Consumers' willingness to pay for food safety attributes of nectarines

A discrete choice experiment in the Polokwane Municipality of Limpopo, South Africa

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Degree project/Independent project • 30 credits
Swedish University of Agricultural Sciences, SLU
Faculty of Natural Resources and Agricultural Sciences/Department of Economics
Agricultural, Food and Environmental Policy Analysis – Master's programme
Degree project/SLU, Department of Economics, 1555 • ISSN 1401-4084
Uppsala 2023

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Credits:	30 credits
Level:	Second cycle, A2E
Course title:	Master thesis in Economics
Course code:	EX0905
Programme/education:	Agricultural, Food and Environmental Policy Analysis – Master's programme
Course coordinating dept:	Department of Economics
Place of publication:	Uppsala
Year of publication:	2023
Copyright:	All featured images are used with permission from the copyright owner.
Title of series:	Degree project/SLU, Department of Economics
Part number:	1555
ISSN:	1401-4084

Keywords: Food safety attributes, willingness to pay, discrete choice experiments, conditional logit, nectarines

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Abstract

Consumer concerns about food safety are growing, and there is an increasing demand for quality fruits and vegetables. As such, fruit control procedures and standards should be based on understanding consumers' choices and preferences. However, not much is known about what consumers are willing to pay for food safety attributes of fruits and vegetables, particularly in developing countries. The purpose of this study was to determine consumers' preferences and willingness to pay for food safety attributes of nectarines in the Polokwane municipality area of Limpopo, South Africa. A discrete choice experiment was employed to assess consumer preferences for nectarine attributes, namely, appearance, food safety certification, country of origin, and price. Primary data was collected through face-to-face interviews using a structured questionnaire from 152 participants in various supermarket chains around the Polokwane Municipality. A conditional logit model was utilized for the data analysis. Results show that consumers prefer and are willing to pay R27.70 more for nectarines that are produced in South Africa relative to nectarines that are imported. They are also willing to pay R16.63 more for nectarines that have a label that communicates information on the safety checks done by health officials relative to no communication received from them. Furthermore, consumers are willing to pay R12.28 less for nectarines that were bruised relative to nectarines that were wholesome looking. Consumer characteristics such as age and income significantly impact the willingness to pay for food safety attributes of nectarines. If policymakers and supermarket chains can effectively react to changes in consumer demand, it can result in new business opportunities. This study's results will contribute richly to the discourse on overcoming food safety challenges through more stringent regulations and policies, such as an efficient food labelling system.

Keywords: Food safety attributes, willingness to pay, discrete choice experiment, conditional logit, nectarines

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Abbreviations

CLM	Conditional Logit Model
CM	Choice Modelling
DCE	Discrete Choice Experiment
MRL	Maximum residue level
MWTP	Marginal Willingness To Pay
RUM	Random Utility Model
SABS	South African Bureau of Standards
SGS	Societe Generale de Surveillance S.A.
WTP	Willingness to Pay

1. Introduction

The World Health Organization (WHO) stated that food safety, nutrition, and food security are firmly linked; around 600 million people globally (about 1 in 10) become ill after consuming contaminated food, resulting in annual casualties as high as 420,000. While this leads to the loss of 33 million healthy life years yearly, US$110 billion is also lost annually in productivity and medical expenses that can be explicitly attributed to unsafe food in low and middle-income countries. Food safety has become a rising concern among consumers across the world (WHO, 2022).

Consumers have a right to expect that the foods they purchase and consume will be safe and of high quality and to voice their opinions about the food control procedures, standards, and activities governments and industries use to ascertain that the food supply has these characteristics (FAO, 1993). However, it is very difficult for consumers to make a conclusive judgment about the safety and quality of food through a prima facie inspection during a purchase. While many countries have comprehensive regulations to ensure that all consumers enjoy food safety as a matter of right, such standards are still not flawless in many developing countries. However, despite policy variations in countries with less stringent food safety laws and regulations to overcome food safety challenges, there is a growing unanimity that a credible food safety labelling system is one possible policy measure that can effectively target such concerns (Ortega and Tschirley, 2017).

Food labelling emerged as a solution since it is perceived to have the potential to transform credence qualities into attributes that can be easily searched for and mitigate information asymmetry (Schrobback et al., 2023). Credence quality refers to producers possessing more knowledge about the true picture of a product's qualities compared to consumers, thereby making it virtually impossible for consumers to make accurate judgments about the quality of the product. This is an example of information asymmetry that discourages consumers from purchasing items that coincide appropriately with their quality preferences.

As consumer awareness about food safety increases, the global market for safer and healthier food products and, more particularly, the demand for fruit and vegetables

has increased significantly (FAO, 2021). Indeed, rich in a wide range of essential nutrients that contribute to maintaining good health, fruits are an integral part of a healthy diet (Moreb et al., 2021). Bakker et al. (2020) observed that populations residing in urban areas in developing countries are increasingly becoming more aware of the benefits of consuming safe fruits and vegetables. This is an indication that there is an increasing demand among consumers for greater food safety. In developing countries, a food safety labelling system empowers consumers to identify products with higher food safety. However, the efficacy of a food safety labelling system ultimately depends on consumers' willingness to use such information. This study investigates the demand for increased food safety among consumers in developing countries, with food safety labels being the determining factor.

Though there is evidence that consumers in developed countries are willing to pay for food safety, only a few studies have explored this behaviour of consumers in developing countries. A study that evaluated consumers' preferences for food safety labels and brands on fresh produce in Thailand found that consumers are willing to pay more for both government-monitored food safety labels and private brands; however, there is high heterogeneity in their preferences (Wongprawmas and Canavari, 2017). The heterogeneity factor was further investigated through a nationwide choice experiment to assess consumer preference for food safety attributes in urban China. The experiment showed that consumers value direct government involvement in the food safety system more than other options (Ortega et al., 2011). Having a clear understanding of consumers' willingness to pay (WTP) for food safety certification is fundamental to determining the appropriate design and implementation of programs to reduce the burden of food-borne illnesses in developing countries (Tran et al., 2022). Therefore, this study will investigate consumer preferences for food safety attributes among consumers in the Polokwane Municipality of Limpopo, South Africa, and I will use nectarines as a case of fresh produce.

For nectarines, the risks associated with cultivation practices in South Africa, especially in small-scale farming, give rise to significant concerns, as this sector contributes substantially to fruit and vegetable production in the country (Adeboye et al., 2021). Mutengwe et al. (2016) added that the lack of access to resources and technical expertise, as well as poor infrastructure, can hinder the implementation of good agricultural practices and lead to increased risks of contamination, which increases concerns about production practices in agriculture, especially with pesticide usage. The most frequently detected pesticide used on nectarines, diphenylamine, has surpassed the maximum residue level (MRL) by 11.15%. This prompted an investigation into the awareness of the harmful effects of chemical

residues in conventionally-grown fruit and vegetables in the country (Mditshwa et al., 2017).

South Africa is renowned for its rich agricultural production and diverse range of fruits and vegetables, with Limpopo being one of the major producers of nectarines, and a portion of its production exported worldwide. However, the sector is often struck with shortages, which may be seasonal and caused by other environmental factors, thereby compelling retailers to import from other countries such as Spain, Chile, and Argentina (Brodie, 2022). Even though nectarines are normally regarded as low-risk fruit for food-borne illnesses, a recent recall of nectarines from Chile due to probable Listeria contamination and related food-borne outbreaks increased awareness of the risk for pathogen transmission through nectarine consumption (Desk, 2019). Despite having laws in place to regulate food safety, South Africa often lacks enough resources to enforce these regulations effectively (Grace, 2015).

This study aims to understand consumers' willingness to pay for enhanced food safety in a developing country context, as signalled by food safety labels on fresh produce. Based on this background, I will collect data in a discrete choice experiment to answer the following research questions:

- What is the willingness to pay for food safety attributes of Nectarines among consumers in the Polokwane Municipality of Limpopo, South Africa?
- Is there heterogeneity in consumer willingness to pay for food safety attributes as explained by socio-economic characteristics?

The data exploited in this thesis to answer these questions are primary data acquired by a discrete choice experiment (DCE), which is a tool used for eliciting preferences of individuals. In the context of discrete choice experiment projections, a high sensitivity (true-positive rate) indicates an opt-in behaviour prediction reliability. This discrete choice experiment classifies opt-in as a choice in to use a product that a respondent does not presently utilize (Quaife et al., 2018). High specificity (true-negative rate) would suggest predictability for opt-out behaviours, defined as a respondent opting not to utilize a product in our DCE (Quaife et al., 2018). The interviewer's potential bias in the questions is a purported drawback of the interviewing process. The survey was piloted on a select set of individuals to mitigate this issue. The focus group responses in the choice experiment suggested that the participants found the questions clear. However, it needs to be mentioned that they might have responded in a way that does not reflect their actual behaviour, indicating that their individual preferences might have influenced them. Finally, despite similarities in socio-economic attributes of the participants in this study

with those of ordinary South Africans, it is pertinent to note that the findings should not be construed as generalized beyond the confines of this study.

To present a persuasive deliberation to seek answers to the research questions, this study is organized in the following chapters. The second chapter examines the relevant literature on consumer preferences and the willingness to pay for food safety attributes. Chapter Three provides the theories underlying the selected econometric models. While Chapter Four discusses the methods and materials used to collect the data. Chapter Five presents the empirical data and the analysis undertaken. Chapter Six highlights the outcome of the study and presents the limitations and policy implications of this study. The final chapter concludes the study.

2. Literature review

Food safety issues have attracted a lot of interest globally. Previous literature on consumers' willingness to pay (WTP) for food safety attributes of fruits and vegetables has set a foundation for various food laws in most parts of the world; it has become a prerequisite that any fruit and vegetables in the market have to be regarded as safe to consume (Focker & van der Fels-Klerx, 2020). Stemming from previous studies, many studies have looked into consumers' needs for better levels of food safety and quality, which are typically quantified in terms of their willingness to pay a larger price premium (Osemeke et al., 2013). These investigations have primarily been conducted in developed countries. In general, the findings of these studies indicate that consumers were willing to pay extra for safe, higher-quality food. Few studies have examined the willingness of consumers in developing countries to pay for safer goods (Ortega and Tschirley, 2017).

In addition, in recent years, food certification labeling has become increasingly important due to the growing demand from consumers for healthier, safer, and more sustainable foods. Credible labels permit businesses to signal the quality of particularly desirable attributes, thereby creating an opportunity for premiums driven by this signal. However, in developing countries, a substantial proportion of fruits and vegetables are sold in informal markets resulting in the inefficient diffusion of safety labels on food products. Consumption of fruits and vegetables from informal marketplaces is prevalent in many countries with high unemployment, low wages, few job opportunities, and limited social programs (Darko and Akoto, 2008). People who rely on such food are typically more concerned with its convenience than its safety, quality, and cleanliness (Oni et al., 2005). This trend is very common even in nations with extant food regulatory agencies. In this instance, consumers' preferences for fruits and vegetables will depend not only on the product's safety characteristics but also on the consumer's capacity to pay.

Many studies have used discrete choice experiments to identify consumer preferences for various aspects of food safety. Joya et al. (2021) found that consumers were willing to pay more for wholesome-looking tomatoes than bruised tomatoes. Wongprawmas and Canavari (2017) discovered that consumers were

often prepared to pay extra for certified products instead of non-certified ones. Also, in another study by Ragasa et al. (2019), consumers in Ghana were generally willing to pay more for safer food. Furthermore, Alphonce and Alfnes (2012) confirmed that consumers from Tanzania were willing to pay a premium for inspected and organically produced tomatoes. Additionally, consumers have a strong preference for tomatoes produced in Tanzania, and they significantly discount tomatoes imported from South Africa, indicating a demand for safer fruits and vegetables from South Africa. Other studies have also demonstrated a positive impact of origin labeling on consumer preferences, including Lai et al. (2018), Lusk et al. (2013), Mørkbak et al. (2010), and Loureiro and Umberger (2007). In addition to disclosing the origins of goods, information on their country of origin is one of several indicators upon which consumer perceptions of food safety are based (Lewis et al., 2017). This highlights the importance of appearance, food safety certification, and origin as attributes to be included in this study.

Furthermore, qualitative and quantitative methods have been used to investigate consumer preferences regarding food safety. Several studies have employed quantitative methods from consumer surveys to discover the interaction between socio-demographic characteristics and consumers' choices for food items and their willingness to pay (e.g., Dewi et al., 2022; Joya et al., 2021; Liu et al., 2020; Wongprawmas & Canavari, 2017). Studies that utilized qualitative methods to investigate consumers' perceptions of food safety characteristics include Chalak et al. (2019) and Bouranta et al. (2022). The findings of these studies indicate that age, gender, level of education, and household income substantially impact consumers' perception and willingness to pay for various attributes.

Typical examples of the methodological approaches of these studies comprise discrete choice experiments (DCE) and experimental auctions. Discrete choice experiments are commonly employed in food safety studies (Akaichi et al., 2013; Premashthira et al., 2022; Yin et al., 2018). Discrete choice experiments mimic the real-life decision-making processes of consumers by evaluating the utility of factors in multiple combinations. Many researchers use a conditional logit model (CLM) or Multinomial logit model (MNL) to determine consumer preferences for food safety attributes when employing the DCE methodology (Wongprawmas & Canavari, 2017; Joya et al., 2021). Nevertheless, the CLM/MNL model cannot directly explain the source of heterogeneity (Liu et al., 2020; Wang & Huo, 2016).

To successfully implement unique food safety policies, it is often necessary to fully understand the consumer profile (Hou et al., 2019). Consequently, scientists often enhance the standard conditional logit model to include various additional characteristics, such as age, education, and income, as interactions that may impact

the willingness to pay, which would then help to explain differences in consumer preferences across individuals (Fontes et al., 2015; Joya et al., 2021).

Most of the studies mentioned above found that consumers are willing to pay more for food safety, with the amount driven by socio-demographic characteristics such as age and level of education, as well as the information obtained regarding the food safety risk and the measures of control applied. From the foregoing, this study will contribute to the literature by applying a multi-attribute choice experiment method to understand consumers' preferences and willingness to pay for food safety attributes of Nectarines in the Polokwane Municipality area of Limpopo, South Africa.

3. Theoretical framework

3.1 Discrete choice theory

Choice Modelling (CM) represents one of the survey-based approaches for modeling preferences for goods or services, in which the goods or services are described in terms of attributes with predetermined levels (Hanley et al., 2001). Figure 1 depicts the four approaches utilized in choice modelling: Contingent Rating, Paired Comparisons, Contingent Ranking and Choice Experiment (Hanley et al., 2001). In accordance with the various approaches of the choice model method, there are a variety of methods for measuring preferences, including rating alternatives, ranking them, and selecting the most preferable good/service. For objectives of this analysis, the discrete choice experiment (DCE) method was utilized. The method is based on Lancaster's consumer choice theory and empirically substantiated by McFadden's Random Utility Model (1974).

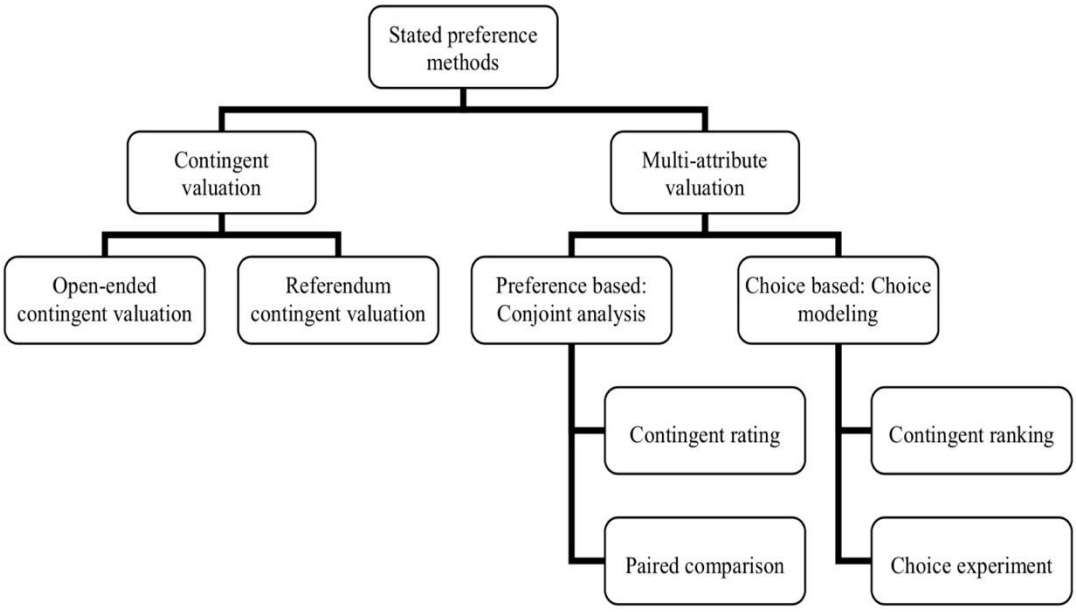

Figure 1: The family of stated preference methods

Source: Castello (2003)

The random utility model is a widely recognized economic theory that uses the properties of error components to derive parameter estimates from the data (Skreli et al., 2017). Horowitz et al. (1994) demonstrated that in a random utility model, the researcher is able to observe the systematic component (consisting of attributes and socio-demographic characteristics in choice modeling), whereas the random component is unobservable (consisting of preferences, perception). This is shown in equation (1). Because utility is unobservable and, therefore, a random variable, the model cannot be utilised to accurately forecast consumer decisions. Instead, the model generates probabilities for the different alternatives. Manski (1977) formalized the effects of different product attributes on choices and their probabilities following Thurstone's (1927) introduction of random utility functions. Louviere and Woodworth (1983) performed the first DCE that followed McFadden's model. In this model, the consumer is concerned with maximizing utility.

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{1}$$

Consequently, the probability that a particular respondent *i* chooses alternative *j* in the choice set over any other option *k* can be represented as the probability that the utility associated with option *j* outweighs that associated with all other options, as shown in equation (2).

$$P[(U_{ij} > U_{ik})\ \forall k \neq j] = P[(V_{ij} - V_{ik}) > (\varepsilon_{ik} - \varepsilon_{ij})] \tag{2}$$

To derive a precise expression for this probability, the distribution of the error terms (ε_{ij}) must be known. A common assumption is that they are independently and identically distributed with an extreme-value distribution:

$$P(\varepsilon_{ij} \leq t) = F(t) = \exp(-\exp(-t)) \tag{3}$$

The aforementioned error term distribution suggests that the probability of any particular alternative *j* being selected as the most preferred can be represented in terms of the logistic distribution (McFadden, 1974) defined in equation (4). This criterion is referred to as the conditional logit model:

$$P(U_{ij} > U_{ik}, \forall k \neq j) = \frac{\exp(\mu V_{ij})}{\sum_j \exp(\mu V_{ij})} \tag{4}$$

where μ is a scale parameter, inversely proportional to the standard deviation of the error distribution. This parameter cannot be uniquely identified, so its value is typically presumed to be 1. A major implication of this specification is that preferences from the choice set must adhere to the Independence from Irrelevant Alternatives (IIA) property (Luce, 1959), which implies that the relative

probabilities of two options being chosen are not affected by the addition or removal of other options. This property results from the independence of the error terms across the various options in the set of alternatives. This model can be estimated using conventional maximum likelihood techniques, with the corresponding log-likelihood function stated in the following equation (5), where z_{ij} is an indicator variable with a value of one if respondent *i* selects option *j* and zero otherwise.

$$\text{Log } L = \sum_{i=1}^{N} \sum_{j=1}^{J} z_{ij} \log \left[\frac{\exp(V_{ij})}{\sum_{j=1}^{J} \exp(V_{ij})} \right] \quad (5)$$

Socio-demographic characteristics can be incorporated alongside choice set attributes in the X terms of equation (1), but because they are constant across choice scenarios for a given individual (for instance, income is the same when the first choice is made as when the second choice is made), they can only be included as interaction terms, i.e., as terms that interact with choice specific attributes.

3.2 Factors influencing consumers' willingness to pay for food products

Consumers' perceptions about the characteristics of a product contribute to their ultimate selection of that product. There are many kinds of products on the market with minor but significant differences, ranging from certification, packaging, and labelling. In the minds of consumers seeking to maximize utility, these distinctions may generate value-added benefits. Different preferences for product characteristics are indicative of consumers' heterogeneous nature, which is reflected in their decision-making behaviour. Consequently, numerous factors considerably influence attribute preference, by expansion, WTP. The framework illustrating consumer behaviour toward food products is depicted in Figure 2 below.

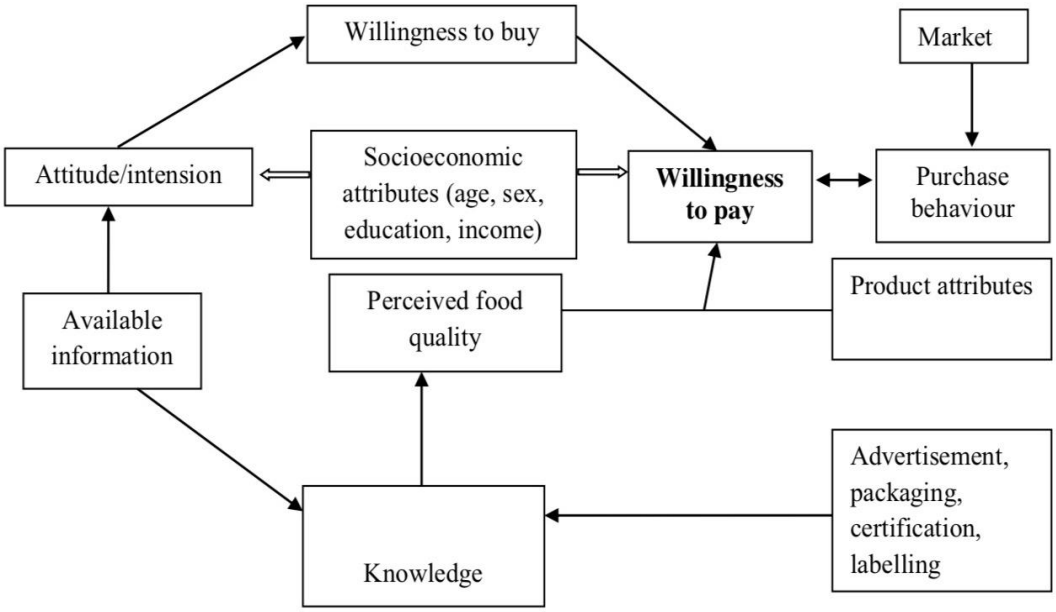

Figure 2: Framework reflecting consumer behaviour towards food products

Source: Bonti-Ankomah and Yiridoe (2006) and Millock (2002)

4. Materials and methods

4.1 Discrete choice experiments

In developing a stated preference survey, a number of elements must be explored. These elements are discussed simultaneously with the design of the survey employed in this study. This thesis utilizes a discrete choice experiment, which is essentially a form of conjoint analysis that combines conjoint analysis and discrete choice theory. The purpose of discrete choice experiments is to determine consumers' preferences which may be based on hypothetical choices made between distinct attributes. A discrete choice study consists of a series of hypothetical scenarios, each of which is comprised of unique alternatives reflecting distinctive attribute combinations. In each hypothetical scenario, the preferences of consumers are assessed by taking into account the trade-off across attribute levels between the various alternatives. An attribute level is a particular property of an attribute; for instance, the "size" attribute may have levels that include small, medium, and large.

In this study, attributes and attribute levels are altered to provide individuals with a variety of choice combinations (alternatives or options). Choice sets describe the collection of two or more alternatives. In this experiment, each choice set consists of two alternatives and a no-choice option; consequently, each choice set consists of three alternatives from which participants can select. The survey questions were framed in terms of behavioral choice context: “imagine that you are shopping for nectarines, the alternatives below are the only ones available for purchase, select the one that you would choose”. Respondents were only permitted to select one of the available options, after which they could proceed to a different choice context. Respondents were not able to examine or modify previously selected options. The incorporation of the "no-choice" option not only helps make decisions more realistic, but it can also assist consumers in deciding not to select a product if they are dissatisfied with it (Gao et al., 2016; Bazzani et al., 2017).

4.1.1 Attributes for the discrete choice experiment

Attribute selection is a crucial component of an experimental design, as the researcher must carefully evaluate the product's attributes that could assist to clarify consumer choice behavior. As observed in Table 1, four attributes were utilized: 1) Food Safety Certification, 2) Appearance, 3) Country of Origin, and 4) Price. These factors have been incorporated in the survey for the following reasons:

Firstly, the food safety certification is a primary concern of this study. The food safety certification can be defined as a certificate that communicates the information done on the safety checks by the health officials, in order to educate and inform consumers on the safety aspects of fresh fruit produce. Although certification has a significant impact on consumer buying habits, stone fruit products on the South African market are rarely certified. The authentication of information will offer consumers with essential reassurances. In accordance with Liu et al. (2020) we have added the verification type attribute to our discrete choice experiment to denote the presence of food safety information validated by specific agencies, such as the South African Bureau of Standards (SABS) and Societe Generale de Surveillance S.A. (SGS). These certification types consist of two levels which are; no certification and certification (a label that communicates the information on the safety checks done by health officials and confirmed to meet the SABS or SGS standards).

Secondly, appearance is one of the crucial concerns of this investigation. The surface color is the first sense that the consumer perceives and utilizes as a determining factor for whether they approve or decline food (Tanner, 2016). Thus, it serves an essential part in how consumers perceive the freshness of nectarines. Additionally, appearance generally has a significant impact on the product selection of consumers (Joya et al., 2021). Consequently, we incorporated the appearance attribute in the choice experiment with two levels: Wholesome (referring to nectarines that appear to be in excellent condition with no defects) and Bruised (referring to nectarines that appear to have minor defects).

Thirdly, Country of Origin is an essential attribute. Kokthi and González-Limón (2015) as well as Yin et al. (2018) note that the country of origin claims are commonly used as proxies for food safety, more precisely when the food safety certification is absent. For instance, the consumer can associate the distance the produce travels from the farm to the market as an indicator for freshness. Henceforth, we added the country of origin attribute in order to distinguish locally and internationally produced nectarines. Moreover, numerous consumer studies have highlighted the country of origin attribute as a valuable attribute to consumers (Gracia et al., 2014; Kokthi and González-Limón, 2015). Therefore, we included

country of origin attribute in the choice experiment with the following levels: South African (represented by the proudly South African logo indicating nectarines which are produced in South Africa) and Imported (which represent nectarines which have been produced in other countries besides South Africa).

Finally, five price levels have been incorporated in this experiment. The price range for a 750g punnets of nectarines was determined based on the prices found at supermarkets, local convenience stores, produce stores, and farmers' markets, as well as by food advertising agencies. The attributes and attribute levels used (with expected signs) in this experiment are defined in Table 1.

Table 1: Attributes and attribute levels with expected signs

Attributes	**Description**	**Levels**	**Expected Sign**
Food Safety Certification	A safety check indicating inspection by local health officials	Not Certified Certified	Positive for Certified
Appearance	The condition of the nectarines and how they appear/look	Wholesome Bruised	Negative for Bruised
Country of Origin	Country where the nectarines are produced	Imported South African	Positive for South African
Price	Price for a 750g punnet of nectarines	20 Rands 35 Rands 50 Rands 65 Rands 80 Rands	Negative for Price

Note: 1 South African Rand (ZAR) = 0.051 Euro (€); Average in March 2023.

4.1.2 Experimental design

The most important design concern is optimizing the survey's ability to acquire information from respondents. Each response to a set of choices ought to yield more details for the statistical model, so that preferences for various attribute levels can be observed individually. Two stages are required to develop a design: 1) determining the combinations of attributes and attribute levels to be utilized in the experiment, and 2) merging the profiles into choice sets. Ultimately, a third stage may be required to organize choice sets into questionnaires. A basis for the development is a full factorial design, which comprises all possible combinations

of attribute levels that represent the various alternatives in the choice set [in this particular situation, $(2^{3}5^{1})^{2}$ = 1600], as shown in Table 1. A full factorial design is typically unmanageable in a choice experiment due to its size. Consequently, a portion of all potential combinations must be selected, resulting in a fractional factorial design. There are different methods for selecting combinations for a fracitonal factorial design. In this study we used an Orthogonal design. While Efficiency criteria designs are common in the field, necessitates the collection of prior information, which was not feasible in this instance due to a limited budget and complex field logistics.

Following the findings by Mangham et al. (2009) that showed that using visual aids like pictures, diagrams, and symbols is very important when administering a DCE in areas where literacy is not taken for granted. An example of a choice set utilized in the experiment is shown in Figure 3. Given that exhaustion is predicted to increase in proportion to the amount of choices respondents make, we designed the survey so that participants would only have to make 10 sets of choices.

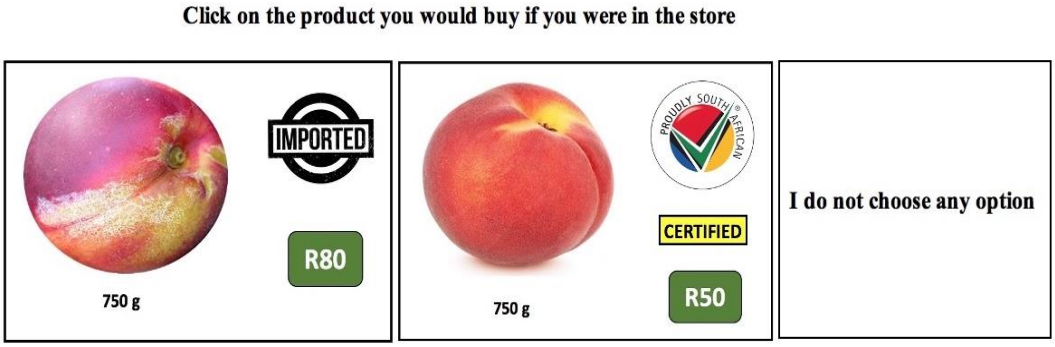

Figure 3: Sample choice scenario

4.1.3 Study sample and data collection

The following sample size (N) was determined using the formula of Orme (1998) as a ***rule of thumb*** for stated choice experiments which estimate main effects only:

$$N \geq 500 \text{ x } \frac{L^{max}}{J \text{ x } S}$$

In this case, L max is the greatest possible number of levels for any of the attributes, J is the total number of possible alternatives, and S is the total number of choice scenarios. Considering that the greatest number of levels across all attributes is 5 and that there are 3 alternatives to each of the 10 choice scenarios. This gives a sample size of:

$$N = 500 \text{ x } \frac{5}{3 \text{ x } 10} = 84$$

Even though the sample required at least 84 participants, primary data was collected from 166 participants in order to account for preference heterogeneity. Pre-testing a survey's instrument is crucial before it is used in an actual situation (Hensher et al., 2005). This is why in February of 2023, we ran a test of our nectarine survey on a small group of 15 participants. The survey was trialled to gauge the dependability of the experimental design and to reveal areas that may be improved, such as the readability of the questions and the time it took to complete the survey. According to the reported timeframes, it took respondents anything from 8 to 13 minutes to finish the survey.

Having a pilot group that is fairly representative of the target population increases the likelihood of receiving valuable input. Participants were invited to fill out a survey and also to suggest a friend who frequently buys nectarines or other fruits to do the same. The targeted respondents were fruit consumers who were requested to fill out the survey online. Further adjustments to the survey instrument were informed by responses obtained from the pilot survey and input from members of the research advisory board. The revised version of the survey was subsequently administered online via the Qualtrics software in March 2023 by a team of qualified researchers. To be eligible for an interview, one has to be an adult of 18 years or above, and be a consumer of nectarines or any other stone fruit. Furthermore, adhering to the suggestions of Bennett and Birol (2010), face-to-face interviews are mostly preferred to other survey techniques mainly being that in a developing country like South Africa, they enable simplification of questions and choice tasks to the survey respondents and ensures that the right member of the household replies to the survey to reduce response biases. Segments of the survey can be viewed in the Appendix section.

The survey targeted fruit consumers in the Polokwane Municipality area and it was administered in English. Polokwane Municipality is a municipality run by the local government in the Limpopo province and one of the main reasons for choosing this area is because of its location, which is in the capital city of the province and has a much higher population density as compared to other municipalities in the province. The data was collected during February and March 2023. The study relied on a convenience sample, but made the following efforts to improve the sample's representativeness. Firstly, the study design began with a store-level stratification strategy. The interviewers were placed at different retailers such as Woolworths, Goseame, Checkers and food lovers market, these were chosen because of their large selection of fruits representing a wide variety of categories (production location, local), as well as its location between both low and high-end suburbs. This approach guaranteed that a wide range of consumers were represented in the sample. Secondly, by approaching respondents near retail stores, either before or

after buying groceries, the sample is refined to include only those who are at least partially responsible for food purchasing. Participants were informed of the nature of the survey and given the opportunity to either agree to its conditions or decline participation before it began. Once respondents gave their informed consent, screening questions were given to filter out anyone who wasn't inclined to purchase fruits. This was important because the survey's primary goal was to seek out the opinions of people who purchase fruits, particularly those who bought them frequently.

The first part of the survey sought to assess the purchasing patterns of respondents. The survey included an opening statement that summarized the project and an acknowledgment that the respondent was at least 18 years old. Once a participant was granted entry into the survey, their consumption frequency was determined by inquiring how often they purchased fruits in an ordinary month. After answering these preparatory questions, respondents were guided to the choice scenarios using a cheap talk script (see Appendix 2), followed by a brief description of the attributes. As a means of demonstrating the following choice section, an illustration of the choice scenarios in a behavioural context was also provided. Each respondent was presented with ten choice scenarios. In addition to the hypothetical choices, the survey included questions meant to assess the participant's level of food safety knowledge. The last part of the survey addressed the socio-demographic characteristics of respondents.

4.2 Estimation Procedure

4.2.1 Variables

The variables utilized in conditional logit models are listed in Table 2. For the logit model, the dependent variable is the respondent's choice in the choice set, which is a function of the product attributes. In contrast, the latent variable analyzed by the logit model is the estimated utility value based on the different attribute levels. Food safety certification, appearance, origin, and price are the main effect explanatory variables in Table 2. These coefficients represent the change in marginal utility caused by a change of one unit in the attribute. The interaction terms include dummy variables, each of which are interacted with the main-effect terms through the conditional logit models (e.g. Burton et al., 2001). From an economic standpoint and identical to the constant utilized in a general regression model, the ASC measures the average effect on utility of all variables not included in the model (Kjaer, 2005). In order to steer clear of the dummy variable trap, the constant is omitted from the regression analysis due to the incorporation of the ASC.

Table 2: Variables included in the conditional logit analyses

Variable	Description
ASC	1 if alternative 3 (no choice alternative) is chosen, 0 otherwise
FS_Cert	1 if nectarine is certified by health officials, 0 otherwise
App	1 if nectarine has a slightly damaged appearance with blemishes, 0 otherwise
Orgn	1 if nectarine is produced in South Africa, 0 otherwise
Price	The retail price of nectarines
Age_31_40*	1 if age is between 31-40, 0 otherwise
Age_41_50*	1 if age is between 41-50, 0 otherwise
Age_51_&_Above*	1 if age is 51 and above, 0 otherwise
Inc_Med*	1 if household income is between 100,000-299,999 Rands, 0 otherwise
Inc_High*	1 if household income is above 299,999 Rands, 0 otherwise

Note: *Dummy variables, utilised only for interaction-effects

4.2.2 Model specification

In this study, two models are utilized. Firstly, the standard Conditional Logit Model (CLM) was estimated by indirectly incorporating the main model for all attributes into the utility model specification. Secondly, the estimation by enhancing the main model by incorporating the attributes and socio-demographic characteristics into the utility specification. Statistical measures such as Pseudo-R^2 and the log-likelihood ratio test were used to compare these two models.

The following utility function of alternative *j*, for the respondents' *i* was utilized for the Conditional Logit model (CLM) and can be expressed as follows:

$$V_{ij} = \beta_0 ASC + \beta_1 X_{FS\_Cert} + \beta_2 X_{App} + \beta_3 X_{Orgn} + \beta_4 X_{Price} \quad (6)$$

Several socio-demographic variables (with S parameters) have been added as interaction terms with the attributes X_k. This was done to enhance the fit of the main model and to represent respondents' preference heterogeneity;

$$\begin{aligned} V_{ij} = {} & \beta_0 ASC + \beta_1 X_{FS\_Cert} + \beta_2 X_{App} + \beta_3 X_{Orgn} + \beta_4 X_{Price} + \\ & \gamma_1 (X_{FS\_Cert} S_{Age\_31\_40}) + \gamma_2 (X_{FS\_Cert} S_{Age\_41\_50}) + \\ & \gamma_3 (X_{FS\_Cert} S_{Age\_51\_\&\_Above}) + \gamma_4 (X_{FS\_Cert} S_{Inc\_Med}) + \gamma_5 (X_{FS\_Cert} S_{Inc\_High}) + \\ & \gamma_6 (X_{App} S_{Age\_31\_40}) + \gamma_7 (X_{App} S_{Age\_41\_50}) + \gamma_8 (X_{App} S_{Age\_51\_\&\_Above}) + \\ & \gamma_9 (X_{App} S_{Inc\_Med}) + \gamma_{10} (X_{App} S_{Inc\_High}) + \gamma_{11} (X_{Orgn} S_{Age\_31\_40}) + \end{aligned}$$

$$\gamma_{12}(X_{Orgn}S_{Age\_41\_50}) + \gamma_{13}(X_{Orgn}S_{Age\_51\_\&\_Above}) + \gamma_{14}(X_{Orgn}S_{Inc\_Med}) + \gamma_{15}(X_{Orgn}S_{Inc\_High}) \quad (7)$$

Next, determine the willingness to pay based on β values, in which β values represent the impact of attribute changes on utility. The negative ratio between the coefficient of an attribute and the price coefficient represents the marginal implicit price of the attributes. Therefore, the MWTP is calculated by dividing the β value of each non-monetary attribute by the value of the monetary attribute, in this case, the price attribute of nectarines.

$$\text{MWTP} = -\left(\frac{\beta_{Attribute}}{\beta_{Price}}\right) \quad (8)$$

This figure indicates variations in the marginal rate substitution (MRS) relative to the present condition or status quo (Hanley et al., 2001).

5. Results

5.1 Descriptive statistics

The online questionnaire administered to fruit consumers resulted in 152 out of 166 responses, after screening out 2 undesired responses, such as those from consumers who never shop or do not consider buying fruits on a monthly bases and 12 responses that were rejected due to incomplete answers. Socio-economic profiles of respondents are shown in Table 3. There were 61 (40.1%) male and 91 (59.9%) female respondents in total. The average age of the respondents was 36.8 years. 79.6% had a job, 88.8% had a college degree and above, 32.9% were married, 50.7% had an annual household income of 100,000 Rands and above. The average household size was 4 members per household. Most of the respondents were primary shoppers who believed that they were in good health and 65.8% of them purchased fruits more than twice every month and they sometimes read food labels. About 36% of the respondents think that the government supervision of food safety is fair.

Table 3: Characteristics of survey respondents and fruit consumption patterns

Characteristics	**Description**	**Frequency**	**Percent**
Gender	Male	61	40.1
	Female	91	59.9
Age (Average = 36.8, Std = 12.55)	18-30 years old	65	42.8
	31-40 years old	29	19.1
	41-50 years old	28	18.4
	51 years old and above	30	19.7
Education level	Less than high school	1	0.7
	High school	16	10.5
	Some college	27	17.8
	Bachelor degree	50	32.9
	Honour's/Postgraduate diploma	38	25
	Master's degree	9	5.9

	Doctorate/Professional degree	11	7.2
Household size (Average = 4, Std = 1.7)	Number of people in the household	152	100
Marital status	Single	95	62.5
	Married	50	32.9
	Divorced	4	2.6
	Widowed	2	1.3
	Separated	1	0.7
Household income (Rands/Year)	< 50,000	53	34.9
	50,000 – 99,999	24	15.8
	100,000 – 199,999	21	13.8
	200,000 – 299,999	14	9.2
	300,000 – 399,999	16	10.5
	400,000 – 499,999	10	6.6
	> 499,999	14	9.2
Employment status	Unemployed	17	11.2
	Full-time employment	84	55.2
	Part-time employment	10	6.6
	Self employment	27	17.8
	Student	12	7.9
	Retired	2	1.3
	Home duties	0	0
Monthly fruit consumption (Average = 3.73, Std = 1.07)	Once	17	11.2
	Twice	35	23
	3 to 4 times	44	29
	> 4 times	56	36.8
Dietary health issues present in household (High blood, type ll diabetes or heart diseases)	Yes	57	37.5
	No	95	62.5
Role in grocery shopping	Primary shopper	76	50
	Someone else is the primary shopper	32	21
	Shopping is shared	44	29

Frequency of reading labels	Never	5	3.3
	Sometimes	52	34
	About half the time	27	17.6
	Most of the time	37	24.8
	Always	31	20.3
Evaluation of government's supervision on food safety in Limpopo	Poor	16	10.5
	Fair	54	36
	Good	51	33.3
	Very good	19	12.4
	Excellent	12	7.8

5.2 Summary of responses to the food safety risk perception

The responses to the Food Safety Risk Perception questions are shown in Figure 4.

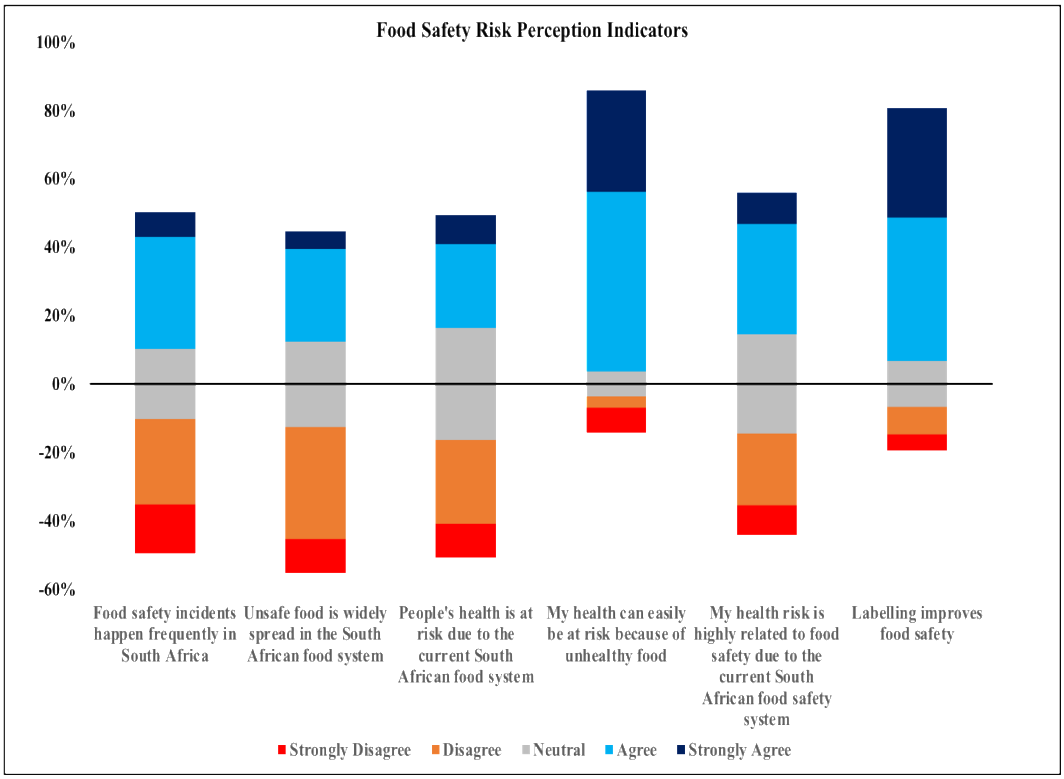

Figure 4: Food safety risk perception questions

The majority of the Food Safety Risk Perception indicator statements are in agreement. No more than 32% of respondents were unsure about the risk statements. Questions that directly involve the food system are of particular interest. We discovered that 49.7% of respondents concur that their health is at risk due to South Africa's current food system. In addition, 56.2% believe that the current South African food system poses a substantial risk to their health in terms of food safety. 80.8% of respondents concur that labelling enhances food safety. Similar to Akinwehinmi et al. (2021) consumers associate their perceived food safety risk with the South African food system, according to the responses.

5.3 Conditional logit model results

The conditional logit model was initially estimated with only main effects (a model that focuses on the secluded effect of an attribute on utility and disregards interactions amongst attributes). The results obtained from the empirical specification of equation 6 are reported in Table 4 below:

Table 4: The conditional logit model without interactions

Variables	**Coefficient**	**Std Error**	**MWTP**
ASC	- 2.694***	0.167	- 128.02***
FS_Cert	0.350***	0.102	16.63***
App	- 0.258**	0.103	- 12.28**
Orgn	0.583***	0.088	27.70***
Price	- 0.021***	0.001	
Number of Observations		4560	
Log-likelihood		- 1079.982	
Pseudo-R^2		0.353	

Note: *** p < 0.01; ** p < 0.05; * p < 0.1

The results can be seen in Table 4 which indicate that the coefficient for food safety certification and country of origin were positive and significant at the 1% level with the expected signs. The positive signs for the country of origin and food safety certification coefficients indicate that fruit consumers in Polokwane have greater preferences and derive positive utility and that they are willing to pay 27.70 Rands more per 750 grams of nectarines that are produced in South Africa relative to nectarines that are imported to South Africa as well as nectarines with a label that communicates information on safety checks done by health officials with a marginal willingness to pay of 16.63 Rands more per 750 grams of nectarines relative to no communication received on safety checks done by health officials.

The next coefficient presented in Table 4 represents the appearance attribute, which is negative and significant at the 5% level with the expected sign. The negative sign for the appearance coefficient indicates that fruit consumers in Polokwane have lesser preference and derive negative utility and that they are willing to pay 12.28 Rands less per 750 grams of nectarines that are bruised relative to nectarines that are wholesome looking. The highest utility increase was caused by the country of origin, followed by the food safety certification. Meanwhile, the presence of bruises on the nectarines caused the decrease in utility. In addition, the CLM estimated a negative and statistically significant price coefficient at the 1% level, which indicates lower utility from higher nectarine prices. In line with economic theory, we normally presume consumers to choose lower prices, so the sign associated with the coefficient coincides with our expectations. The alternative specific constant (ASC) for the opt out option turned out negative and statistically significant, indicating a distinct opposition to the status quo. This indicates, on average, consumers were substantially more likely to choose alternatives 1 or 2.

The conditional logit model without interactions unveils a relatively good fit for the data. This is noticeable from McFadden pseudo-R^2 value of 0.353. A pseudo-R^2 value ranging between 0.200 and 0.400 reflects a relatively good fit (Hensher et al., 2005). Consumers viewed all the selected attributes (food safety certification, appearance, country of origin, and price) as appropriate (Wongprawmas and Canavari, 2017).

5.4 Preference heterogeneity

The results for the interaction model obtained from the empirical specification of equation 7 are reported in Table 5. There were six interaction terms identified. It is important to note that the final set of interactions was determined after exhaustive testing of the appropriate variables and attributes. When the primary attributes interact with socio-demographic characteristics, the model's fitness is enhanced. The incorporation of socio-demographic characteristics could account for choice heterogeneity (Fontes et al., 2015) and precision in the model estimation (Hanley et al., 2001). However, certain attribute signs and coefficients stay the same as in the conditional logit model without interactions, while others change.

Table 5: The conditional logit model with interactions

Variables	**Coefficient**	**Std Error**	**MWTP**
ASC	- 2.741***	0.170	- 126.49***
FS_Cert	0.384**	0.152	17.72**
App	0.103	0.157	4.75
Orgn	0.449***	0.139	20.75***
Price	- 0.021***	0.001	
Interaction Terms			
FS_Cert_Age_31_40	0.041	0.246	1.92
FS_Cert_Age_41_50	- 0.420*	0.245	- 19.42*
FS_Cert_Age_51_&_Above	- 0.142	0.240	- 6.58
FS_Cert_Inc_Med	0.230	0.191	10.64
FS_Cert_Inc_High	- 0.167	0.285	- 7.72
App_Age_31_40	- 0.598**	0.245	- 27.63**
App_Age_41_50	0.306	0.241	14.15
App_Age_51_&_Above	0.004	0.239	0.19
App_Inc_Med	- 0.491**	0.192	- 22.69**
App_Inc_High	- 1.147***	0.277	- 52.96***
Orgn_Age_31_40	0.101	0.220	4.68
Orgn_Age_41_50	0.520**	0.225	23.99**
Orgn_Age_51_&_Above	0.215	0.219	9.93
Orgn_Inc_Med	- 0.194	0.174	- 8.97
Orgn_Inc_High	0.444*	0.259	20.51*
Number of Observations		4560	
Log-likelihood		- 1054.292	
Pseudo-R^2		0.368	

Note: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

The results show that food safety certification and country of origin are statistically significant with the expected signs in both the conditional logit model without interactions and conditional logit model with interactions, which can be explained by the fact that respondents placed a high value on both of these attributes. The price and alternative specific constant (ASC) remained negative and statistically significant at the 1% level for both models suggesting a lower utility from higher nectarine prices and a specific preference against the status quo. However, appearance was reported not to be significant with an expected sign that is not correct in the interaction model.

As mentioned by Joya et al (2021), the role of age is very important in the willingness to pay for attributes of fruits and vegetables. Firstly, the interaction with age produced a negative and incorrect expected sign to the FS_Cert_Age_41_50

variable and it is statistically significant at the 10% level. This indicates that individuals aged between 41 to 50 years derive less utility and that they are willing to pay 19.42 Rands less per 750 grams of nectarines with a label that communicates information on safety checks done by health officials relative to individuals aged between 18 to 30 years. Secondly, the interaction with age produces a negative and expected sign to the App_Age_31_40 variable and it is statistically significant at the 5% level. This indicates that individuals aged between 31 to 40 years derive less utility and are willing to pay 27.63 Rands less per 750 grams of nectarines that are bruised relative to individuals aged between 18 to 30 years. Consequently, the interaction with age produces a positive and expected sign to the Orgn_Age_41_50 and it is statistically significant at the 5% level. This indicates that individuals aged between 41 to 50 years derive a higher utility and are willing to pay 23.99 Rands more per 750 grams of nectarines that are produced in South Africa relative to individuals aged between 18 to 30 years. The older age variable (represented by 51 & above) was reported not to be significant for all the attributes of nectarines. The interaction with income level produces a negative sign to the appearance variable and it is statistically significant at the 5% and 1% level, respectively. This indicates that individuals with medium to high income levels derive less utility and that they are willing to pay 22.69 and 52.96 Rands respectively, less per 750 grams of nectarines that are bruised relative to individuals with low income levels. Additionally, the interaction with income produces a positive and expected sign to the Orgn_Inc_High and it is statistically significant at the 10% level. This indicates that individuals with high income derive a higher utility and are willing to pay 20.51 Rands more per 750 grams of nectarines that are produced in South Africa relative to individuals aged between 18 to 30 years. The levels of income interactions were not statistically significant for food safety certification.

Based on the results, the conditional logit model with interactions has a better goodness of fit as compared to the conditional logit model without interactions. It can be observed from the McFadden pseudo-R^2 value for the conditional logit model without interactions to the model with interactions has increased from 0.353 to 0.368 respectively as well as a higher level of model fit with improvements in the likelihood value which is -1054.292 as compared to -1079.982 in the conditional logit model without interactions. Furthermore, based on the likelihood ration test, we can say that the conditional logit model with interactions represents a significant improvement in relative to the conditional logit model without interactions [$LR\chi 2(15) = 51.38$, $p < 0.000$].

6. Discussion

Food safety among many consumers in developing countries has become a major source of concern. Evidence from the literature reviewed shows that many consumers are willing to pay more for safer food, hence the current study looks at the demand for increased food safety among consumers in developing countries with food safety labels as one of the determining factor's. This study has utilised the discrete choice experiment to determine what the consumers prefer and their willingness to pay for food safety attributes of nectarines in the Polokwane Municipality area of Limpopo, South Africa. To demonstrate the uniqueness of this study on food safety attributes, food safety certification was introduced. The conditional logit analysis presents an in-depth analysis of attribute preferences, demonstrating that consumers have extremely distinct preferences for different nectarine attributes. Generally, the results show that the food safety certification and the country of origin were the most preferred attributes, meaning that consumers highly valued and were willing to pay more for nectarines with a label that communicates information on safety checks done by health officials relative to no communication received on safety checks done by health officials. Additionally, consumers are willing to pay less for nectarines which are bruised relative to wholesome looking ones. These findings were consistent with Joya et al. (2021).

Another focus of this study looked at the heterogeneity in consumers willingness to pay for food safety attributes as explained by socio-economic characteristics. Age and income were found to have a significant impact on the willingness to pay for attributes of nectarines. Furthermore, this study discovered that older consumers (between 31 and 50 years) are more likely to be aware of concerns about food safety and willing to pay more than younger consumers (between 18 and 30 years). Consistent with the findings of Muhammad et al. (2015) and Joya et al. (2021) which revealed that older consumers were willing to pay more for organic and safer fresh produce. This demonstrated that older consumers placed a greater emphasis on the attributes of nectarines than did younger consumers, more especially on the food safety certification, country of origin, appearance. The results also show that consumers valued the food safety certification and country of origin as the most essential attributes. In particular, food safety certification was the main focus of this study and it was non-negotiable as we accounted for preference heterogeneity in

consumers. However, on the contrary, it must be added that older consumers were willing to pay 19.42 Rands less for nectarines that had a label that communicates information on safety checks done by health officials relative to the younger consumers, this outcome may have been caused by many respondents who have disagreed that unsafe food is widely spread in the South African food system, perceiving that there is a low risk of obtaining unsafe food. Similarly, in the case of Nigerian consumers, Osemeke et al. (2013) found that consumers generally were not willing to pay more where it is believed that there is a low risk in the fresh produce. Furthermore, it was discovered that the older consumers were willing to pay 23.99 Rands more compared to the younger consumers, for nectarines produced in South Africa, this may be attributed to the fact that most consumers believed that the government supervision of food safety was fair. Similar results have been found in (Ortega et al., 2011; Wongprawmas & Canavari, 2017; Liu et al., 2020) in which consumers were willing to pay more for the country of origin for fruit produce and improved government supervision. These findings have significant implications for the fruit and vegetable industry, policymakers, and regulatory authorities in terms of risk assessment, risk management, and risk communication to increase consumer trust in the food system (Shonhiwa et al., 2018).

Furthermore, the results also showed that consumers valued the appearance as the least important attribute. In particular, appearance attribute became insignificant in the interaction model and it was explained further by the preference heterogeneity in consumers aged between 31 and 50 with medium to high income levels and were willing to pay less for bruised nectarines compared to consumers whom were age between 18 and 30 with a low income level. This finding was consistent with Joya et al. (2021) who found that older consumers were willing to pay less for bruised tomatoes compared to the younger consumers in low income level categories. Furthermore, the importance of a reasonable price was recognized by all participants. This indicates that, despite the importance of the other attributes, price may prevent these consumers from converting their tastes into purchasing behaviour.

The study of consumer preferences in the Polokwane Municipality offers policymakers and those responsible for implementing new and enhanced policy instruments in South Africa valuable insights. The consumer preferences analysis reveals that consumers in Polokwane give a greater emphasis to nectarines with a label that communicates information on safety checks done by health officials relative to no communication received on safety checks done by health officials. Considering that the food safety certification is rarely found on the market, it is clear that there is still a significant gap of information that still remains among fruit consumers in Limpopo, South Africa. Concentrating on the limited development of

food safety labelling in the South African agri-food markets, Ran et al. (2022) contends that the lack of information to consumers is the primary obstacle to the development of sustainable and safer food production. Lack of information and little confidence in the governments supervision of food safety systems generally lead to older consumers in Polokwane putting less importance on food safety issues occurring in the country. For these reasons, policy instruments aimed at enhancing consumer information awareness should be developed in the future for fruit consumers in Polokwane, Limpopo in order to alleviate this asymmetry, as the results reveal that consumers are interested and place a value on the food safety certification. This recommendation may have significant policy implications and result in the implementation of an alternative label for agricultural-related goods. This alternative will become more simpler to access to a greater number of small holder producers in the province and become more appealing to consumers. Furthermore, the possibility of introducing a label that addresses the primary consumer concerns and provides information on the testing, verification, and certification process should also be taken into account by public authorities, as this label may achieve and add onto the purpose of the "Rinse before use" sign currently implemented on fresh produce in the country.

In contrast, a "locally produced" label for fresh produce might be effectively applied. The findings of this study may support the decision taken by the South African government to suggest a quality sign (similar to the existing "Proudly South African" label) that may be implemented widely across supermarkets on agri-food products regardless of being a private label or not, as some of the supermarkets do not implement this sign on their fresh produce. This will make the fruit products more appealing as consumers are willing to pay more for nectarines produced in South Africa. These can be transformed into business opportunities if producers have the abilities to react to consumer demands effectively. The application procedures and requirements that must be met for carrying out these ideas are still vague and inadequately specified. These findings may assist policymakers in defining the features that this label must possess in order to be beneficial and widely accepted by consumers.

There were several limitations to the study's approach in this instance. If it is feasible to broaden the scope of future research, the research framework can be improved. The following suggestions emerged from this study. The experiment conducted in this study was hypothetical with emphasize that, when studying attributes that are not (yet) on the market, observational data is not possible, and the DCE method is therefore commonly applied. Only four attributes for nectarines (food safety certification, appearance, country of origin and price) were established for the purpose of this study, but additional attributes can be incorporated. For

instance, the type of production system (e.g. organic or conventional), packaging, traceability and other types of markets (e.g. wet/fresh market) and so forth, may be utilized to gain a deeper understanding of what consumers are willing to pay in relation to price increases or decreases, in addition to preferences for various products and attributes. (Liu et al., 2020).

This study was limited to the consumer perspective, and the results represent only the current consumer preferences and willingness to pay for food safety attributes of nectarines. The objective of follow-up research could be to investigate the producer's perspective and compare the views of different respondents regarding the different attributes of nectarines or other stone fruit cultivars. Moreover, because the survey is limited to a convenience sample in the Polokwane Municipality of Limpopo, South Africa, the findings of this study cannot be generalized to the whole country. In order to tackle this limitation, future research may consider investigating other regions in South Africa and applying random probability sampling. Future research can use the random parameter logit or latent class model to test for unobserved heterogeneity in respondent preferences regarding the food safety attributes of nectarines and other types of stone fruit cultivars. Furthermore, this type of study can be applied to the subject matter of meat and animal products as well as milk and dairy products, as these are the products that require the most resources to produce. Therefore, leading to higher exposure of chemical and biological food-borne risks.

7. Conclusion

This study provides an analyses of relevant food safety attributes of fresh fruit produce which may be addressed in future research evaluations in South Africa. A discrete choice experiment was used to measure the preferences and willingness to pay for food safety attributes of nectarines from 152 fruit consumers at supermarkets located around the Polokwane Municipality area of Limpopo, South Africa. The study investigated consumer preferences and willingness to pay for food safety attributes of nectarines. These objectives were attained through a survey that called for consumers to choose between different types of nectarines from a hypothetical choice set. Four attributes of food safety namely; food safety certification, appearance, country of origin and price were incorporated into the design, each dispensing different information regarding nectarines. Results show that along with the country of origin, the food safety certification was the most preferred attribute, meaning that consumers highly valued and were willing to pay more for nectarines with a label that communicates information on safety checks done by health officials relative to no communication received on safety checks done by health officials. This suggests that a credible food safety labelling regime has the potential to assist consumers in identifying safer fruit and vegetables, and that this could potentially be a useful policy tool. Additionally, the appearance attribute was the least preferred attribute meaning that it was not highly valued by consumers and they were willing to pay less for nectarines that were bruised relative to the wholesome looking ones.

The study also explored the heterogeneity in consumers willingness to pay for food safety attributes which varied by socio-demographic characteristics. For instance, older consumers were willing to pay less for nectarines with a label that communicates information on safety checks done by health officials relative to the younger consumers as well as nectarines that were bruised relative to the younger consumers. Furthermore, the older consumers were also willing to pay more for nectarines that were produced in South Africa relative to the younger consumers. We also found that medium to higher income earning consumers were willing to pay less for nectarines that were bruised relative to lower income earning consumers. As noted earlier, there is a need for policy formulation to ensure fruit producers supply fruit that meets the required safety standards and this could be

done through labels in order to communicate attributes with greater effectiveness; if they have an in-depth understanding of the socio-demographic characteristics of the consumers they are targeting. The possibility of obtaining a price premium through the detection of such interventions via labels appears optimistic. Attracting consumers who value these interventions will necessitate a sophisticated presentation of information on labels that subsequently eliminates consumers' concerns and points to the product's increased safety.

References

Adeboye, A.S., Babarinde, G.O., Oyedepo, J.A., Aniagor, E.N. and Emmambux, N.M., (2021). Smart crops for climate change and food security in Africa. Food Security and Safety: African Perspectives, pp.415-449.

Akaichi, F., Nayga Jr., R.M., Gil, J.M., (2013). Are results from non-hypothetical choice based conjoint analyses and non-hypothetical recoded-ranking conjoint analyses similar? Am. J. Agric. Econ. 95 (4), 949–963.

Akinwehinmi, O., Ogundari, K. and Amos, T.T. (2021). 'Consumers' food control risk perception and preference for food safety certification in Emerging Food Markets', Journal of Agricultural Economics, 73(3), pp. 690–708. doi:10.1111/1477-9552.12474.

Alphonce, R. and Alfnes, F. (2012). "Consumer willingness to pay for food safety in Tanzania: An incentive-aligned conjoint analysis," International Journal of Consumer Studies, 36(4), pp. 394–400. Available at: https://doi.org/10.1111/j.1470-6431.2011.01067.x.

Bakker, S., Mc Mahon, D. and Uwase, V. (2020). "Patterns and determinants of fruit and vegetable consumption in urban Rwanda: Results of an urban consumer study in Kigali and north-western Rwanda." Available at: https://doi.org/10.18174/529441.

Bazzani, C., Caputo, V., Nayga, R. M., Jr., & Canavari, M. (2017). Revisiting consumers' valuation for local versus organic food using a non-hypothetical choice experiment: Does personality matter? Food Quality and Preference, 62,539 144–154.

Bennett, J. and Birol, E. (2010). "Choice experiments in developing countries." Available at: https://doi.org/10.4337/9781781000649.

Bonti-Ankomah S. and Yiridoe, E.K. (2006). Organic and conventional food: A literature review of the economics of consumers‟ perceptions and preference. Final Report. Organic agriculture centre of Canada. Nova Scotia Agricultural College, Truro, Nova Scotia, Canada.

Bouranta, N. et al. (2022). 'Consumers' food safety perceptions in three Mediterranean countries', New Medit, 21(4). doi:10.30682/nm2204f.

Brodie, L. (2022). Stone fruit from South Africa March 2022, Lucentlands. Available at: http://lucentlands.co.za/news/stone-fruit-from-south-africa-march-2022/ (Accessed: October 16, 2022).

Burton, M., Rigby, D., Young, T., and James, S. (2001). "Consumer Attitudes to Genetically Modified Organisms in Food in the UK." European Review of Agricultural Economics. 28(4): 479-498.

Castello, M.A. (2003). Eliciting consumers preferences using stated preference discrete choice models: contingent ranking versus choice. PHD Thesis. Departament d‟Economia i Empresa, Universitat Pompeu Fabra, Ramon Trias Fargas 25-27, 08005 Barcelona, Spain.

Chalak, A. et al. (2019). 'Qualitative and quantitative cues in consumers' valuation of food safety: Evidence from Lebanon', Journal of Food Safety, 39(3). doi:10.1111/jfs.12632.

Competition Commission. (2021). Measuring Concentration and Participation in the South African Economy: Levels and Trends. Summary Report of Findings and Recommendations, p45.

Darko, G. and Akoto, O. (2008). 'Dietary intake of organophosphorus pesticide residues through vegetables from Kumasi, Ghana', Food and Chemical Toxicology, 46(12), pp. 3703–3706. doi:10.1016/j.fct.2008.09.049.

Desk, N. (2019). Fresh peaches, nectarines and plums from Chile recalled for listeria, Food Safety News. Available at: https://www.foodsafetynews.com/2019/01/fresh-peaches-nectarines-and-plums-from-chile-recalled-for-listeria/ (Accessed: October 16, 2022).

Dewi, H. et al. (2022). "Examining consumer preferences and willingness to pay for organic vegetable attributes: Using a discrete choice experiment," HABITAT, 33(2), pp. 112–121. Available at: https://doi.org/10.21776/ub.habitat.2022.033.2.12.

Dinnella, C. et al. (2014). "An exploratory study of sensory attributes and consumer traits underlying liking for and perceptions of freshness for ready to eat mixed salad leaves in Italy," Food Research International, 59, pp. 108–116. Available at: https://doi.org/10.1016/j.foodres.2014.02.009.

FAO. (1993). Consumers and food safety: A food industry perspective. Consumers and food safety: A Food Industry Perspective. https://www.fao.org/3/V2890t/v2890t05.htm.

FAO. (2021). Fruit and vegetables – your dietary essentials. The International Year of Fruits and Vegetables, background paper. Rome. https://doi.org/10.4060/cb2395en.

Focker, M; van der Fels-Klerx, HJ. (2020). Economics applied to food safety. Current Opinion in Food Science, 36(1), 18-23. doi:10.1016/j.cofs.2020.10.018.

Fontes, M.A., Giraud-Héraud, E. and Pinto, A.S. (2015). "Consumers' behaviour towards Food Safety: A Literature Review," Food Safety, Market Organization, Trade and Development, pp. 111–131. Available at: https://doi.org/10.1007/978-3-319-15227-1_6.

Gao, Z., Yu, X., Li, C., and Mcfadden, B. R. (2019). The interaction between country of origin and genetically modified orange juice in urban China. Food Quality and Preference, 71, 475–484.

Grace, D. (2015). 'Food safety in low and middle income countries', International Journal of Environmental Research and Public Health, 12(9), pp. 10490–10507. doi:10.3390/ijerph120910490.

Gracia, A., Barreiro-Hurlé, J., and Galán, B. L. (2014). Are local and organic claims complements or substitutes? A consumer preferences study for eggs. Journal of Agricultural Economics, 65(1), 49–67.

Hanley, N., Mourato, S and Wright, R. E. (2001). Choice Modeling Approaches: A Superior Alternatives for Environmental Evaluation? Journal of Economic Surveys 15(3): 436-453.

Hensher, D.A., Shore, N. and Train, K. (2005). Households' willingness to pay for water service attributes. Environmental & Resource Economics 32: 509-531.

Horowitz, J., Keane, M., Bolduc, D., Divakar, S., Geweke, J., Gonul, F., Hajivassiliou, V., Koppelman, F., Matzkin, R., Rossi, P. and Ruud, P. (1994). Advances in Random Utility Models. Marketing Letters, 5 (4).

Hou B, Wu L, Chen X, Zhu D, Ying R, Tsai F-S. (2019). Consumers' Willingness to Pay for Foods with Traceability Information: Ex-Ante Quality Assurance or Ex-Post Traceability? Sustainability 11(5):1464. https://doi.org/10.3390/su11051464

Huber, J., and K. Zwerina. (1996). The Importance of Utility Balance in Efficient Choice Designs. Journal of Marketing Research 23: 301–317.

Ingrassia, M. et al. (2016). "Study of consumer preferences in regard to the blonde Orange CV.washington navel'arancia di Ribera PDO,'' Journal of Food Products Marketing, 23(7), pp. 799–816. Available at: https://doi.org/10.1080/10454446.2016.1164102.

Joya, K. et al. (2021). "Consumers' willingness to pay for food safety attributes of Tomato," British Food Journal, 124(3), pp. 701–717. Available at: https://doi.org/10.1108/bfj-02-2021-0164.

Kjaer, T. (2005). A review of discrete choice experiment- with emphasis on its application in health care. Odense: University Of Southern Denmark.

Kokthi, E. and González-Limón, M. (2015). 'Origin or Food Safety attributes? Analyzing consumer preferences using Likert Scale. Empirical evidence from Albania', New Medit, 14(4), pp. 50–57.

Lai, J., Wang, H. H., Ortega, D. L., and Olynk Widmar, N. J. (2018). Factoring Chinese consumers' risk perceptions into their willingness to pay for pork safety, environmental stewardship, and animal welfare. Food Control, 85, 423–431. https://doi.org/10.1016/j.foodcont.2017.09.032.

Lancaster, K.J. (1966). A New Approach to Consumer Theory. Journal of Political Economy, 74 (2), 132–157

Lewis, K. E., Grebitus, C., Colson, G., and Hu, W. (2017). German and British consumer willingness to pay for beef labeled with food safety attributes. Journal of Agricultural Economics, 68(2), 451–470. https://doi.org/10.1111/1477-9552.12187.

Liu, R. et al. (2020). 'Food Safety Concerns and consumer preferences for Food Safety Attributes: Evidence from China', Food Control, 112, p. 107157. doi:10.1016/j.foodcont.2020.107157.

Loureiro, M. L., and Umberger, W. J. (2007). A choice experiment model for beef: What US consumer responses tell us about relative preferences for food safety, country-of-origin labeling and traceability. Food Policy, 32(4), 496–514. https://doi.org/10.1016/j.foodpol.2006.11.006.

Louviere J. J. and Woodworth G. G. (1983). Design and analysis of simulated choice or allocation experiments: an approach based on aggregate data. Journal of Marketing Research 20: 350-367.

Luce, R. D. (1959) Individual Choice Behaviou: A Theouetical Analysis, New York: John Wiley & Sons.

Lusk, J. L., Schroeder, T. C., and Tonsor, G. T. (2013). Distinguishing beliefs from preferences in food choice. European Review of Agricultural Economics, 41(4), 627–655. https://doi.org/10.1093/erae/jbt035

Mangham, L.J., Hanson, K. and McPake, B. (2009). "How to do (or not to do) … designing a discrete choice experiment for application in a low-income country," Health Policy and Planning, 24(2), pp. 151–158. Available at: https://doi.org/10.1093/heapol/czn047.

Manski, C.F. (1977). The Structure of Random Utility Models. Theory and Decision, 8 (3), 229–254.

McFadden, D. (1974). Conditional Logit Analysis of Qualitative Choice Behaviour. Frontiers in Econometrics, edited by P. Zarembka, 105-142. New York Academic Press.

Mditshwa, A. et al. (2017). "Postharvest quality and composition of organically and conventionally produced fruits: A Review," Scientia Horticulturae, 216, pp. 148–159. Available at: https://doi.org/10.1016/j.scienta.2016.12.033.

Mhlophe, B. (2016). "Consumer purchase intentions towards Organic Food: Insights from South Africa," Business & Social Sciences Journal (BSSJ), 1(1). Available at: https://doi.org/10.26831/bssj.2016.1.1.1-32.

Millock, K., L.G. Hansen, M. Wier and L.M. Anderson., (2002). Willingness to pay for organic products: A comparison between survey data and panel data from Denmark ,AKF Denmark.

Moreb, N.A. et al. (2021). "Fruits and vegetables in the management of underlying conditions for COVID-19 high-risk groups," Foods, 10(2), p. 389. Available at: https://doi.org/10.3390/foods10020389.

Mørkbak, M. R., Christensen, T., and Gyrd-Hansen, D. (2010). Choke price bias in choice experiments. Environmental and Resource Economics, 45(4), 537–551. https://doi.org/10.1007/s10640-009-9327-z.

Muhammad, S., Fathelrahman, E. and Tasbih, U.R.U. (2015), "Factors affecting consumers' willingness to pay for certified organic food products in United Arab Emirates", Journal of Food Distribution Research, Vol. 46 No. 1, pp. 37-45, doi: 10.22004/ag.econ.199045.

Mutengwe, M.T., Chidamba, L. and Korsten, L. (2016). "Pesticide residue monitoring on South African fresh produce exported over a 6-year

period," Journal of Food Protection, 79(10), pp. 1759–1766. Available at: https://doi.org/10.4315/0362-028x.jfp-16-022.
Oni O.A, Oladele O.I, Inedia O.F. (2005). Consumer Willingness To Pay For Safety Labels In Nigeria: A case study of Potassium Bromate in bread. Journal of Central European Agriculture, 6(3) pp. 381-388.
Orme, B. (1998). Sample size issues for conjoint analysis studies, Sawtooth Software Technical Paper, Sequim.
Ortega, H., Wang, H., Wu, L., Nicole J., Olynk. (2011). Modeling heterogeneity in consumer preferences for select food safety attributes in China. , 36(2), 318–324. doi:10.1016/j.foodpol.2010.11.030
Ortega, D. L., and Tschirley, D. L. (2017). Demand for food safety in emerging and developing countries: a research agenda for Asia and Sub-Saharan Africa. Journal of Agribusiness in Developing and Emerging Economies, 7(1), 21-34.
Osemeke, A.E., Ayodele, F.E. and Omobowale, O.A. (2013). "Consumers' Willingness to Pay for Safety Attributes of Bread in Lagos metropolis, Nigeria," International Conference of the African Association of Agricultural Economics [Preprint]. Available at: https://doi.org/10.22004/ag.econ.161630.
Premashthira, A. ., Photchanaprasert, N. ., & Sanglestsawai, S. (2022). "Consumer preferences for pork safety characteristics in Thailand," Kasetsart Journal of Social Sciences, 43(3), 653–660.
Quaife, M. et al. (2018) 'How well do discrete choice experiments predict health choices? A systematic review and meta-analysis of external validity', The European Journal of Health Economics, 19(8), pp. 1053–1066. doi:10.1007/s10198-018-0954-6.
Ragasa, C. et al. (2019). "Consumer demand and willingness to pay for Safe Food in Accra, Ghana: Implications for public and private sectors' roles in food safety management," IFPRI Discussion Paper 01795 [Preprint]. Available at: https://doi.org/10.2499/p15738coll2.133054.
Ran, Y. et al. (2022). 'Information as an enabler of sustainable food choices: A behavioural approach to understanding consumer decision-making', Sustainable Production and Consumption, 31, pp. 642–656. doi:10.1016/j.spc.2022.03.026.
Schrobback, P., Zhang, A., Loechel, B., Ricketts, K., & Ingham, A. (2023). Food credence attributes: A conceptual framework of supply chain stakeholders, their motives, and mechanisms to address information asymmetry. Foods, 12(3), 538. https://doi.org/10.3390/foods12030538.
Shonhiwa, A.M. et al. (2018). 'A review of foodborne disease outbreaks reported to the outbreak response unit, National institute for communicable diseases, South Africa, 2013 – 2017', 2Centre for Enteric Diseases, NICD, 16(1).
Skreli, E., Imami, D., Chan-Halbrendt, C., Canavari, M., Zhllima, E. & Pire, E. (2017). Assessing consumer preferences and willingness to pay for

organic tomatoes in Albania: a conjoint choice experiment study. Spanish Journal of Agricultural Research, 15 (3), e0114.
Tanner, D. (2016). Impacts of storage on food quality. Reference Module in Food Science, 1–3. https://doi.org/10.1016/b978-0-08-100596-5.03479-x
Thurstone, L.L. (1927). A law of comparative judgment. Psychological Review, 34 (4), 273–286. https://doi.org/10.1037/h0070288.
Train, K. E. (2009). Discrete Choice Methods with Simulation. Cambridge University Press.
Tran, N., Shikuku, K. M., Hoffmann, V., Lagerkvist, C. J., Pincus, L., Akintola, S. L., Fakoya, K. A., Olagunju, O. F., & Bailey, C. (2022). Are consumers in developing countries willing to pay for Aquaculture Food Safety Certification? evidence from a field experiment in Nigeria. *Aquaculture*, *550*, 737829. https://doi.org/10.1016/j.aquaculture.2021.737829.
Wang, L. and Huo, X. (2016a). 'Willingness-to-pay price premiums for certified fruits —a case of fresh apples in China', Food Control, 64, pp. 240–246. doi:10.1016/j.foodcont.2016.01.005.
Wekeza, S. and Sibanda, M. (2019). "Factors influencing consumer purchase intentions of organically grown products in Shelly Centre, Port Shepstone, South Africa," International Journal of Environmental Research and Public Health, 16(6), p. 956. Available at: https://doi.org/10.3390/ijerph16060956.
Wongprawmas, R. and Canavari, M. (2017). "Consumers' willingness-to-pay for food safety labels in an emerging market: The case of fresh produce in Thailand," Food Policy, 69, pp. 25–34. Available at: https://doi.org/10.1016/j.foodpol.2017.03.004.
World Health Organization. (2022). Towards Stronger Food Safety Systems and global cooperation. Available at: https://apps.who.int/iris/bitstream/handle/10665/364638/9789240061200-eng.pdf (Accessed: 05 July 2023).
Yin, S., Hu, W., Chen, Y., Han, F., Wang, Y. and Chen, M. (2018a). "Chinese consumer preferences for fresh produce: interaction between food safety labels and brands", Agribusiness, Vol. 4 No. 2, pp. 1-16, doi: 10.1002/agr.21585.

Acknowledgements

This thesis is dedicated to my Mom (Eunice Mashego) your sacrifices and guidance have made this achievement possible. I love you always.

I am incredibly grateful for the opportunity to express my heartfelt appreciation to all those who have supported me throughout my academic journey. I would like to extend my sincere gratitude to the Agricultural, Food and Environmental Policy Analysis (AFEPA) committee for awarding me the scholarship, which has allowed me to pursue my academic dreams and goals.

I would also like to express my appreciation to my supervisors Anna Kristina Edenbrandt and Elena Castellari, who have been a constant source of guidance and support. Your encouragement and belief in me have been invaluable, and I am eternally grateful for your mentorship.

I would like to express my deepest gratitude to Jens Rommel, Enoch Owusu Sekyere, Seputu Mampane and Phillimon Mabe for the part they have played in the completion of my thesis. Your encouragement and help have been extremely valuable, and I am privileged to have had you by my side althrough this endeavor.

To my family and friends, I cannot thank you enough for your unwavering support, love, and encouragement. Your belief in me has been my driving force, and I am grateful for the sacrifices you have made to ensure that I achieve my academic aspirations.

Finally, I would like to thank all those who have believed in me, encouraged me, and supported me throughout my academic journey. Your kindness and generosity have made all the difference, and I will forever be grateful for your support.

Appendix 1

Introduction and consent to the survey

A SURVEY ABOUT FRUIT CONSUMPTION

Dear Participant,

My name is Kgodisho Mashego, I am a student in the department of Economics at the Swedish University of Agricultural Sciences. I am conducting a study in the Polokwane municipality area and I would be pleased if you devote **10-15 minutes** of your time to fill in this questionnaire. Please note, you must be **18 years** or older to participate.

Purpose of the study:
This questionnaire is part of the requirements of my master's thesis research course and it is intended to assess your preferences and attitudes towards different aspects of fruit consumption.

Description of the discomforts, inconveniences, and/or risks that can be reasonably expected as a result of participation:
There are no foreseeable risks, discomforts, or inconveniences associated with participation in this study.

Compensation and benefits for participating in this study:
While there is no monetary compensation for participating in this survey, your participation is of great importance for my master thesis and possible benefits may include learning something about how an experiment is designed and conducted, what issues are of interest to social scientists, and how your own cognitive abilities come into play in decision-making situations.

Contact information:
If you should have any questions about this research study or possible injury, please feel free to contact me at kgma0001@stud.slu.se

Confidentiality:
The questionnaire is anonymous and intended for research purposes only and I will not be able to identify you or any other participant.

Many thanks

STATEMENT BY PERSON AGREEING TO PARTICIPATE IN THIS STUDY
I have read this informed consent document and the material contained in it has been explained to me verbally. I understand each part of the document, all my questions have been answered, and I freely and voluntarily choose to participate in this study.

- ○ Yes, I consent
- ○ No, I do NOT consent

Appendix 2

Screening Question

Cheap talk script

Before you go through the upcoming section, I would like you to take note:

Imagine that you are in a supermarket shopping, you suddenly remember that you are out of fruits and decide to shop for 750g punnet's of nectarines. There are different nectarines available with varying attributes and at different prices. The nectarines may have other attributes that are not included and the available prices may be different from the ones you now see at the supermarket you shop at.

However, we want you to imagine that the prices and attributes available below are the ones that you see on a shopping trip, and make your choice based on what you actually believe you would choose. So, it is important that you answer the questions exactly as you would answer if you were really going to face these choices at your local supermarket and buy the item with real money.

Appendix 3

Food safety risk perception questions

Please Indicate to what extent you agree with the following statements.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Food safety incidents happen frequently in South Africa	○	○	○	○	○
Unsafe food is widely spread in the South African food system	○	○	○	○	○
People's health is at risk due to the current South African food system	○	○	○	○	○
My health can easily be at risk because of unhealthy food	○	○	○	○	○
My health risk is highly related to food safety due to the current South African food safety system	○	○	○	○	○

Appendix 4

Conditional Logit Model without Interactions results

Table 6: Conditional logit model without interaction results

Variables	Coefficient	Std Error	z	P >| z |	[95% conf. interval]
ASC	- 2.694	0.167	- 16.12	0.000	[-3.021; -2.366]
FS_Cert	0.350	0.102	3.43	0.001	[0.150; 0.550]
App	- 0.258	0.103	- 2.49	0.013	[-0.461; -0.054]
Orgn	0.583	0.088	6.62	0.000	[0.410; 0.755]
Price	- 0.021	0.001	- 12.98	0.000	[-0.024; -0.017]
Number of Observations			4560		
Log-likelihood			- 1079.982		
Pseudo-R^2			0.353		

Appendix 5

Conditional Logit Model with Interactions results

Table 7: Conditional logit model with interactions results

Variables	Coefficient	Std Error	z	P >| z |	[95% conf. interval]
ASC	- 2.741	0.170	- 16.10	0.000	[-3.074; -2.407]
FS_Cert	0.384	0.152	2.51	0.012	[0.084; 0.683]
App	0.103	0.157	0.65	0.513	[-0.206; 0.412]
Orgn	0.449	0.139	3.22	0.001	[0.176; 0.723]
Price	- 0.021	0.001	- 13.11	0.000	[-0.024; -0.018]
Interaction Terms					
FS_Cert_Age_31_40	0.041	0.246	0.17	0.865	[-0.440; 0.524]
FS_Cert_Age_41_50	- 0.420	0.245	- 1.71	0.087	[-0.902; 0.060]
FS_Cert_Age_51_&_Above	- 0.142	0.240	- 0.59	0.553	[-0.613; 0.328]
FS_Cert_Inc_Med	0.230	0.191	1.21	0.228	[-0.144; 0.605]
FS_Cert_Inc_High	- 0.167	0.285	- 0.59	0.557	[-0.726; 0.391]
App_Age_31_40	- 0.598	0.245	- 2.44	0.015	[-1.080; -0.116]
App_Age_41_50	0.306	0.241	1.27	0.205	[-0.167; 0.780]
App_Age_51_&_Above	0.004	0.239	0.02	0.986	[-0.465; 0.473]
App_Inc_Med	- 0.491	0.192	- 2.56	0.011	[-0.868; -0.114]
App_Inc_High	- 1.147	0.277	- 4.13	0.000	[-1.692; -0.602]
Orgn_Age_31_40	0.101	0.220	0.46	0.646	[-0.331; 0.534]
Orgn_Age_41_50	0.520	0.225	2.31	0.021	[0.078; 0.962]
Orgn_Age_51_&_Above	0.215	0.219	0.98	0.328	[-0.215; 0.646]
Orgn_Inc_Med	- 0.194	0.174	- 1.11	0.266	[-0.536; 0.147]
Orgn_Inc_High	0.444	0.259	1.71	0.087	[-0.064; 0.953]
Number of Observations			4560		
Log-likelihood			-1054.292		
Pseudo-R^2			0.368		

Appendix 6

Marginal Willingness to Pay

Table 8: Marginal Willingness to pay results

Variables	**Conditional Logit Model without Interactions**		**Conditional Logit Model with Interactions**	
	MWTP	**95% Confidence Interval**	**MWTP**	**95% Confidence Interval**
ASC	- 128.02***	[-152.61; -108.34]	- 126.49***	[-150.24; -106.98]
FS_Cert	16.63***	[7.09; 26.06]	17.72**	[3.59; 31.84]
App	- 12.28**	[-23.34; -2.74]	4.75	[-9.04; 17.83]
Orgn	27.70***	[20.16; 35.46]	20.75***	[8.72; 32.35]
Interaction Terms				
FS_Cert_Age_31_40			1.92	[-18.88; 25.25]
FS_Cert_Age_41_50			- 19.42*	[-41.70; 3.16]
FS_Cert_Age_51_&_Above			- 6.58	[-27.34; 15.62]
FS_Cert_Inc_Med			10.64	[-5.98; 27.16]
FS_Cert_Inc_High			- 7.72	[-33.71; 16.18]
App_Age_31_40			- 27.63**	[-49.85; -5.74]
App_Age_41_50			14.15	[-7.02; 37.78]
App_Age_51_&_Above			0.19	[-19.51; 22.41]
App_Inc_Med			- 22.69**	[-40.81; -3.80]
App_Inc_High			- 52.96***	[-80.62; -26.23]
Orgn_Age_31_40			4.68	[-15.73; 23.42]
Orgn_Age_41_50			23.99**	[4.29; 44.38]
Orgn_Age_51_&_Above			9.93	[-9.93; 31.28]
Orgn_Inc_Med			- 8.97	[-25.16; 7.36]
Orgn_Inc_High			20.51*	[-1.89; 44.84]

Note: *** p < 0.01; ** p < 0.05; * p < 0.1

Appendix 7

Likelihood-ratio test

LR Test
Assumption: Conditional Logit Model without Interactions nested within Conditional Logit Model with Interactions

LR chi2(15) = 51.38
Prob > chi2 = 0.0000

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