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THE DEVELOPMENT AND CONSUMER ACCEPTANCE OF GOAT MEAT BURGER PATTIES AND SAUSAGES AMONG YOUNG ADULTS IN KWAZULU-NATAL, SOUTH AFRICA

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ABSTRACT

Although goat meat is a nutritious and sustainable Animal Food Source (AFS), it is not commonly preferred as an AFS in sub-Saharan Africa even though goats thrive in the region. To explore the potential of promoting goat meat consumption among young adults in KwaZulu-Natal, South Africa, an experimental study was conducted involving the development, nutrient analysis and microbial testing of two goat meat products through a series of recipe development trials. This study aimed to use food processing techniques to improve the sensory qualities of goat meat (texture and aroma) in value-added products. Goat meat patties and sausages were developed and evaluated for consumer acceptance using Check-All-That-Apply (CATA) food action rating scale and paired preference testing (n=100). Results from the nutrient analysis showed that both the patty (31.57g/100g) and the sausage (26.88g/100g) were high in protein. The total fat content for each sample was less than 10g per 100g portion.The coliform counts for both samples were very low and well within the acceptable range. The yeast and mould counts were very low, and total bacterial counts were low and within an acceptable range. The CATA test revealed the most frequently selected term used to describe the sensory attributes were 'smoky' for aroma (82%, 55%), 'brownish-grey' for appearance (68%, 80%), 'meaty' for flavour (92%, 86%), and 'tender' for texture (59%, 51%) for the goat meat patty and sausage, respectively. Participants showed a more positive attitude towards purchasing and consuming the goat meat patty (96%) than the goat meat sausage (88%). Both products received positive sensory feedback. However, the majority of the participants preferred the goat meat patty (66%) over the sausage (34%). The findings suggest that promoting goat meat consumption in South Africa can be achieved through the introduction of value-added convenience products like the goat meat patties and sausages developed in this study.

Key words: Goat meat, goat meat patty, sausages, young adults, consumer acceptance

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INTRODUCTION

Nutritionally, goat meat is superior to other red meats due to its lower saturated fat and cholesterol content and its higher polyunsaturated fatty acids content than beef and lamb [1]. Goat meat is also reported to be a good source of B vitamins, including vitamin B6 (20% of the daily requirement) and vitamin B12 (70% of the daily requirement), which is comparable to other meat sources [2].

The low percentage of Greenhouse Gas (GHG) emissions that small ruminants such as goats contribute confirms the potential for these animals to be part of the solution to sustainable and green food sources. Concerning sustainability, goats and sheep have a lower footprint on graywater (water pollution as a result of livestock production) and blue water (ground or surface water) as opposed to beef, poultry, and pork [3]. In addition, GHG emissions are relatively lower from goats (6%) compared to beef (41%), pork (9%), chicken and eggs (8%) [4].

However, despite the nutrient content and sustainability of goat meat, consumption of goat meat and sheep in Europe is lower than other meat types like chicken and beef [5]. More especially, there is a lack of demand for sheep and goat meat by younger European consumers. There is more interest in pork and poultry than red meat [5]. Goat meat consumption in the United States has been focused on areas where specific ethnic populations consume goat meat as a traditional food; this includes various ethnic groups such as the Muslim, Latino, Asian, Afro-American, Haitian, and Eastern European groups [6].

A study in south-west India documented that it was cheaper and more profitable to rear goats as opposed to sheep using extensive (open field grazing), semi-intensive (open field grazing and feeding in stalls), and intensive (stall-fed) feeding methods [7]. Consumption of goat meat in South Africa is similar to Zimbabwe; marketing of goats remains mainly in the informal sector for cultural and religious purposes [8].

The Southern African region is home to approximately 38 million goats, with 70% being reared under traditional management systems in local communities; the marketing of goats in South Africa remains mainly in the informal sector for cultural and religious purposes [8]. Even though goat meat is rich in nutrients, the sensory attributes of goat meat are less desirable compared to meat sourced from other species [9]. Thus, goat meat consumption and retail availability in South Africa still fall behind other countries [10]. In terms of red meat in general, cattle are regarded as a priority over goats due to the multipurpose uses, marketing and other positive

associations with the meat as opposed to goat meat [8]. The lack of demand in the formal sector and possible difficulties in maintaining a constant regulated supply pose a barrier to goat meat being widely available in the formal market.

Formal marketing of goat meat is not done by rural and small-scale farmers as goat meat is often not regarded as a profitable meat source due to various misconceptions. Hence, the availability of goat meat in formal markets is scarce, which directly influences consumption as consumers cannot eat what is not readily available in the retail sector outside the scope of traditional events where goat meat is consumed [11].

Research shows that the unappealing sensory properties of goat meat, which include its distinct aroma [12], flavour profile due to fatty acid content [13], and texture which is associated with being tough, or chewy [14,15] may influence consumer acceptance and willingness to consume goat meat. An approach that can be used to improve consumer acceptance of goat meat is food processing. Processing techniques and methods such as mechanical mincing can enhance the texture of meat, while adding seasonings and spices can improve flavour. Globally, processed goat meat in the form of ground meat (mince) or cured and salted goat meat, are techniques used to add value and make it more appealing to consumers [9]. The value and acceptability of goat meat may be increased through production practices and meat processing [9]. Stajic and other authors have reiterated that goat meat could be used to develop acceptable meat products for consumers. This includes potential products such as dry fermented sausages and cured meats made by substituting goat fatty tissue (with undesirable sensory attributes) with alternative fat sources. Using spices and seasoning could also improve the sensory acceptability by masking the undesirable sensory attributes of goat meat [1,16]. Special precaution needs to be taken when developing innovative food products using goat meat, as the composition of the meat will influence the modifications that can be made to meet consumers' needs and be sensorily acceptable [13]. A study on the potential of goat meat acceptance concluded that there is potential for the emergence of goat meat and value-added products in the South African market specifically aimed at young adults [17].

This paper, therefore, aims to describe the use of food processing techniques to improve the sensory qualities and acceptability of goat meat.

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MATERIALS AND METHODS

Sample size and selection

A sample size of 100 participants for the consumer acceptance sensory evaluation was selected for this study. This study was granted ethical clearance from the Durban University of Technology Institutional Research Committee (071/21). Participants included both male and female university students of different year levels, ethnic backgrounds, and fields of study who were selected from two universities in KwaZulu-Natal (KZN), South Africa. The chosen target audience was young adults because this age cohort is more willing to be experimental or adventurous with food options [17]. Participants were recruited using advertisements that were placed strategically at both university campuses. Interested persons were required to meet the inclusion criteria of being willing to eat goat meat and not being allergic to any food item. All participants were given information letters and completed consent forms indicating their willingness to participate in the study.

Sample preparation for goat meat patties

Primal meat cuts from a Boer goat carcass less than 18 months old were sourced from an accredited abattoir. The shoulder, flank, and leg portions were deboned and cubed into 3 cm x 3 cm pieces. The chilled pieces of goat meat were passed through an electric mincer fitted with an 8mm mincing plate, mixed with seasoning and cereal rusk, and then passed through the mincer again using a 6mm mincing plate. A manual patty press was used to shape and form the patties with clear plastic separators to prevent the mixture from sticking to the equipment. Once formed, the patties were covered and left to chill in the refrigerator for 10 minutes until firm. The patties were pan-fried using sunflower oil in a Teflon-coated non-stick pan, for 5 minutes per side till an internal temperature on a digital thermometer reflected as 72 ºC. The fried patties were placed on a paper towel to drain the oil. Each patty was cut into six equal wedges using a stainless-steel chef's knife. Table 1 and 2 shows the formulation, percentage of ingredients used and method to prepare the patty and sausages, respectively.

Sample preparation for goat meat sausages

Chilled goat meat was passed through an electric stainless steel countertop mincer/meat grinder (CromeCater Model TT-22) using an 8mm mincing plate. The mince was then passed through the mincer again using a 6mm plate for a finer sausage grind. The finely ground mince was left in the fridge to chill whilst the seasoning and cereal flakes, sourced from a reputable industry supplier (Freddy Hirsch Cape Town, South Africa), were prepared. To prepare the cereal flakes

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(butchers rusk), chilled water was added to the cereal flakes, which were placed in a bowl and mixed until all the water was absorbed. The seasoning was added directly to the goat mince, and mixed thoroughly using a stainless-steel spoon, then the cereal flake mixture was added, and the mince was mixed once more using a Kenwood™ stand mixer. The sausage mixture was then filled into size 26mm sheep casing (Freddy Hirsch, Cape Town, South Africa). The casings were thoroughly rinsed before filling. Once filled, the sausages were formed into links and then cut into individual 8cm sausages to ensure uniformity and aid the cooking process. The sausages were then chilled for 15 minutes in the fridge before cooking.

The sausages were fried in 10 ml of sunflower oil over medium heat for 12 minutes, with 6 minutes of cooking time per side. The sausages were constantly moved around in the pan to prevent sticking and rupturing of the sausage casing and to allow for even colouring. Once cooked to an internal temperature of 72°C using a digital thermometer probe (Thermo-pro TP- food thermometer), and the sausages were evenly browned, each sausage was removed and placed onto a paper towel to allow the excess oil from the cooking process to drain.

Proximate analysis

The quantity of protein present in the sausage and patty was determined using the Kjeldahl method, which was calculated by digesting the products in a strong acid, resulting in a release of nitrogen that is determined by a suitable titration technique. The amount of protein is calculated from the nitrogen concentration of the food (conversion factor 6.25) [18].

The fat content of the two goat meat products was determined using the Soxhlet method, which uses a solvent to extract the fat from the sample, the fat is then weighed [19]. The carbohydrate content was calculated by difference, and the approximate carbohydrate value was determined by subtracting the measured protein, fat, ash and moisture from the total weight [20].

Sensory evaluation

Participants were seated in a classroom setting; each participant had a privacy screen to prevent undue bias. Three-digit random number coding was used to label the goat meat patty sample, which was placed in a sealed glass container and kept in a Bain Marie water bath to maintain a warm temperature. The sample, along with a cup of spring water, unsalted dry cracker (palate cleanser), score cards, and a pencil with an eraser, was placed on a white serving tray which was given to participants. Participants first evaluated the sample using a Check-All-

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That-Apply (CATA) score card which enlisted a range of words used to describe the sensory attributes of goat meat developed by a trained sensory panel. Afterwards, participants completed the food action rating scale score card to indicate willingness and intent to purchase the goat meat burger patty sample they had evaluated.

Analysis

The developed goat meat burger patty was tested for the microbial load (coliform count, yeast and mould, total plate count), and proximate testing to determine the total fat, protein, carbohydrate, cholesterol, ash, moisture, and iron content was done before sensory evaluation. The Statistical Package for Social Sciences (SPSS®) version 28.0 (IBM SPSS Inc, Chicago, IL) was used for descriptive statistics, including means and standard deviations, where applicable. Frequencies are represented in tables or graphs. Using the Chi-square goodness-of-fit test, a univariate test was used on a categorical variable to test whether any response options were selected significantly more/less often than the others. The binomial test was used to test whether a significant proportion of participants chose one of a possible two responses.

RESULTS AND DISCUSSION

Product development

Results from the proximate analysis showed that the goat meat patty (31.57g/100g) and sausage (26.88g/100g) were high in protein (Table 3). The total fat content for both products was less than 10g per 100g portion and met the requirement of a minimum of 75% total meat [21]. The carbohydrate content was attributed to the presence of cereal in the form of butcher's cereal flakes, which is a permitted ingredient in the formulation of processed meat products [21]. Another study on goat meat patty development used different fat sources (beef and pork) and processing methods (drying and curing) and therefore are not a direct comparison to the products developed in this study [22]. However, per a 100g, comparing the total fat (14.5g) and protein (15.9g) content of beef patties from a popular retail store to the goat meat patties, the goat meat patties were lower in fat (4.05g) and higher in protein (31.57g) [23]. Table 4 depicts the results for the microbial testing results which indicates the products are safe for consumption.

Coliform counts were very low and well within the acceptable range for both samples. Yeast and mould counts were very low and total bacterial counts were low and within acceptable range. The results are in accordance with the Foodstuffs, Cosmetics and Disinfectants Act, and regulations governing

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microbiological standards for foodstuffs and related matters, hence the goat meat patties and sausages are suitable for consumption [21].

Consumer acceptance sensory evaluation

The demographic profile showed that all participants were of African ethnicity, mostly females (68%) and within the age cohort 17-24 years old (94%).

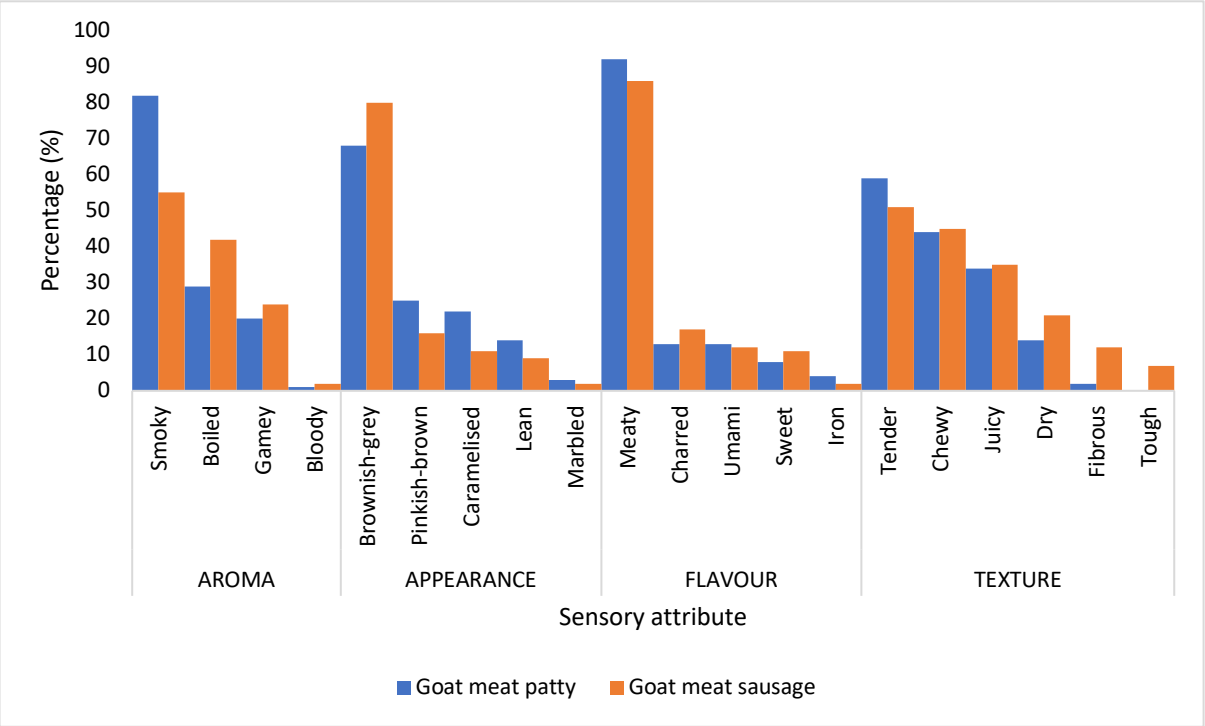

Figure 1: Check-All-That-Apply responses for the goat meat patty and sausage (n=100)

Results for the CATA test revealed the most frequently selected term used to describe the sensory attributes were 'smoky' for aroma (82%,55%), 'brownish-grey' for appearance (68%, 80%), 'meaty' for flavour (92%, 86%), and 'tender' for texture (59%, 51%) for the goat meat patty and sausage respectively (Figure 1). Table 5 depicts the results for the food action rating scale responses for the goat meat patty and sausages. As shown in the food action rating scale responses, participants showed a more positive attitude towards the goat meat patty (96%) than the goat meat sausage (88%). This was also validated by the paired preference results, whereby participants preferred the goat meat patty (66%) compared to the sausage (34%).

Whilst trained panels are necessary for product refinement, consumer panels are important for informing product developers about their perceptions and preferences

[24]. Overall, consumer feedback from the evaluation of the goat meat patty indicated that the sensory properties of the two products were best described using the terms 'smoky' for the aroma, 'brownish-grey' for appearance, 'meaty' to describe flavour and 'tender' for the texture. Aroma plays a vital role in sensory acceptability as it is one of the first attributes a consumer encounters, even without intending to do so. A systematic review of studies that used a Food Choice Questionnaire (FCQ) across 25 countries reported that sensory appeal was ranked as one of the most critical dimensions influencing food choice [25].

Cooking methods greatly influence the aroma of the food being prepared. In this study, shallow pan frying was used to prepare both goat meat products. The intention to use shall pan frying was in line with what was commonly used by students to prepare these two products. Food exposed to thermal treatment may display a series of reactions referred to as Maillard reactions or commonly known as non-enzymatic browning. The products of Maillard reactions influence product attributes such as flavour, colour, aroma, and texture [26]. This influence was evident in the goat meat patty, whereby consumers were able to associate the terms 'smoky' (aroma) and 'brownish-grey' (colour) with the product, and this is reflective of the cooking method used. Even though some participants associated the aroma as 'smoky', the aroma 'boiled' was also selected as a descriptor for the goat meat patty. Grilling, or braaiing/barbequing, as a cooking method usually involves some type of wood or charcoal, which imparts a particular aroma, flavour, and colour. In this case, no wood/charcoal was used in the cooking method, so the words 'charred' (flavour) and caramelised (colour) were not as frequently selected as previously mentioned.

Uncooked/raw meat is slightly flavoured, but the heat treatment of meat provides a non-species-specific 'meaty flavour', while heating meat that contains fat develops a flavour more specific to the species it is sourced from Ripoll *et al.* [13]. The meaty flavour is composed of thousands of volatile compounds; however, only a few contribute to the characteristic odour and flavour of meat [27]. The flavour terms that were frequently selected to describe the goat meat burger patty included 'meaty' and 'umami,' which are appealing attributes. The aroma of food can greatly influence its acceptance or rejection and can also trigger a specific appetite for the queued food before even being visually identified [28].

The formulation for both products contained rusk, which was used to improve moisture retention and allow for a juicy patty and sausage as the butchers' rusk (cereal flakes) absorbs the freely available moisture which remains in the product during cooking. Goat meat is generally associated with being tough or chewy

[14,15] but in this study, due to the mincing process, which is mechanically tenderising the meat, the texture of both the products were frequently selected as 'tender' with only some consumers selecting 'chewy' as being more descriptive of the texture [29]. Mechanical processing, such as mincing, is commonly used to improve the texture of meat and meat products, especially for lower quality cuts or carcasses of older animals. The breaking down of muscle fibre reduces meat toughness and chewiness [29]. By mincing the meat into a patty, the overall texture of the goat meat was made more desirable to most of the consumers.

While the sensory attributes do provide some indication of whether a product is considered favourably or not, marketers are keen to find out if a consumer would be willing to purchase a product or to determine their attitude towards a product [16]. Participants selected positive statements regarding the intent to purchase options in the food action rating score card. A low percentage of the overall participants indicated they were neutral (20% and 18%) or had negative responses (4% and 12%) towards the intent to purchase goat meat sausages or burgers, respectively. A study on the consumer sensory evaluation of sheep and goat meat sausages concluded that consumers perceived goat meat sausages to be harder, more fibrous, and less juicy than sheep meat sausages. Despite the different consumer perceptions, there was no preference for one sausage, indicating goat meat sausages have market potential [30].

This is also the case in the current study, whereby both products developed using goat meat show potential for acceptance in retail. Even though more preference was given to goat meat burgers, the goat meat sausages were not entirely disliked. Instead, certain sensory characteristics were not found to be as favourable as the goat meat burgers. While most of the participants from a university located in a rural area indicated intent to purchase the goat burger, there were similar responses for the preference of sausage and burger from the urban-located university. Considering adults eat what they prefer, food preference is an important factor that must be considered. Food choice is primarily influenced by palatability and food preferences. As such, adults eat what they prefer and not necessarily what would be the healthier or more nutritious option [25].

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

Goat meat is a sustainable and nutritious meat source not commonly consumed by young adults. The results indicate that promoting goat meat consumption to young adults can be achieved by introducing value-added products like goat meat patties and sausages, as developed in this study. Goat meat demonstrated its suitability

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as a primary ingredient in developing meat patties and sausages. Compared to beef patties, goat meat patties and sausages offer notable nutritional benefits. The sensory evaluation indicated that goat meat patties are preferred over meat sausages, however, the young adult demographic, whose food choice is largely self-influenced, found both goat meat patties and sausages to be agreeable choices.

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Table 1: Goat meat patty formulation with percentage of ingredients

Ingredients	**Percentage (%)**
Goat meat, leg	36.6
Goat meat, flank and rib	27.4
Goat meat, shoulder	27.4
Garlic powder	0.4
Onion powder	0.4
Ginger powder	0.2
White pepper powder	0.4
Salt, iodised	0.5
Cereal flakes (butchers rusk)	2.2
Ice cold water	4.6
Sodium metabisulphite	0.1
Recipe yield	25 patties
Preparation method	
Step 1	Cube meat into small pieces, 3x3cm, removing all bones. Place the pieces in a bowl, cling wrap and allow to chill for 10 minutes in the freezer until firm but not frozen.
Step 2	Using the 8mm grinding plate, place the chilled meat into the mincing funnel to mince.
Step 3	Mix the cereal flakes and ice-cold water until the water is completely absorbed by the cereal flakes. Once the mince is formed, add the seasoning ingredients and the cereal flakes mixture using a stand mixer. Using the 6mm plate, mince the mixture again.
Step 4	Using a 100mm manual patty press, shape the minced meat mixture into patties. Allow the patties to chill in the fridge for 10 minutes before cooking.

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Table 2: Goat meat sausage formulation

Ingredients	Percentage (%)
Goat meat, leg	36.3
Goat meat, flank	27.2
Goat meat, shoulder	27.2
Garlic powder	0.4
Onion powder	0.4
Ginger powder	0.1
White pepper powder	0.4
Salt, iodised	0.7
Sodium metabisulphite	0.1
Cereal flakes (butchers rusk)	2.7
Ice cold water	4.5
Sheep casing (26mm)	1 strand (1m)
Recipe yield	30 sausages
Method	
Step 1	Cube meat into small pieces, 3x3cm, removing all bones. Place the pieces in a bowl, cling wrap and allow to chill for 10 minutes in the freezer until firm but not frozen.
Step 2	Using the 8mm grinding plate, place the chilled meat into the mincing funnel to mince.
Step 3	Change the mincing plate to size 6mm and pass the minced meat through the mincer again.
Step 5	Once the mince is formed, add the seasoning ingredients and cereal flakes mixture. Mix thoroughly to combine.
Step 6	To prepare the sausage casing, rinse thoroughly with tepid water to remove all residual salt.
Step 7	Using a manual sausage filling machine with size 26mm sheep casing, fill the goat meat mince into the casing. Once the casing is filled, twist the sausage into 8cm portions and link.

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Table 3: Proximate analysis of goat meat burger patty and goat meat sausage per 100g

Proximate analysis	Goat meat patty	Goat meat sausage
Total carbohydrates (g)	12.61	17.31
Total fat (g)	4.05	6.08
Cholesterol (mg)	64.28	81.38
Protein (g)	31.57	26.88
Moisture (g)	44.04	42.8
Ash (%)	7.73	6.93
Iron (mg)	4.16	3.71

Table 4: Microbiological profile of goat meat patty and goat meat sausage

Analysis	Goat patty cfu/g	Goat sausage cfu/g	Acceptable limits cfu/g
Coliform count	30	37	$<10^4$
Yeast and mould	30	30	$<10^4$
Total plate count	410	200	$<10^6$

*cfu- coliform forming units

Table 5: Food action ratings for the goat meat patty and sausage (n=100)

	Food action response	Goat meat patty	Goat meat sausage
		%	%
Positive attitude	I would eat this at every opportunity that I had	24	24
	I would eat this very often	20	22
	I like this and would eat it now and then	34	22
	Total for positive attitude	78	68
Neutral	I would eat this if available but would not go out of my way to do so	18	20
	Total for neutral	18	20
	Total for positive and neutral attitude	96	88
Negative attitude	I don't like this but would eat it on occasion	2	7
	I would hardly ever eat this	2	4
	I would eat this only if forced to	0	1
	Total for negative attitude	4	12

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