accessed 11 November 2024).

Godfray, H.C.J., Aveyard, P., Garnett, T., Hall, J.W., Key, T.J., Lorimer, J., Pierrehumbert, R.T., Scarborough, P., Springmann, M., Jebb, S.A., 2018. Meat consumption, health, and the environment. Science 361, 6399. https://doi.org/10.1126/science:aam5324.

Gómez-Luciano, C.A., de Aguiar, L.K., Vriesekoop, F., Urbano, B., 2019. Consumers' willingness to purchase three alternatives to meat proteins in the United Kingdom, Spain, Brazil and the Dominican Republic. Food Qual. Prefer. 78, 103732. https://doi.org/10.1016/j.foodqual.2019.103732.

Grasso, A.C., Hung, Y., Olthof, M.R., Verbeke, W., Brouwer, I.A., 2019. Older consumers' readiness to accept alternative, more sustainable protein sources in the European Union. Nutrients 11 (8), 1904. https://doi.org/10.3390/nu11081904.

Grobler, S., 2023. Food that never mooed – the cultivated meat revolution. Food Thought. https://www.foodformzansi.co.za/food-that-never-mooed-the-cultivated-meat-revolution/ (Accessed 11 November 2024).

Harnack, L., Mork, S., Valluri, S., Weber, C., Schmitz, K., Stevenson, J., Pettit, J., 2021. Nutrient composition of a selection of plant-based ground beef alternative products available in the United States. J. Acad. Nutr. Diet. 121 (12), 2401–2408. https://doi.org/10.1016/j.jand.2021.05.002.

Hartmann, C., Shi, J., Giusto, A., Siegrist, M., 2015. The psychology of eating insects: a cross-cultural comparison between Germany and China. Food Qual. Prefer. 44, 148–156. https://doi.org/10.1016/j.foodqual.2015.04.013.

Heijnk, V., Espey, A., Schuenemann, F., 2023. A comparison of influencing factors on attitudes towards plant-based, insect-based and cultured meat alternatives in Germany. Food Qual. Prefer. 110, 104966. https://doi.org/10.1016/j.foodqual.2023.104966.

Heller, M.C., Keoleian, G.A., 2018. Beyond Meat's Beyond Burger Life Cycle Assessment: A Detailed Comparison Between a Plant-Based and an Animal-Based Protein Source. University of Michigan, Ann Arbor, pp. 1–38. CSS Report. https://hdl.handle.net/2027.42/192044.

Higgs, S., 2015. Social norms and their influence on eating behaviours. Appetite 86, 38–44. https://doi.org/10.1016/j.appet.2014.10.021.

Hlongwane, Z.T., Slotow, R., Munyai, T.C., 2021. Indigenous knowledge about consumption of edible insects in South Africa. Insects 12 (1), 22. https://doi.org/10.3390/insects12010022.

Hocquette, A., Lambert, C., Sinquin, C., Peterolff, L., Wagner, Z., Bonny, S.P., Hocquette, J.F., 2015. Educated consumers don't believe artificial meat is the solution to the problems with the meat industry. J. Integr. Agric. 14 (2), 273–284. https://doi.org/10.1016/S2095-3119(14)60886-8.

Hoek, A.C., Luning, P.A., Weijzen, P., Engels, W., Kok, F.J., De Graaf, C., 2011. Replacement of meat by meat substitutes. A survey on person- and product-related factors in consumer acceptance. Appetite 56 (3), 662–673. https://doi.org/10.1016/j.appet.2011.02.001.

Hole, A.R., 2007. A comparison of approaches to estimating confidence intervals for willingness to pay measures. Health Econ 16 (8), 827–840. https://doi.org/10.1002/hec.1197.

Hu, F.B., Otis, B.O., McCarthy, G., 2019. Can plant-based meat alternatives be part of a healthy and sustainable diet? JAMA 322 (16), 1547–1548. https://doi.org/10.1001/jama.2019.13187.

Imathiu, S., 2020. Benefits and food safety concerns associated with consumption of edible insects. NFS J. 18, 1–11. https://doi.org/10.1016/j.nfs.2019.11.002.

Ingredients Network, 2024. Top EU Court Rules that Using 'Meaty' Names for Plant-Based Products is Lawful. Ingredients network.Com. ://www.ingredientsnetwork.com/top-eu-court-rules-that-using-meaty-names-for-news125663.html (Accessed 7 May 2025).

Kennedy, J., Alexander, P., Taillie, L.S., Jaacks, L.M., 2024. Estimated effects of reductions in processed meat consumption and unprocessed red meat consumption on occurrences of type 2 diabetes, cardiovascular disease, colorectal cancer, and mortality in the USA: a microsimulation study. Lancet Planet. Health 8 (7), e441–e451. https://doi.org/10.1016/S2542-5196(24)00118-9.

Kornher, L., Schellhorn, M., Vetter, S., 2019. Disgusting or innovative-consumer willingness to pay for insect-based burger patties in Germany. Sustainability 11 (7), 1878. https://doi.org/10.3390/su11071878.

Krinsky, I., Robb, A.L., 1986. On approximating the statistical properties of elasticities. Rev. Econ. Stat. 68 (4), 715–719. https://doi.org/10.2307/1924536.

Kunst, J.R., Hohle, S.M., 2016. Meat eaters by dissociation: how we present, prepare and talk about meat increases willingness to eat meat by reducing empathy and disgust. Appetite 105, 758–774. https://doi.org/10.1016/j.appet.2016.07.009.

Lancaster, K.J., 1966. A new approach to consumer theory. J. Polit. Econ. 74 (2), 132–157. https://www.jstor.org/stable/1828835.

Latunde-Dada, G.O., Kajarabille, N., Rose, S., Arafsha, S.M., Kose, T., Aslam, M.F., Hall, W.L., Sharp, P.A., 2023. Content and availability of minerals in plant-based burgers compared with a meat burger. Nutrients 15 (12), 2732. https://doi.org/10.3390/nu15122732.

Liceaga, A.M., 2022. Edible insects, a valuable protein source from ancient to modern times. Adv. Food Nutr. Res. 101, 129–152. https://doi.org/10.1016/bs.afnr.2022.04.002.

Lim, P.Y., Suntornnond, R., Choudhury, D., 2025. The nutritional paradigm of cultivated meat: bridging science and sustainability. Trends Food Sci. Technol. 156, 104838. https://doi.org/10.1016/j.tifs.2024.104838.

Lombardi, A., Vecchio, R., Borrello, M., Caracciolo, F., Cembalo, L., 2019. Willingness to pay for insect-based food: the role of information and carrier. Food Qual. Prefer. 72, 177–187. https://doi.org/10.1016/j.foodqual.2018.10.001.

Lucas, B.F., da Cunha, D.T., Luce, J.-B., Brunner, T.A., 2025. Factors influencing insect burger choice in a real-life setting: a study in university restaurants in Switzerland. Future Foods 11, 100602. https://doi.org/10.1016/j.fufo.2025.100602.

Madubela, A., 2023. 24 months, you will be able to buy lab-grown meat. Mail Guardian, 20 February. https://mg.co.za/business/2023-02-20-in-24-months-you-will-be-able-to-buy-lab-grown-meat/ (Accessed 6 May 2025).

Magano, N.N., Tuorila, H., De Kock, H.L., 2023. Food choice drivers at varying income levels in an emerging economy. Appetite 189, 107001. https://doi.org/10.1016/j.appet.2023.107001.

Makhado, R., Potgieter, M., Timberlake, J., Gumbo, D., 2014. A review of the significance of mopane products to rural people's livelihoods in Southern Africa. Trans. R. Soc. S. Afr. 69, 117–122. https://doi.org/10.1080/0035919X.2014.922512.

Mancini, M.C., Antonioli, F., 2022. Italian consumers standing at the crossroads of alternative protein sources: cultivated meat, insect-based and novel plant-based foods. Meat Sci 193, 108942. https://doi.org/10.1016/j.meatsci.2022.108942.

Mancini, S., Sogari, G., Menozzi, D., Nuvoloni, R., Torracca, B., Moruzzo, R., Paci, G., 2019. Factors predicting the intention of eating an insect-based product. Foods 8, 270. https://doi.org/10.3390/foods8070270.

Matthews, Y., Scarpa, R., Marsh, D., 2017. Stability of willingness-to-pay for coastal management: a choice experiment across three time periods. Ecol. Econ. 138, 64–73. https://doi.org/10.1016/j.ecolecon.2017.03.031.

McFadden, D., 1973. Conditional logit analysis of qualitative choice behavior. Front. Economet. Academic Press, New York, pp. 105–142.

Melios, S., Gkatzionis, K., Liu, J., Ellies-Oury, M.-P., Chriki, S., Hocquette, J.-F., 2025. Potential cultured meat consumers in Greece: attitudes, motives, and attributes shaping perceptions. Future Foods 11, 100538. https://doi.org/10.1016/j.fufo.2025.100538.

Milford, A.B., Le Mouël, C., Bodirsky, B.L., Rolinski, S., 2019. Drivers of meat consumption. Appetite 141, 104313. https://doi.org/10.1016/j.appet.2019.06.005.

Moonaisur, M., Marx-Pienaar, N., de Kock, H.L., 2023. Plant-based meat alternatives in South Africa: an analysis of products on supermarket shelves. Food Sci. Nutr. 12 (1), 627–637. https://doi.org/10.1002/fsn3.3765.

Mosca, O., Merlino, V.M., Fornara, F., Passaro, R.L., Roma, R., Bonerba, E., Schiavone, A., Brun, F., Tarantola, M., 2025. Forging a sustainable agricultural future: tradition and innovation in shaping acceptance of insect-based foods. Future Foods 11, 100516. https://doi.org/10.1016/j.fufo.2024.100516.

Mwangi, M.N., Oonincx, D.G.A.B., Stouten, T., Veenenbos, M., Melse-Boonstra, A., Dicke, M., van Loon, J.J.A., 2018. Insects as sources of iron and zinc in human nutrition. Nutr. Res. Rev. 31 (2), 248–255. https://doi.org/10.1017/S0954422418000094.

Ntengento, W., 2022. Growth Expected in Edible Insect and Mopane Worms Sector. Rédaction Africanews. https://www.africanews.com/2022/01/18/sa-growth-expected-in-edible-insect-and-mopane-worms-sector// (Accessed 6 May 2025).

Numata, T., 2023. Japan's insect-eating tradition gets a modern makeover. Zenbird. https://zenbird.media/japans-insect-eating-tradition-gets-a-modern-makeover/ (Accessed 7 May 2025).
OECD/FAO, 2021. Agricultural Outlook 2021-2030. OECD Publishing, Paris. https://doi.org/10.1787/19428846-en.
OECD/FAO, 2020. OECD-FAO Agricultural Outlook 2020-2029. OECD Publishing, Paris/FAO, Rome. https://doi.org/10.1787/1112c23b-en.
Onwezen, M.C., Bouwman, E.P., Reinders, M.J., Dagevos, H., 2021. A systematic review on consumer acceptance of alternative proteins: pulses, algae, insects, plant-based meat alternatives, and cultured meat. Appetite 159, 105058. https://doi.org/10.1016/j.appet.2020.105058.
Oonincx, D.G.A.B., De Boer, I.J.M., 2012. Environmental impact of the production of mealworms as a protein source for humans – A life cycle assessment. PloS One 7 (12), e51145. https://doi.org/10.1371/journal.pone.0051145.
Ortega, D.L., Sun, J., Lin, W., 2022. Identity labels as an instrument to reduce meat demand and encourage consumption of plant based and cultured meat alternatives in China. Food Policy 111, 102307. https://doi.org/10.1016/j.foodpol.2022.102307.
Parlasca, M.C., Qaim, M., 2022. Meat consumption and sustainability. Annu. Rev. Resour. Econ. 14, 17–41. https://doi.org/10.1146/annurev-resource-111820-032340.
Payne, C.L., Scarborough, P., Rayner, M., Nonaka, K., 2016. Are edible insects more or less 'healthy' than commonly consumed meats? A comparison using two nutrient profiling models developed to combat over- and undernutrition. Eur. J. Clin. Nutr. 70 (3), 285–291. https://doi.org/10.1038/ejcn.2015.149.
Pohjolainen, P., Vinnari, M., Jokinen, P., 2015. Consumers' perceived barriers to following a plant-based diet. Br. Food J. 117, 1150–1167. https://doi.org/10.1108/BFJ-09-2013-0252.
Post, J.M., 2012. Cultured meat from stem cells: challenges and prospects. Meat Scie 91, 297–301. https://doi.org/10.1016/j.meatsci.2012.04.008.
Racz, E., 2024. South Africa court overturns government ban on plant-based meat terms. JustFood, 16 April. https://www.just-food.com/news/south-africa-plant-based-meat-can-use-meaty-names-again/?cf-view.
Ratnasiri, S., Bandara, J., 2017. Changing patterns of meat consumption and greenhouse gas emissions in Australia: will kangaroo meat make a difference? PLoS One 12 (2), e0170130. https://doi.org/10.1371/journal.pone.0170130.
Reuters, 2022. In meat-loving South Africa, climate concerns whet appetite for veggie burgers. Engineering News. https://www.engineeringnews.co.za/article/in-meat-loving-south-africa-climate-concerns-whet-appetite-for-veggie-burgers-2022-11-03 (Accessed 26 November 2024).
Rubio, N.R., Xiang, N., Kaplan, D.L., 2020. Plant-based and cell-based approaches to meat production. Nat. Commun. 11 (1), 1–11. https://doi.org/10.1038/s41467-020-20061-y.
Santo, R., Kim, B., Goldman, S.E., Dutkiewicz, J., Biehl, E., Bloem, M.W., Neff, R.A., Nachman, K.E., 2020. Considering plant-based meat substitutes and cell-based meats: a public health and food systems perspective. Front. Sustain. Food Syst. 4. https://doi.org/10.3389/fsufs.2020.00134.
Schonfeldt, H., Pretorius, B., Hall, N., 2013. Fish, chicken, lean meat and eggs can be eaten daily: a food-based dietary guideline for South Africa. S. Afr. J. Clin. Nutr. 26, S66–S76. http://sajcn.co.za/index.php/SAJCN/article/view/747.
Siddiqui, S.A., Khan, S., Farooqi, M.Q.U., Singh, P., Fernando, I., Nagdalian, A., 2022. Consumer behavior towards cultured meat: a review since 2014. Appetite 106314. https://doi.org/10.1016/j.appet.2022.106314.
Siegrist, M., Hartmann, C., 2023. Why alternative proteins will not disrupt the meat industry. Meat Sci 203, 109223. https://doi.org/10.1016/j.meatsci.2023.109223.
Siegrist, M., Hartmann, C., 2020. Perceived naturalness, disgust, trust and food neophobia as predictors of cultured meat acceptance in ten countries. Appetite 155, 104814. https://doi.org/10.1016/j.appet.2020.104814.
Siegrist, M., Hartmann, C., Keller, C., 2013. Antecedents of food neophobia and its association with eating behavior and food choices. Food Qual. Prefer. 30 (2), 293–298. https://doi.org/10.1016/j.foodqual.2013.06.013.
Sirimungkararat, S., Saksirirat, W., Nopparat, T., Natongkham, A., 2010. Edible products from eri and mulberry silkworms in Thailand. In: Durst, P.B., Johnson, D.V., Leslie, R.N., Shono, K. (Eds.), Forest Insects as Food: Humans Bite Back. FAO, Bangkok, Thailand, pp. 190–200.
Slade, P., 2018. If you build it, will they eat it?: consumer preferences for plant-based and cultured meat burgers. Appetite 125, 428–437. https://doi.org/10.1016/j.appet.2018.02.030.
Smirnov, N.V., 1939. Estimate of deviation between empirical distribution functions in two independent samples. Bull. Moscow Univ. 2 (2), 3–16.
Smith, M.H., Myrick, J.W., Oyageshio, O., Uren, C., Saayman, J., Boolay, S., van der Westhuizen, L., Werely, C., Möller, M., Henn, B.M., Reynolds, A.W., 2023. Epidemiological correlates of overweight and obesity in the Northern Cape Province, South Africa. Peer J 11, e14723. https://doi.org/10.7717/peerj.14723.
Sogari, G., Menozzi, D., Mora, C., 2016. Exploring young foodies ' knowledge and attitude regarding entomophagy: a qualitative study in Italy. Int. J. Gastron. Food Sci. 7, 16–19. https://doi.org/10.1016/j.ijgfs.2016.12.002.
South African Veterinary Council, 2023. The Rise of Cultivated Meat: How will this New Technology Affect Farmers and Veterinary Professionals? https://savc.org.za/the-rise-of-cultivated-meat/ (Accessed 6 May 2025).
Southey, F., 2022. South Africa Bans Meaty Names for Vegan Products. A 'Long Awaited' of 'Counterproductive' Measure? Food Navigator Europe. https://www.foodnavigator.com/Article/2022/06/27/South-Africa-bans-meaty-names-for-vegan-products-A-long-awaited-or-counterproductive-measure? (Accessed 7 May 2025).
Stevens, L., 2022. National GHG Inventory Report: South Africa 2000–2020. Department Forestry, Fisheries and the Environment. https://www.dffe.gov.za/sites/default/files/reports/8nationalgreenhousegasreport2022.pdf (Accessed 11 November 2024).
Stout, A.J., Mirliani, A.B., Soule-Albridge, E.L., Cohen, J.M., Kaplan, D.L., 2020. Engineering carotenoid production in mammalian cells for nutritionally enhanced cell-cultured foods. Metab. Eng. 62, 126–137. https://doi.org/10.1016/j.ymben.2020.07.011.
Stubbs, R.J., Scott, S.E., Duarte, C., 2018. Responding to food, environment and health challenges by changing meat consumption behaviours in consumers. Nutr. Bull. 43, 125–134. https://doi.org/10.1111/nbu.12318.
Sucapane, D., Roux, C., Sobol, K., 2021. Exploring how product descriptors and packaging colors impact consumers' perceptions of plant-based meat alternative products. Appetite 167, 105590. https://doi.org/10.1016/j.appet.2021.105590.
Swing, C.J., Thompson, T.W., Guimaraes, O., Geornaras, I., Engle, T.E., Belk, K.E., Gifford, C.L., Nair, M.N., 2021. Nutritional composition of novel plant-based meat alternatives and traditional animal-based meats. J. Food Sci. Nutr. 7, 109. https://doi.org/10.24966/FSN-1076/100109.
Szejda, K., Stumpe, M., Raal, L., Tapscott, C.E., 2021. South African consumer adoption of plant-based and cultivated meat: a segmentation study. Front. Sustain. Food Syst. 5, 744199. https://doi.org/10.3389/fsufs.2021.744199.
Train, K.E., 2009. Discrete Choice Methods with Simulation, 2nd ed. Cambridge University Press, Cambridge. https://doi.org/10.1017/CBO9780511805271.
Tsvakirai, C., Nalley, L., Rider, S., Van Loo, E., Tshehla, M., 2023. The alternative livestock revolution: prospects for consumer acceptance of plant-based and cultured meat in South Africa. J. Agric. Appl. Econ. 55 (4), 710–729. https://edepot.wur.nl/645685.
Tuomisto, H.L., Teixeira de Mattos, M.J., 2011. Environmental impacts of cultured meat production. Environ. Sci. Technol. 45 (14), 6117–6123. https://doi.org/10.1021/es200130u.
Unilever, 2024. The State of South Africa's Plate. https://www.unilever.co.za/brands/health/articles/the-state-of-south-africas-plate/#:~:text=Key%20findings%20unearthed%20in%20the,meat%20being%20the%20most%20popular (Accessed 7 May 2025).
Vainio, A., 2019. How consumers of meat-based and plant-based diets attend to scientific and commercial information sources: eating motives, the need for cognition and ability to evaluate information. Appetite 138, 72–79. https://doi.org/10.1016/j.appet.2019.03.017.
Van Huis, A., 2003. Insects as food in sub-Saharan Africa. Int. J. Trop. Insect Sci. 23 (3), 163–185. https://doi.org/10.1017/S1742758400023572.
Van Huis, A., Rumpold, B., 2023. Strategies to convince consumers to eat insects? A review. Food Qual. Prefer. 110, 104927. https://doi.org/10.1016/j.foodqual.2023.104927.
Van Loo, E.J., Caputo, V., Lusk, J.L., 2020. Consumer preferences for farm-raised meat, lab-grown meat, and plant-based meat alternatives: does information or brand matter? Food Policy 95, 101931. https://doi.org/10.1016/j.foodpol.2020.101931.
Verbeke, W., 2015. Profiling consumers who are ready to adopt insects as a meat substitute in a Western society. Food Qual. Prefer. 39, 147–155. https://doi.org/10.1016/j.foodqual.2014.07.008.
Verbeke, W., Marcu, A., Rutsaert, P., Gaspar, R., Seibt, B., Fletcher, D., Barnett, J., 2015a. Would you eat cultured meat?': consumers' reactions and attitude formation in Belgium, Portugal and the United Kingdom. Meat Sci 102, 49–58. https://doi.org/10.1016/j.meatsci.2014.11.013.
Verbeke, W., Sans, P., Van Loo, E.J., 2015b. Challenges and prospects for consumer acceptance of cultured meat. J Int. Ag. 14 (2), 285–294. https://doi.org/10.1016/S2095-3119(14)60884-4.
Viroli, G., Kalmpourtzidou, A., Cena, H., 2023. Exploring benefits and barriers of plant-based diets: health, environmental impact, food accessibility and acceptability. Nutrients 15 (22), 4723. https://doi.org/10.3390/nu15224723.
Wang, O., Perez-Cueto, F.J.A., Scarpa, R., Scrimgeour, F., 2024. The influence of innovation-adoption characteristics on consumers' trust and purchase intentions of innovative alternative proteins: a comparison between plant-based food, cultured food, and insect-based food. Food Qual. Prefer. 113, 105072. https://doi.org/10.1016/j.foodqual.2023.105072.
Wilks, M., Phillips, C.J., 2017. Attitudes to in vitro meat: a survey of potential consumers in the United States. PLoS ONE 12 (2), e0171904. https://doi.org/10.1371/journal.pone.0171904.
Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L.J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J.A., De Vries, W., Majele Sibanda, L., Afshin, A., Chaudhary, A., Herrero, M., Agustina, R., Branca, F., Lartey, A., Fan, S., Crona, B., Fox, E., Bignet, V., Troell, M., Lindahl, T., Singh, S., Cornell, S.E., Srinath Reddy, K., Narain, S., Nishtar, S., Murray, C.J.L., 2019. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. Lancet 393 (10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4.
Zhang, M., Li, L., Bai, J., 2020. Consumer acceptance of cultured meat in urban areas of three cities in China. Food Control 118, 107390. https://doi.org/10.1016/j.foodcont.2020.107390.
Zhang, X., Zhang, T., Zhao, Y., Jiang, L., Sui, X., 2024. Structural, extraction and safety aspects of novel alternative proteins from different sources. Food Chem. 436, 137712. https://doi.org/10.1016/j.foodchem.2023.13771.