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Producer prices, carcass classification and consumers' willingness to pay for different sheep meat grades: an experimental auction approach

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ABSTRACT

South African sheep farmers receive different prices for animals of different age, carcass form and fat level. Older animals trade at a substantive discount to the younger animals due to the perceived tenderness and juiciness of the younger animal. There is however a question whether the size of the discount is warranted given that certain cuts from older animals are preferred by consumers for specific purposes. This paper applies an experimental auction combined with sensory tests to establish the consumers' willingness to pay for sheep meat products from carcasses with different age categories. In this way the paper endeavours to test whether the price differentiation in the mind of the consumer (through its perceived intrinsic value) corresponds with the price differentiation at the abattoir level. Consumers' sensory assessment results and average bid prices via the experimental auction indicated a difference in preference towards the three age classes for the stew meat, loin, and leg cuts respectively. The results validate previous results with trained panels and confirm the specific consumer preferences for specific cuts of different age categories. It was also found that the difference in the bids for different age categories was far smaller than the difference in abattoir prices for the different age categories.

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Sensory analysis; experimental economics; producer prices

1. Introduction

The quality and consumer preferences related to sheep meat is the focus of this paper and is shaped in the context of the existing South African Carcass Classification System. Animals of different ages, carcass form and fat levels, fetch different prices at the abattoir level. It is generally perceived that the carcasses from younger animals are more tender and juicier, and therefore due to popularity, should receive higher prices. It is however, so that certain meat cuts from older animals could have favourable sensory attributes and might be more acceptable to consumers for specific recipes and cooking methods. Could these superior tastes in the carcasses from older animals potentially reduce the large price difference between the different age categories of sheep slaughtered in South African abattoirs? By using an experimental auction combined with sensory tests this paper establishes consumers' willingness to pay for sheep meat products from carcasses with different age categories. In this way the paper endeavours to test whether the

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This paper is largely based on the Master's Thesis of Carina Troost (Troost, 2019).

price differentiation in the mind of the consumer (through its perceived intrinsic value) corresponds with the price differentiation at the abattoir level.

Current pricing arrangements in the South African sheep meat market reflect a price differentiation based on the official Carcass Classification System and the age of the animal, with A2 and A3 lamb being sold at a premium to older and fatter animals.

The Carcass Classification System classifies lamb, mutton, beef, and goat carcasses based on a set of characteristics outlined in the Standards Act no. 119 of 1990, largely focusing on animal age and carcass fat content (Vermeulen, Schönfeldt, and Pretorius 2015). The animal's age is one of the most important components of the current Carcass Classification System as the age of livestock is believed to affect meat quality. Age classes are classified in Table 1 into four groups, namely A (0 permanent incisors), AB (1–2 permanent incisors), B (3–6 permanent incisors) and C (>6 permanent incisors) (DAFF 2015). Each age class is also classified into six separate fat codes, ranging from 0 (no fat) to 6 (excessively overfat). The Classification System only permits classification of meat based on age and fat categories. However, additional attributes such as tenderness, flavour and overall product quality are not guaranteed by the meat being certified as being of a specific class.

In order to illustrate the price differential between different grades of lamb and mutton at abattoirs in South Africa, we have selected a random week in 2020 and used the average prices across all reporting abattoirs to show the price differences.

Table 2 reveals a R19.68/kg price difference between the A2 and B2 classes as well as a R17.79/kg difference between the A3 and B3 classes. If the abattoir price of A2 lamb is compared with C2 mutton a R21.79/kg price difference is found. Class A meat therefore enjoys a higher abattoir price than the AB, B and C classes. The recent trends in prices for lamb and mutton also reflect these price differences, as depicted in Figure 1. This figure indicates the average selling prices of the abattoirs to the meat trade. A continuous price difference can be seen between class A, AB and C, where the A class obtained the highest market prices.

This study therefore seeks to understand whether the price differences in the meat trade are supported or warranted by the perceived quality and sensory differences and value to the consumer. The main purpose of this study is therefore to use the sensory experiences of consumers and their perceived monetary value of this sensory experience for different classes of meat, and to establish whether there are any differences. This is then compared with the price in the market for the different age classes.

In order to put these arguments into context, the paper sets out to first discuss the quality attributes of red meat and highlight the different consumer perceptions related to meat quality. This provides the theoretical and scientific background for a set of sensory tests and an experimental auction to assess the true value of sheep meat cuts in different age categories.

Table 1. Classification of red meat carcasses in South Africa.

Age	Class
0 Incisors	A
1–2 Incisors	AB
3–6 Incisors	B
More than 6 incisors	C
Fatness	**Class**
No fat	0
Very lean	1
Lean	2
Medium	3
Fat	4
Slightly overfat	5
Excessively overfat	6

Source: DAFF (2015).

Table 2. National South African price information for lamb and mutton Week 37 (2020).

Class	Units	Avg. mass per carcass (kg)	Avg. abattoir purchase price (R/kg)
A0	15	12.76	73.07
A1	85	14.70	87.48
A2	5135	20.54	88.16
A3	895	23,17	87.45
A4	193	24,66	79.71
A5	12	26.25	72.11
A6	24	25.05	70.97
AB2	44	20.51	74.63
AB3	16	24.51	77,86
B2	250	22.00	68.48
B3	19	28.52	69.66
C2	563	24.64	66.37
C3	52	29.08	67.20

Source: RMAA (2020).

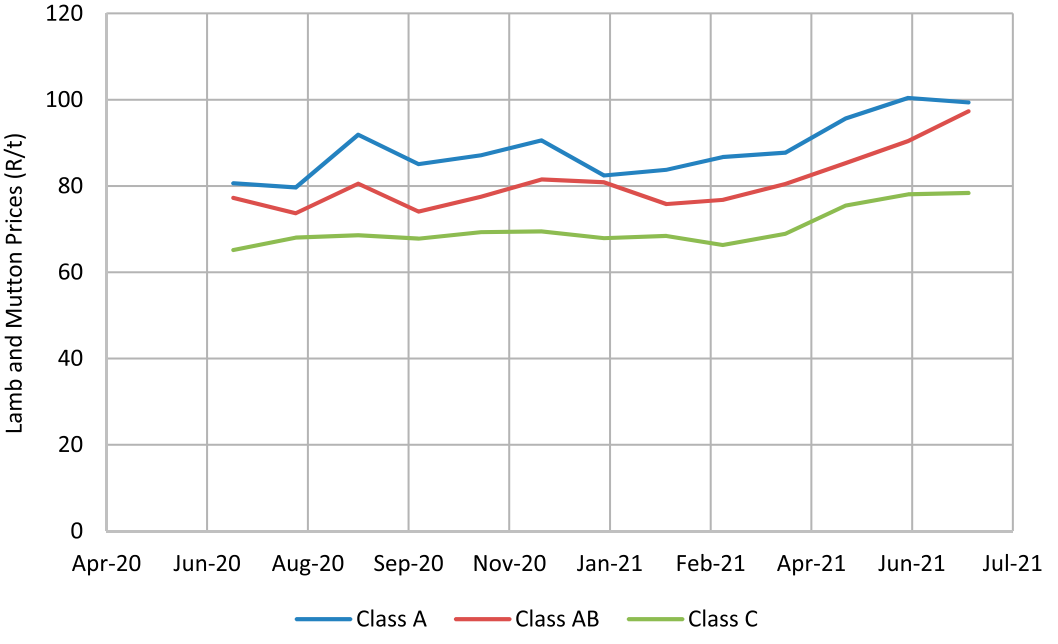

Figure 1. Trends in lamb and mutton prices. Source: RMAA (2021).

2. Quality in red meat products

From the perspective of the consumer, quality refers to perceived quality, which is a perception process that may have different meanings for various people (Oude Ophuis and Van Trijp 1995). At the same time the measurability of food quality is multifaceted as it depends on various product characteristics. Becker (2000) defines product characteristics as "those features of a product which are used as technical indicators for product quality and are measurable with standardised analytical and sensory methods". They can further be classified into four categories (Becker 2000):

- product characteristics indicating the nutritional value (for example protein, fat, and carbohydrate content).
- characteristics indicating the processing quality (e.g., shear-force and sarcomere length).
- characteristics indicating the hygienic-toxicological quality (e.g., residues, contaminants); and
- characteristics indicating the sensory quality (e.g., tenderness, juiciness, overall liking and flavour).

The nutritional, processing and hygienic-toxicological evaluation of meat relies primarily on laboratory methods, while the sensory studies rely on consumer and trained panels. Steenkamp's (1990) conceptual model describes the consumers' quality perception process during purchase decisions. In this process it is important to distinguish between quality attributes and quality cues.

Quality attributes consist of search, experience, and credence attributes. Search attributes can be identified immediately by consumers before purchase, such as the colour, price, label, and country of origin. Experience attributes can be identified during consumption such as the taste, tenderness, overall liking and juiciness of the meat.

One of the most important determining factors of choice is the extent to which the experience attributes of meat influence the consumer. Davel, Bosman, and Webb (2003) argue that consumers consider tenderness as the most important determinant of meat quality. In addition, De Andrade et al. (2016) and Van Wezemael et al. (2014) indicate that tenderness and juiciness are quality attributes that positively influence consumers' preferences for lamb.

Meat tenderness can be measured objectively by laboratory instruments and subjectively by means of sensory analysis such as professional and consumer taste panels. Another important element highlighted in other studies which resembles quality is the taste, and therefore the flavour, of meat. Flavour is, next to tenderness, one of the most important determinant factors in a consumer's perception of quality (O'Sullivan and Kerry 2009; Watkins et al. 2014; Khan, Jo, and Tariq 2015).

Flavour of meat is thermally derived, since uncooked meat has only a blood-like taste with little or no aroma (Mottram 1998). Thermal decomposition occurs between non-volatile components of lean and fatty tissues during cooking, which results in various reactions (Mottram 1998). The volatile compounds formed during cooking are therefore responsible for, and contribute the most to, the characteristic flavours of meat. The flavour precursors can be measured and identified by means of chemical analyses as well as laboratory and consumer taste panels.

Credence attributes are intangible and are not accessible during the purchase process or through consumption. Consumers have to rely on the information of additional stakeholders to evaluate the product, for example word of mouth and information provided on labels (Northen 2000; Vermeulen, Schönfeldt, and Pretorius 2014).

Quality cues, on the other hand, are determined by consumers' senses prior to consumption. Perceived quality, as reflected in Figure 2, is based on quality cues which are used to predict attributes. Consumers encounter these cues before consumption while making a purchase decision. Two types of quality cues exist: intrinsic and extrinsic (Oude Ophuis and Van Trijp 1995; Becker 2000; Henchion et al. 2014).

The intrinsic cues are part of the physical product, for example the colour, shape and appearance of the meat.

Extrinsic cues, on the other hand, are related to the product but not physically part of it, such as price and label of origin (Oude Ophuis and Van Trijp 1995; Sepúlveda, Maza, and Mantecon 2010). The price and label of origin contribute to the perception of quality and influence consumers' purchase decisions (Lange, Rousseau, and Issanchhou 1998; Font-i-Furnols et al. 2011). According to Oude Ophuis and Van Trijp (1995), price is one of the best-known extrinsic indicators of quality. In addition to price as a determinant choice factor, other aspects such as health (e.g., in terms of nutritional value of the meat) and perishability may also affect consumption. Vermeulen, Schönfeldt, and Pretorius (2014) studied consumers' concerns regarding red meat among three different income classes. Figure 3 indicates that affordability is the overall key concerning factor in all the marginalised (poor), emerging (low income) and established income groups.

In addition, Sepúlveda, Maza, and Mantecon (2010) evaluated quality aspects at the time of purchase and found that price was one of the most important aspects that consumers consider when evaluating the quality of lamb. They indicated that consumers and producers equally value direct appraisals as the most important determinant factor of quality. Both consumers and producers also considered meat quality labels as a key determinant in evaluating quality. Meat products are

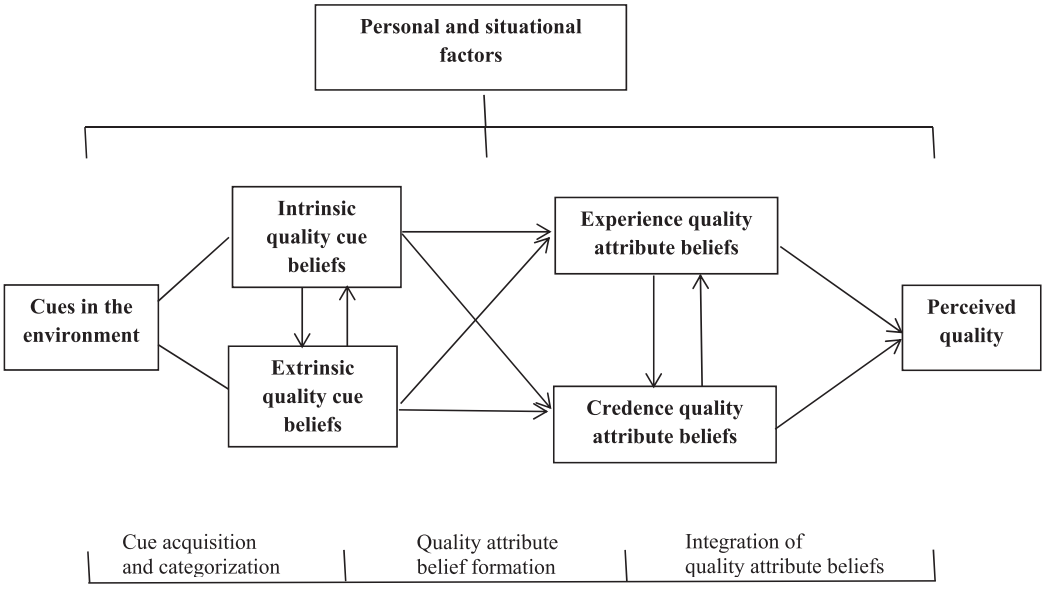

Figure 2. Conceptual model of the quality perception process. Source: Steenkamp (1990); Oude Ophuis and Van Trijp (1995).

considered to have credence attributes as product quality and experience cannot be evaluated before consumption of the product. The product is only evaluated by information and associated claims provided by the label. Meat labelling therefore became increasingly important to consumers as it delivers messages about the safety and wholesomeness of the product, such as product specific nutrient information (hormones, antibiotics, fat or cholesterol) (Gellynck, Verbeke, and Vermeire 2006).

The experience attributes: taste, tenderness as well as juiciness of meat, are highly correlated with overall experience quality, purchase intention and willingness to pay (Font-i-Furnols and Guerrero 2014). The value consumers attach to specific product characteristics are therefore important and must be measured. In addition, the level of consumers' acceptance towards the particular experience attributes will influence consumers' willingness to pay for the product. In order to quantify the value

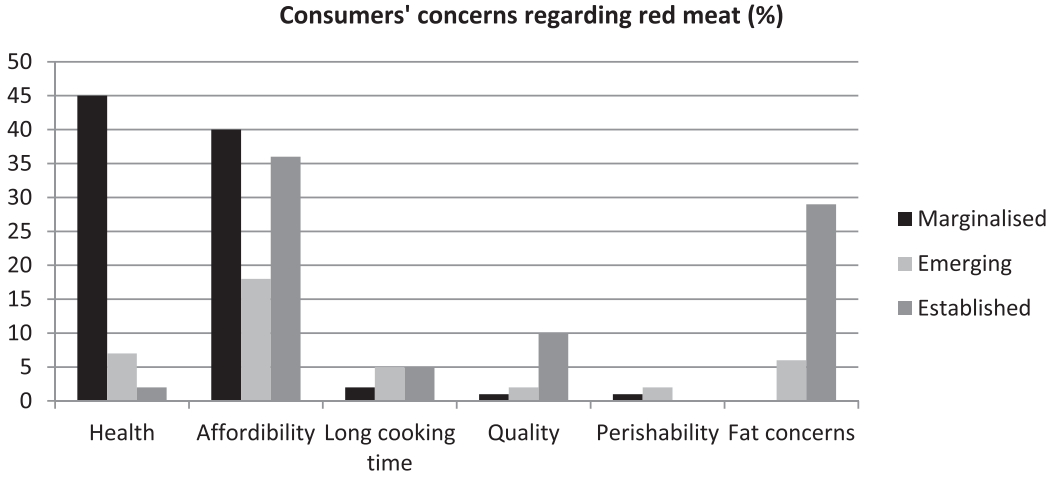

Figure 3. Consumers' concerns regarding red meat (%). Source: Adapted from: Vermeulen, Schönfeldt, and Pretorius (2014).

consumers attach to a particular attribute, the willingness to pay (WTP) for a product attribute is obtained. It is therefore important to measure the actual monetary value consumers place on quality attributes to elicit consumer perceptions and preferences. A study to measure the effects of extrinsic factors, and consequently how they interact with the perception of intrinsic product characteristics, is therefore imperative.

3. Consumer perceptions related to meat quality

Meat quality is a complex concept which can be measured both objectively by means of laboratory instruments and subjectively by consumer sensory panels. It is essential to evaluate consumer perceptions toward product characteristics to correctly position a product in the market.

Tenderness, juiciness, and flavour are three of the most commonly used attributes to determine meat quality during consumer sensory assessments. It is commonly believed that tenderness is influenced by the age of the animal. Older animals are largely associated with tougher meat (Dreyer et al. 1977), and therefore it is generally assumed that meat from older animals has a reduced consumer acceptance. However, older animals have more intramuscular fat which makes the meat more flavourful (Pannier et al. 2015). Flavour intensity consequently increases concomitantly with animals' age. The effect of animal age on meat tenderness has been investigated by several studies, but the results differ. Firstly, several studies on both beef and sheep meat reported a decrease in meat tenderness with an increase of animal age (Shorthose and Harris 1990; Pethick et al. 2005; Schönfeldt and Strydom 2011; Moholisa et al. 2016), while another has found an increase in tenderness as the animal ages (Duckett, Snowder, and Cockett 2000).

Meat & Livestock Australia (MLA) in turn studied the effect of animal age on sensory experience with consumer tastings of grilled lamb and mutton cuts. Figure 4 substantiates the current argument by indicating that tenderness and juiciness scores decrease as sheep age increase while flavour only gradually decreases as sheep age increases (Meat & Livestock Australia 2012).

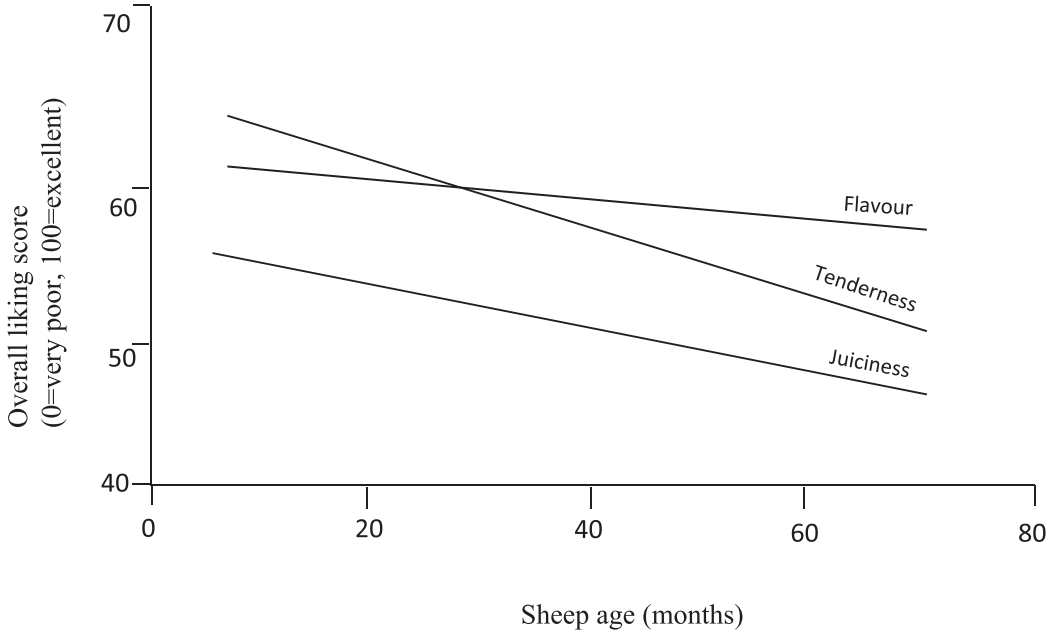

Figure 4. Change in eating quality attributes with sheep age. Source: Adapted from MLA (2012).

Consumers perceive meat of class A-carcasses (younger animals), which enjoy higher market prices, to have the best eating quality attributes compared to the other age classes. The AB and B classes can have erupted permanent incisor teeth by the time they reach slaughter weight and thus cannot be classified in the A lamb category. However, sheep in these classes may still produce consumer-acceptable eating-quality meat. Pannier et al. (2015) studied the impact of Australian Merinos' age on consumer sensory scores and found no significant difference in sensory scores of grilled loin samples between lamb of 8.5 months (A class) and yearlings of 20 months (AB and B classes). They concluded that the loin from yearlings has a similar acceptability to lamb among Australian consumers. In addition, Bruwer (1984), concluded in his study that there are no significant differences in terms of meat quality characteristics, i.e., juiciness, taste, and total collagen, between the A and B classes. Given the change in tenderness and flavour of sheep meat as animals age, it is important to obtain consumer sensory information to determine the final consumer acceptance of sheep meat in a commercial context.

4. Research methodology

In order to assess whether there should be an implicit price difference between different sheep meat products from different carcasses we need to assess consumers' willingness to pay for different classes of meat. In this study we combine sensory assessments and an experimental auction to get as close to reality as possible to understand the inherent value consumers attach to different meat products. We now briefly explain the auction set-up and the sensory tests.

4.1 Measuring willingness to pay via the random nth*-price auction*

This auction mechanism combines elements of the Vickrey auction, which encourages competition among bidders and the Becker-DeGroot-Marschak (BDM) mechanism, which gives all bidders an equal chance to win the auction (Lusk and Shogren 2007). The key characteristic of the random *n*th-price auction is the random but endogenously determined market-clearing price (Shogren et al. 2001). The auction is demand revealing because all bidders are engaged and have a chance to be a winner and purchase the auctioned product.

The auction commences with each participant submitting a sealed bid for the auctioned product. The monitoring person collects the bids and sorts them from the highest to the lowest bid. A random number (n) is drawn between 2 and (k) where k is equal to the number of participants. The person will consequently sell one unit to each of the $(n-1)$ highest bidders at the randomly drawn nth price (Shogren et al. 2001). It is important to take note that the distribution starts from 2 to (k) and not 1 to (k). If the distribution was from 1 to (k) and the random number drawn is $n=1$, then there would be no winners as the winners of the auction would be equal to $(n-1)$ which will be zero. The random number (n) being drawn is not the actual purchase price, however, but only the position being drawn (Van Zyl, Vermeulen, and Kirsten 2013). The winners will have to purchase the auctioned product at the nth price. For example, if a random nth-price auction is held with 30 participants ($k=30$), a random (n) number will be drawn from the distribution 2 to 30. If the monitor draws a random number $n=6$, the five highest bidders will each have to purchase the auctioned product at the nth price, in this case, the sixth highest bid.

4.2 Sample selection

The sample size of an experimental auction depends on a variety of factors, including the research objectives and financial constraints (Lusk and Shogren 2007). According to Lusk and Shogren (2007) the objectives of an experimental auction can either be to identify whether there are differences in valuation between goods or to provide an estimate of the mean WTP for goods among the

population. They further indicate that the larger the sample size, the more statistically significant results will be obtained throughout the study.

It was evident from the literature reviewed that a variety of sample sizes were used to conduct experimental auctions. Rousu et al. (2004) used a sample size of 44 consumers to elicit consumers' WTP for food products with different tolerant labels, while Lee et al. (2011) used a total of 100 auction participants. The study by Lusk, Feldkamp, and Schroeder (2004) recruited 25 and 29 participants respectively to evaluate their preferences for different types of ribeye steaks in two random *n*th-price experimental treatments. Van Zyl (2011) applied experimental economics to determine consumers' WTP for certified Karoo lamb with a sample size of 31 participants. Hurter (2018) studied the impact of secondary information on consumers' WTP for differentiated fresh lamb meat products in South Africa, having had a total of 15 auction participants.

While this paper investigates consumers' sensory assessments for specific meat characteristics and their WTP values, previous studies' sample sizes, which combine both these elements, have to be reviewed. A variety of sample sizes were used to conduct consumer sensory assessments in combination with experimental auctions in other similar studies observed in the literature reviewed. Umberger and Feuz (2004) used 12 panels, which varied from 6 to 12 participants, to determine consumers' taste preferences and to elicit consumers WTP for six different steak samples. In a study by Melton et al. (1996), a random sample of 36 consumers evaluated sensory attributes for pork chops and indicated their WTP. Hobbs, Sanderson, and Haghiri (2006) determined consumer preferences for bison and their WTP for specific credence attributes in 5 Canadian locations. The experimental auctions were carried out in groups averaging 12 people. Meanwhile, in a study by Umberger et al. (2002) on US consumers' preference and WTP for domestic corn-fed beef versus international grass-fed beef, a total of 248 consumers participated in the study, 124 from Chicago and 124 from San Francisco.

The sample size for the experimental procedure in this paper consisted of 42 participants. All consumers were exposed to the same experimental treatments simultaneously; the sample size therefore had to be carefully managed in order to keep all the treatments standardised for each participant. Furthermore, the participants had to be regular (at least 3–4 times per month) consumers of lamb and mutton meat. They also had to be classified into the higher-income consumer segment as measured by the Socio-Economic Measurement (SEM) segmentation tool. The SEM scale has ten groups from SEM 1, which represents low socio-economic living, to SEM 10, representing high socio-economic living. The participants in this study had to be classified into the SEM 8–10 group (similar to established income group) in order to be affluent enough to meet the expense of lamb and mutton meat as this is a niche product. The participants were selected from the Cape Winelands district and the City of Cape Town metropolitan area in the Western Cape.

4.3 Meat samples

Three different lamb and mutton age classes were used in this study in order to have a representative consumer meat purchasing sample distribution. The A lamb (no permanent incisors), AB mutton (1–2 permanent incisors) and C mutton (more than 6 permanent incisors) carcasses with fatness level 2 were selected. Two carcasses of each age class were used, amounting to a total of 6 carcasses utilised.

It was essential to keep all the variables standardised. Therefore, the 6 carcasses ($n = 6$) were obtained from one registered farmer in the Karoo's Carnarvon district. The sheep were thus exposed to identical environmental conditions, grazing on identical Karoo veldt and treated similarly. The carcasses further compromised one of the most commonly used meat producing breeds, namely the Dorper. Quality variation, especially meat flavour, exists between different breed types (Sink and Caporaso 1977; Channon, Lyons, and Bruce 2003; Hoffman et al. 2003), and only Dorper sheep were consequently sourced. Gender also has a significant influence on the palatability of meat (Navajas et al. 2008; Hopkins and Mortimer 2014), and only ewes were therefore selected for all 6 carcasses in the different age classes.

The animals were taken off the veldt 2 days prior to slaughter and were slaughtered using standard commercial procedures. Thereafter, the carcasses were classified according to the South African Classification System by a qualified classifier at the abattoir. Each carcass was weighed individually and clearly marked for the researcher so that the specific carcasses for the study were clearly identifiable. The carcasses were then stored in a refrigerated cooling chamber 30 minutes post-slaughter for 24 hours before transportation.

The wholesale cuts used in this study were the loin, leg, ribs, shanks, neck and shoulder. The ribs, shanks, neck and shoulder were used together as stew cuts. These cuts were chosen as they represent the most commonly consumed cuts among the South African lamb and sheep meat consumer (Schönfeldt and Strydom 2011; Cavalier, 2018). Bratzler (1971) indicated that the loin section has been used most frequently for studies evaluating meat tenderness and juiciness due to the size and uniformity of the loin section (Van Heerden 2007). In addition, Woodhams, Kirton, and Jury (1966) described it as a large, important muscle in the detection of palatability differences and the main contributor to the meat content of a chop.

Two cooking methods were applied for the sensory evaluation. Firstly, a standardised laboratory cooking method was applied to the loin and leg cuts. For this method, all variables were kept constant so that the only variable present was the age of the animal. The temperature and cooking duration were consequently identical for each age class. The method was carried out by cooking the meat until the optimal cooking time for the A class lamb. The same cooking time was applied to the AB and C age classes and it was therefore comparable in terms of cooking duration with the A class lamb. It was important to keep all treatments identical for each age class. The reason for not applying this cooking method to the stew cuts is due to the fact that the AB and C class meat will not properly be cooked off the bone in the same cooking time as the A class. It will therefore not be standardised and representative of all the meat cuts together if different individual samples of meat from different cuts are served to the participants to evaluate. The individual meat cuts also comprise varying flavours and textures.

Secondly, an optimal home-use cooking method was applied to all meat cuts used in this study. For this method, the meat was cooked until the optimal cooking time for each age class. The cooking time differed for each class, but the temperature was kept the same. Two variables were present in this method – the cooking time and the age of the animal. The reason for the application of this method is to test the effect of time and electricity.

The meat was thawed and deboned 24 hours prior to cooking at 10°C. The meat was cooked on the day of the sensory assessments and experimental auction (23 August 2018) by a Stellenbosch professional chef and her team. The ribs, shanks, neck and shoulder (stew meat cuts) were cooked together using a moist cooking method on the stove, while the deboned legs and loins were roasted separately in identical electric convection ovens using a dry heat cooking method. The moist cooking method entailed adding 2 litres (ℓ) of water prior to cooking in each pot. The dry heat cooking method required the meat uncovered in a flat open pan with a rack to keep the meat out of the drip; no water was added during cooking. A hand-held probe was used to record the internal temperatures at the centre of each meat cut.

First, the ribs, shanks, neck and shoulder (stew meat cuts) were cooked together on the stove according to a standardised moist cooking method at full gas flame. The age classes were cooked separately in large stainless steel casserole pots. The pots were individually labelled, indicating the meat age class. The legs were roasted on a rack in identical convection ovens according to the dry heat cooking method at 175°C to an internal temperature of 75°C measured in the centre of the cut. The deboned legs were butterflied for standardisation purposes so that they were evenly cooked all-round. The loins were roasted whole on a rack in the oven according to the dry heat cooking method in identical electric convection ovens at 220°C to an internal temperature of 75°C, measured in the centre of the cut. All of the meat was cut into 1.5 cm^3 cubed samples (Hoffman et al. 2003) while the stewed meat was served in a similar size sample.

4.4 Experimental procedure

The experimental auction was held during one evening and consisted of a pre-auction survey, followed by the sensory assessment and one experimental auction amongst all participants. Participants were asked to complete a pre-auction survey on arrival. Thereafter, the surveys were collected and the sensory assessments together with the random *n*th-price auction commenced.

There was one practice round, five sensory assessment rounds and five experimental auction rounds. The sensory assessments and random *n*th-price auction procedures were conducted in a total of 19 steps, as outlined in Table 3.

Each meat sample was placed in a tasting cup with a labelled 3-digit code. It was clearly conveyed to the participants that it was very important to write the corresponding 3-digit code on the scoresheet with their auction identification number. The participants had to taste and rate three samples of different age classes of lamb and sheep meat on the scoresheet in terms of flavour, juiciness, tenderness and overall liking, using a 9-point hedonic scale. An explanation was given on how each participant's ID number was determined. Those ID numbers were used for anonymity and to identify the auction winners. Each meat sample was scored on an individual scoresheet.

Furthermore, they were informed that they would taste three different meat cuts in three separate stages. In the first stage three samples of stew meat were tasted (in the different age classes), in the second stage three samples of loin were tasted (in the different age classes), in two sets. In the third stage, they tasted three samples of leg of lamb and mutton in two sets. The participants were asked to sensory assess the meat samples according to their previous sensory experiences with lamb and mutton meat and then to compare it with a constant of lamb stew cuts, lamb loin cut and lamb leg cut found predominantly in the retail outlets. The retail prices from five different retailers in the Western Cape were observed and recorded in order to obtain an average full product price to use as a reference price for each meat cut that was tested. These prices were observed in August 2018. The retail prices for 500 g stew meat cuts, 500 g loin chops and deboned legs of lamb are indicated in Tables 4–6. These respective prices are comparable with lamb for each cut due to lamb being predominantly available in the retail outlets.

After the information session, which provided detail on the auction process, the participants were asked to peruse the information sheet provided, which contained more detailed written auction instructions.

Following the practice round, the first phase of sensory assessments and experimental auction began. This phase consisted of one round of three tasting and bidding rounds. A reference

Table 3. Steps in the experimental procedure.

Steps	Description
Step 1	Participants fill in pre-auction survey.
Step 2	Verbal explanation by the auction monitor of the sensory assessments and random *n*th-price auction procedure.
Step 3	Practice round with a *droëwors* sample; payment price and winners' ID numbers are revealed.
Step 4	The first three meat samples are served to each participant.
Step 5	The first sensory assessments and bidding round are done (scoresheets are collected after each round).
Step 6	Binding sample is randomly drawn; payment price and winners' ID numbers are revealed.
Step 7	Winners come forward to purchase their packet of meat with their R200 note.
Step 8	The second round of three meat samples is served to each participant.
Step 9	The second sensory assessment and bidding round are done.
Step 10	The third round of three meat samples is served to each participant.
Step 11	The third sensory assessment and bidding round are done.
Step 12	Binding round and binding sample are randomly drawn; payment price and winners' ID numbers are revealed.
Step 13	Winners come forward to purchase their packet of meat with their R200 note.
Step 14	The fourth round of three meat samples is served to each participant.
Step 15	The fourth sensory assessment and bidding round are done.
Step 16	The fifth round of three meat samples is served to each participant.
Step 17	The fifth sensory assessment and bidding round are done.
Step 18	Binding round and binding sample are randomly drawn; payment price and winners' ID numbers are revealed.
Step 19	Winners come forward to purchase their packet of meat with their R200 note.

Table 4. Observed prices for stew meat cuts.

Retailer/butcher	Price of stew meat cuts (R/kg)
Retailer/butcher 1	R129.99/kg
Retailer/butcher 2	R119.99/kg
Retailer/butcher 3	R149.99/kg
Retailer/butcher 4	R129.99/kg
Retailer/butcher 5	R139.99/kg
Retailer/butcher 6	R120/kg

Source: Prices observed in August, 2018.

product, a 500 g packet of stew meat cuts, was shown with its average full market price (R65). Lusk, Feldkamp, and Schroeder (2004) point out that participants can be endowed with a product and asked the amount they would be willing to pay for the full value of the product or the amount they would be willing to pay to upgrade, the original product, to a product with adjusted characteristics. The three meat samples were served and participants were asked to taste each meat sample individually and score it on the corresponding scoresheet with the maximum amount they would be willing to pay for a 500 g packet of stew meat cuts, based on the sample they had tasted. Participants were asked to bid in increments of R1 to simplify the purchase process.

The scoresheets were collected and the binding sample was determined by randomly drawing a number from 1 to 3 from a bag (1 = sample one, 2 = sample two, 3 = sample three). Only one meat sample in this phase was binding, in other words, only one sample was determined where the auction winners had to purchase the reference product at the determined purchase price. The binding sample's bidding prices were captured on a Microsoft Excel 2010 spreadsheet and sorted from the highest to lowest bid. Thereafter, a random number (n) was drawn by the moderator to determine the cut-off price. A random number (n) was drawn from the distribution between 2 and the number of participants (k). The main reason for drawing a random number as the cut-off price was to get a market clearing price with no influence by the monitor. Each participant who bid higher than the cut-off price had to purchase the reference product. The cut-off price was revealed together with the ID numbers of the auction winners. The auction winners had to purchase their packet of stew meat cuts with the R200 note at the determined purchase price. (The same steps were followed in each of the rounds described below.)

The second phase of sensory assessments and experimental auction consisted of two separate rounds with a total of six tasting and bidding rounds. A reference product, a 500 g packet of loin

Table 5. Observed prices for fresh lamb loin chops.

Retailer/butcher	Price of loin chops (R/kg)
Retailer/butcher 1	R179.99/kg
Retailer/butcher 2	R149.99/kg
Retailer/butcher 3	R199.99/kg
Retailer/butcher 4	R159.99/kg
Retailer/butcher 5	R167.99/kg
Retailer/butcher 6	R170/kg

Source: Prices observed in August, 2018.

Table 6. Observed prices for fresh deboned leg of lamb.

Retailer/butcher	Price of deboned leg of lamb (R/kg)
Retailer/butcher 1	R157.99/kg
Retailer/butcher 2	R179.99/kg
Retailer/butcher 3	R179.99/kg
Retailer/butcher 4	R174.99/kg
Retailer/butcher 5	R199.99/kg
Retailer/butcher 6	R190/kg

Source: Prices observed in August, 2018.

chops, was presented and its average full market price (R88) given. The first round's three meat samples were served and participants were asked to taste each meat sample individually and score it on the corresponding scoresheet with the maximum amount they would be willing to pay for a 500 g packet of loin chops, based on the sample they had tasted.

Due to having two rounds in this phase, only one round and one meat sample had to be binding, in other words, only one round was determined where the auction winners of the round had to purchase the product at the determined purchase price. The binding round was determined by a coin toss, heads for round one and tails for round two. Subsequently, the binding meat sample was determined by randomly drawing a number of 1–3 from a bag (1 = sample one, 2 = sample two, 3 = sample three).

The third phase of sensory assessments and experimental auction also consisted of two separate rounds with a total of six tasting and bidding rounds. A reference product, a 500 g deboned leg of lamb, was presented with its average full market price (R95). The first round's three meat samples were served and participants were asked to taste each meat sample individually and score it on the corresponding scoresheet with the maximum amount they would be willing to pay for a 500 g deboned leg of lamb, based on the sample they had tasted.

5. Results and discussions

5.1 Socio-economic profile and consumers' sensory assessments of lamb and mutton

The first objective of this research was to determine consumers' sensory acceptance of different meat classes and secondly, to test the impact of sheep age on consumer sensory scores. To address these two objectives, sensory assessments were performed by the consumer panel. It is important to keep in mind that the consumer panel is untrained in sensory assessment methods and will experience taste and flavour based on personal preferences. They also tasted the cooked meat samples which were prepared under normal home conditions with standard kitchen equipment.

The participants tasted three different meat cuts (stew meat, loin and leg). The optimal cooking method was applied to the stew meat cuts whereas both standardised and optimal cooking methods were applied to the loin and leg cuts. The sensory mean and standard deviations scores for each meat cut within each age class were recorded. Participants' prior sensory preferences were compared to the actual sensory results in order to determine if any relationship exists between their prior preferences and the sensory scores.

The overall mean and standard deviations scores for each meat cut within each age class were not as volatile. The standard deviations for each sensory characteristic within each age group were relatively small. The cause of limited deviations between means may be a result of the restricted set of answers the participants had to score for each meat sample. Only a 9-point hedonic scale may be used, with 1 denoting extremely undesirable for flavour, extremely dry, extremely tough, extremely undesirable for overall liking, and 9 denoting extremely desirable for flavour, extremely juicy, extremely tender, and extremely desirable for overall liking. The sensory scores do not reflect a large variation in the study group; participants were overall consistent in their assessments of the various meat samples.

It was interesting to capture the factors influencing participants' purchasing behaviour and to determine whether any relationship exists between participants' prior stated preferences and their actual sensory scores. Overall, the C class sample for the stew meat cuts was preferred over the A and AB class meat samples.

The pre-auction survey results indicate that the majority of participants (79%) preferred the stew meat cuts from mutton rather than lamb. Participants' prior tasting preferences were thus similar to their actual sensory scores. The A class sample was most preferred for the loin cuts in the standardised cooking method and the AB class sample for the optimal cooking method. The pre-auction survey results indicate that 88% of participants preferred the loins from lamb rather than from mutton. Participants' prior tasting preferences were comparable with the actual sensory scores for the standardised cooking method, but not for the optimal cooking method. Finally, the A class

sample was most preferred for the leg cuts in the standardised cooking method and for the optimal cooking method; both the leg of lamb and the AB class sample were preferred. The pre-auction survey results indicate that 81% of participants preferred the leg of lamb rather than mutton. Participants' prior tasting preferences were analogous with the actual sensory scores for the standardised cooking method, but varied for the optimal cooking method.

Participants valued lamb and mutton flavour equally prior to the sensory assessments. However, the mean sensory scores for flavour for the different meat cuts varied. The C class sample's flavour obtained the highest mean score for the stew meat cuts, while the AB class sample's flavour obtained the highest score for the loin cut in both the standardised and optimal cooking methods. Additionally, the A class sample's flavour was most preferred for the standard cooking method and the AB class sample's flavour was most preferred for the optimal cooking method.

Considering the various sensory scores obtained for the three meat cuts within each age category, it can be concluded that the lamb (0 permanent incisors) and AB class (1–2 permanent incisors, between one and two years of age) sensory characteristics are overall more preferred over the C class. Participants' prior sensory preferences indicated a higher overall preference for lamb than for mutton. The actual sensory scores therefore indicate the opportunity for the AB class to compete with lamb meat in the loin and leg cuts. There may be an opportunity for the AB class to enjoy increased market share.

5.2 Experimental auction results and the analysis of consumers' bidding behaviour

A summary of consumers' bidding behaviour and results for the different meat cuts within the three age classes is presented in Table 7. The purpose of the experimental auction was to determine for which age class the participants are willing to pay more, and thus which age class is preferred over the other.

To test whether the bid values for the meat cuts from the different age classes were statistically significantly different, Friedman's two-way analysis of variance (ANOVA) test was applied. In addition, the significant difference was tested between the different sensory scores recorded by the consumer panel. An analysis of variance test was also applied to determine any statistically significant differences at 5% between the mean values of the auction bids and the sample's demographic characteristics. These tests were performed with the use of the statistical packages SPSS and STATA.

The Friedman ANOVA results indicate a statistically significant difference in the bid prices for each meat cut depending on the age of the animal. A statistically significant difference was found between the sensory scores recorded by the consumer panel for each meat cut, except for the stew meat cuts and loin cut for the optimal cooking method. For example, in the standardised cooking method for the loin cut, the Friedman test indicated a statistically significant difference in bid prices depending on the age of the animal, $\chi^2(2) = 250.008$, $p < .001$. The significant difference in bid prices is displayed by the average bid prices within the three age classes in Table 7. A difference of R2.43 can be calculated between the mean bids of the A and C class. A significant difference was found in the sensory characteristics of lamb and mutton meat with $\chi^2(2) = 7.594$, $p = .0055$. The most significant difference is displayed in the tenderness rating with the A class being most preferred with a rating of 7.83 and the AB class the least preferred with a rating of 6.48.

Table 7. Overall auction results for each meat cut within three age classes (price in R/500 gram).

		Age class		
Meat cut	Cooking method	A	AB	C
Stew meat cuts	Optimal	R61.05	R65.29	R67.52
Loin cut	Standard	R83.45	R83.43	R81.02
	Optimal	R82.50	R86.86	R84.00
Leg cut	Standard	R95.40	R86.38	R86.43
	Optimal	R93.67	R93.29	R87.10

5.3 Bid prices in relation to socio-demographic variables

When the average bid prices were evaluated in relation to socio-demographic variables, it was found that men indicated an overall higher bid price than women during the experimental auction.

A statistically significant difference was found in participants' average bid prices and gender with the optimal cooking method for the loin cut as seen as an example in Table 8. Similarly, a significant difference was found with the optimal cooking method for the leg cut.

The mean bids linked to income levels also indicated a significant difference between the two cooking methods for the leg cut. Additionally, the mean bids linked to age groups indicated a significant difference regarding the optimal cooking method for the loin cut. It was interesting to note that the 25–34 year age group indicated the highest mean bids overall for the different cuts.

Table 8. Mean bids linked to gender in each phase.

			Mean bid		Significant difference	
Phase	Variable levels	Percentage of total sample ($n = 42$)	Standard	Optimal	Standard	Optimal
Phase 1 – Stew cut	Male	52%		R65.28		$F = 0.05$
	Female	48%		R64.13		df = 1
						$p > .05$
Phase 2 – Loin cut	Male	52%	R83.98	R86.73	$F = 1.73$	$F = 7.33$
	Female	48%	R81.15	R81.95	df = 1	df = 1
					$p > .05$	$p = .0077$
Phase 3 – Leg cut	Male	52%	R90.68	R94.47	$F = 1.38$	$F = 9.37$
	Female	48%	R88	R87.92	df = 1	df = 1
					$p > .05$	$p = .0027$

6. Conclusions

This study used a combination of sensory anlaysis and willingness to pay techniques to establish whether there is a reason for the price difference between different age classes of lamb and mutton sold in South Africa. In essence the study also tests the hypothesis whether sensory experiences also influence the willingness to pay for different meat cuts prepared according to alternative cooking methods. The application of the exprimental auction immediately after a well-coordinated and structured tasting opportunity provided a unique setting for any economic analysis. In the end, the results helped us to understand the different intrinsic values of similar meat cuts prepared in the same way for different age classes of mutton.

The average bid prices from the random *n*th-price auction were evaluated for each of the three meat cuts. The standardised and optimal cooking method results were evaluated separately. If the auctions were efficient at capturing consumer preference differences and WTP, the relative difference in bids should be correlated with the relative difference in sensory ratings.

The C class was most preferred for the stew meat cut with an average bid price of R67.52. The average bids for the stew meat cut were correlated with the sensory ratings. The A and AB class were most preferred in the standardised cooking method for the loin cut, with average bid prices of R83.43 and R83.45 respectively. The AB class was most preferred in the optimal cooking method, with an average bid price of R86.86. The average bids for the loin cut were correlated with the sensory ratings in the optimal cooking method, while in the standardised cooking method, the AB class was preferred in addition to the A lamb. The leg of lamb was most preferred in the standardised cooking method with an average bid price of R95.40. The leg of lamb and the AB leg were most preferred in the optimal cooking method, with average bid prices of R93.67 and R93.29 respectively. The average bids for the leg cut were correlated with the sensory ratings.

The total average auction prices for the three age classes are indicated in Table 9. The consumer price margin between the respective classes is exceedingly small in comparison to retail prices.

Table 9. Average auction prices for three age classes.

Class	Average WTP by consumers
A2	R79.52
AB2	R80.09
C2	R78.93

Consumers' sensory assessment results and average bid prices via the experimental auction indicated a difference in preference towards the three age classes for the stew meat, loin and leg cuts respectively. This paper highlights the quality attributes of the different cuts within each age class.

The results of this paper validates previous results with trained panels and confirm consumer preferences for specific cuts of different age categories. It therefore suggests that farmers and abattoirs can get more for the lower "valued" carcasses if the focus is shifted towards the availability and marketing of the older C class mutton for the stew meat cuts. Furthermore, the AB class should be promoted with the A class in the loin cut, and the AB class should be promoted with the A class in the leg cuts. The demand for the specific cuts in the different age classes will potentially increase and consequently increase profitability. However, the possible negative externalities to this proposed marketing strategy leads to the problem of carcass balancing that the meat industry faces. For example, if more mutton stew cuts are provided to the consumers, a surplus of lamb stew cuts will arise. A possible outcome is to lower the price of lamb stew cuts due to the surplus caused by the preferred lamb loin and leg cuts.

The results presented indicate that consumers' willingness to pay for certain meat cuts from older animals is substantially higher than their willingness to pay for similar cuts from younger animals. It thus poses a question why older animals are traded at a comparatively higher discount than lamb at the abattoir and wholesale level. Although one can conclude that the classification system is responsible for the discount, it is not definite whether these results could influence an alternative red meat classification system. The reality is that the higher willingness to pay only apply to certain meat cuts in the older age classes which is likely to complicate the redesign of classification systems.

The most important illustration of this study is to highlight the use of sensory analysis with an experimental auction process. In this way we highlighted the value of "experience" in influencing the bids in the experimental auction and thus consumers' willingness to pay. This procedure can be used in similar studies with alternative food products for future research to help establish a more realistic value for willingness to pay estimates.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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