Product development, lexicon creation and sensory acceptability of goat meat products for the emerging consumer

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DECLARATION

I, Karina Palmer, hereby declare that the research work presented in this dissertation is my original work and all the materials used are appropriately acknowledged and explicitly referenced. A reference list is attached to the thesis.

I also confirm that the dissertation has not been submitted in any of its part or entirety for any degree in any other institution of higher learning locally or internationally.

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DEDICATION

I dedicate this dissertation to:

My daughter, Eliyanah Atarah Palmer,
I love you my angel, may you be inspired to follow your dreams
With God nothing is impossible
Luke 1:37

To all mothers, young and old, ‘mom guilt’ exists so
please remember to have ‘mom grace’

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ABSTRACT

Background: Animal food sources (AFS) play an important role in the diet; however, the environmental impact and sustainability of AFS has become a critical stressor to the planet as livestock production contributes significantly towards green-house gas emissions. On the other hand, goats are both adaptable and resilient animals and are therefore an important sustainable AFS which can contribute towards meeting the protein requirements of the growing population. Recent global meat consumption trends report an increase in goat meat consumption. However, despite goat meat being a nutritious and sustainable AFS, the consumption, availability, goat meat is not a preferred AFS in sub-Saharan African countries including South Africa.

Aim: The study aim is to investigate the meat consumption preferences of young adults and develop two sensorially acceptable goat meat products. The study further aimed to develop a goat meat lexicon using different goat meat primals and sub-primals through different cooking methods to establish a lexicon vocabulary that could guide product developers and encourage consumption of goat meat as a sustainable and nutritious food source.

Methods: The first objective of the study was to determine the meat consumption pattern and preferences of young adults from the Durban University of Technology (DUT) and University of Zululand (UNIZULU). An online meat consumption and preference questionnaire was developed and disseminated through email to students and completed (n=416). Objective two of the study involved product development of the most popular processed meat products identified in objective one, which were burger patties and sausages. Through a series recipe development trial, goat meat patty and sausage were developed and tested for consumer acceptance by a pilot sample (n=10). Essential to all food product development, the third objective involved nutrient and microbial analysis and shelf-life testing. Selection, recruitment and training of a sensory panel was the fourth objective of the study. The trained panel proceeded to develop a comprehensive goat meat lexicon. Consumer acceptance of the goat meat patty and sausages by students at both universities was determined by means of a food action rating scale, “Check-All-That-Apply” (CATA) using terms from the goat meat lexicon, and a paired preference test (n=100).

Results: Young adults from DUT and UNIZULU completed the online meat consumption and preference questionnaire. Most of the participants were African (93%), mainly women (68%), and most participants fell within the 18-20 years old (33.9%) and 21-24 years old (44.5%) age

ranges. Findings indicated that a significant proportion of the participants consumed chicken more than four times a month, consumed beef more than three times a month and consumed pork at most twice a month ($p<0.001$). Most of the participants (78.6%) reported consuming goat meat; however, the frequency of consumption was much lower in comparison to chicken, beef and pork. Goat meat consumption by young adults was reported to be mainly due to cultural practices. Key barriers to goat meat consumption included a lack of availability (33.7%) and an unappealing aroma (25.8%). Findings from the first objective led to the development of goat meat patties and sausages as these processed meats were commonly consumed by students. Keeping in mind the barriers to consumption of goat meat, especially the sensory attributes, development of the products involved a series of formulation trials, nutrient analysis, microbial testing and shelf-life testing. Results from the nutrient analysis showed that both the patty (31.57 g/100 g) and the sausage (26.88 g/100 g) were high in protein. The total fat content for each sample was less than 10 g per a 100 g portion.

To understand the full range of sensory attributes associated with goat meat to aid in the development process, a goat meat lexicon was developed. Prior to the lexicon development, participants were recruited (pre-screening survey), screened and attended a series of sensory training workshops to heighten their sensory acuity (n=13). A comprehensive sensory training manual was developed. The manual included pre-screening tests, three training workshops, which covered a range of sensory evaluation tests including identification, discrimination, and descriptive tests (conducted in duplicate) and a series of phases involved in developing the lexicon. Upon completion of the training, nine of the participants met the minimum requirements to proceed to the lexicon development phase. Lexicon development involved a series of phases to generate, select and test the terms and definitions that the trained assessor selected as covering the full range of sensory attributes of goat meat.

The terms developed in the lexicon were then tested by untrained participants using consumer sensory evaluation. A total of 100 students (n=50 DUT and n=50 UNIZULU) were involved in consumer sensory evaluation. Findings indicated that the words participants associated with the goat meat burger included ‘smoky’ (aroma), ‘brownish-grey’ (appearance), ‘meaty’ (flavour) and ‘tender’ (texture). The words associated with the goat meat sausage were ‘smoky’, ‘brownish grey’, ‘meaty’ and ‘chewy’. The majority of participants from both universities identified the appearance of the goat meat sausage as ‘brownish-grey’. Comparing across the universities, a significant number of students from UNIZULU selected the word ‘boiled’ for the

goat meat sausage aroma (p=.015), whilst a significant number of students from DUT selected ‘smoky’ for the aroma (p=.003). In terms of the appearance of the sausage, a significant number of students from DUT selected the word ‘pinkish-brown’ (p=.029), whilst a significant number from UNIZULU selected ‘brownish-grey’ (p<.001). A significant number of participants from DUT selected the descriptors ‘tender’ (p=.009) and ‘juicy’ (p=.012) to describe the texture of the sausage.

Overall, participants preferred the goat meat patty (66%) compared to the sausage (34%). The majority of the participants from both universities showed a positive attitude as to whether they would continue to eat the goat meat burger (78%) and sausage (68%).

Conclusion: The findings indicated the potential to promote goat meat availability at retail outlets in South Africa, specifically through value-added convenience products. The study produced a valid and reliable goat meat lexicon that could be used to assist product developers in improving the sensory attributes of products developed with goat meat in the future. An integrated approach, including consumer education and the increasing availability of goat meat and value-added products, would improve the consumption of this sustainable and nutritious protein source.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF IMAGES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

DUT	Durban University of Technology
UNIZULU	University of Zululand
FAO	Food and Agriculture Organisation
IFAD	International Fund for Agricultural Development
IREC	Institutional Research Ethics Committee
KZN	KwaZulu-Natal
R	Rand
SA	South Africa
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences
STATS SA	Statistics South Africa
SDG	Sustainable Development Goal
UN	United Nations
UNICEF	United Nations International Children's Emergency Fund
US	United States
WFP	World Food Programme
WHO	World Health Organisation
NIDS-CRAM survey	National Income Dynamics Study – Coronavirus Rapid Mobile Survey
ANOVA	Analysis of Variance
ASF	Animal Source Foods
COVID-19	Coronavirus Disease 2019
GNR	Global Nutrition Report
GHG	Rising greenhouse gas
DRDLR	Department of Rural Development and Land Reform
DARD	Department of Agriculture and Rural Development
IUCN	International Union for Conservation of Nature
IPCC	Intergovernmental Panel on Climate Change
QDA	Quantitative Descriptive Analysis, also referred to as Tragon QDA
CATA	Check-All-That-Apply

LIST OF DEFINTIONS

Term	Definition
Ageusia	A rare condition that is characterised by a complete loss of taste function of the tongue (Jain and Rathee 2022).
Anosmia	Anosmia is the partial or complete loss of the sense of smell that may be temporary or permanent (Heymann and Lawless 2010: 206).
Sensory acuity	Sensory Acuity refers to the ability to notice, to monitor, and to make sense of the external cues from other people (Fischer 2013).
Cabrito	Carcass classified by animal age between 1-6 months old that has been milk fed (Guerrero *et al*. 2018: 267).
Chevon	Goats that are older than two years of age (Louw 2022).
Food security	A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Based on this definition, four food security dimensions can be identified: food availability, economic and physical access to food, food utilisation, and stability over time (FAO 2019).
Lexicon	To describe the specific sensory attributes in the food or beverage sample and can be used to evaluate the changes in these attributes (O'Sullivan 2016: 14).

Term	Definition
Nutritional analysis	The process of determining the nutritional content of food (Dimitrova 2019: 12).
Proximate analysis	Proximate Analysis stands for a method, which determines the values of the macronutrients in food samples (Brown 2018: 27).
Processed meat	meat that has been transformed through salting, curing, fermentation, smoking, or other processes to enhance flavour or improve preservation (Reinagel 2016: 5).
Product development	Refers to all the stages involved in bringing a product from concept or idea through market release and commercialisation (Anuragbhai 2021)
Sensory evaluation	Sensory evaluation comprises a set of techniques for accurate measurement of human responses to foods (Heymann and Lawless 2010: 10).
Warmed over flavour	Rapid increase in oxidation in cooked meat products, which is characterised by the rancid flavour developed during storage under refrigeration (Mielche and Bertelsen 1994: 322)
Olfactory	Having to do with sense of smell (Lawless and Heymann 2010: 34).
Ruminant	An animal that has 4 compartments in their stomach. It contains a rumen, reticulum, omasum and obomasum (Andrews 2015).
Quantitative descriptive analysis	Descriptive sensory evaluation technique that involves panelist's ability to verbalize perceptions of a product in a reliable manner (Kemp, Hort and Hollowood 2018: 290)

Term	Definition
Sustainable	A method of harvesting or using a resource so that the resource is not depleted or permanently damaged (FAO 2019).
Food systems	Encompass the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption and disposal of food products that originate from agriculture, forestry or fisheries, and parts of the broader economic, societal and natural environments in which they are embedded (FAO 2019).
Sustainable food systems	Is a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised (FAO 2019).

CHAPTER ONE: INTRODUCTION

1.1 Introduction

The introductory chapter presents an overview and summary of the research study and describes the importance, aim, problem statement, objectives, assumptions, and the delimitations. Lastly, the chapter provides an outline of the research study and structure of the dissertation.

1.2 Importance of the study

Diet quality has been identified as the critical link between food and nutrition security; however, a major challenge exists as healthy and nutritious foods are usually not affordable to the majority of the global population (FAO 2022: 47). There is particularly limited accessibility of animal source foods, which are rich in micronutrients, to low-income communities. However, goats are a readily available and accessible animal source food (ASF) compared to cows and sheep, goats are routinely reared with substantial populations being found in Africa and Asia (Mazhangara *et al.* 2019: 2; Monau *et al.* 2020: 3; Kaliber, Koluman and Silanikove 2016: 83; Simela and Merkel 2008: 102). 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 (Shivakumara and Kiran 2019: 557). This indicates that input costs are relatively lower for goats, hence making them a more profitable farming option, and possibly, a cheaper food choice.

Nutritionally, goat meat has a lower saturated fat and cholesterol content and contains more polyunsaturated fatty acids than beef and lamb (Ivanović, Pavlović and Pisinov 2016: 112). Southern Africa is home to approximately 38 million goats, with 70% being reared under traditional management systems in local communities. The southern African indigenous goat breeds are well known for their resilience to disease and adaptability to rugged living conditions. These breeds are comprised of the commercial breed, Boer and the indigenous Nguni breed (Monau *et al.* 2020: 1).

The major breed reared for chevon meat (also referred to as goat meat) in South Africa is the Boer goat, noted for its premium quality, followed by the indigenous breeds (Pophiwa, Webb and Frylinck 2017: 795; Mazhangara *et al.* 2019: 4). The commercial availability, trading and

marketing of goat meat is not as popular compared to other meats. Locally, goat meat is mainly available at informal markets. However, the demand for goat meat in Africa and Asia is increasing and the addition of goat meat convenience products would add value to the marketing and trading of this underutilised meat source (McMillin and Brock 2005: E62).

Whilst there is a growing interest in both goat meat and milk worldwide there is a need for innovation and product development to make this food source appeal to consumers. Processed products such as goat cheese and yoghurt have the potential to be competitive in the dairy industry (Riskó and Csapó 2019: 26). However, in South Africa, fresh goat milk is not a popular dairy option due to the unappealing sensory properties as goat milk has a distinct smell and flavour (Idamokoro, Gunya and Aliber 2019: 5). Globally, processed goat meat in the form of ground meat, or cured and salted goat meat are techniques that have been used to add value and make it more appealing to consumers (McMillin and Brock 2005: E65).

Goats are generally reared under natural veld in developing countries and are usually not administered pharmacological agents to improve their health or increase the number of offspring. Hence, goats reared under these typical conditions may be regarded as 'green produce', which poses an advantage in the marketing of products made from goat meat (Mazhangara *et al.* 2019: 6). The 'naturalness' of goat meat directly feeds into the consumer shift towards healthier food options that are regarded as 'better for you'. The nutritional benefits coupled with the natural rearing conditions make goat meat an ideal choice for the health-conscious consumer (McMillin and Brock 2005: E62; Elias and Tischew 2016: 104; Rana and Paul 2017: 159; Mazhangara *et al.* 2019: 8).

There is a growing need for animal source foods, whilst environmental impact and sustainability are seen as being of critical importance as livestock production requires land and contributes towards green-house gas emissions (Enahoro *et al.* 2019: 114). Goats are both adaptable and resilient animals and are therefore an important sustainable resource which can contribute towards meeting the protein requirements of the growing population (Mazhangara *et al.* 2019: 9). A report on climate change and its impact on southern African food systems refers to goats as the second most valued livestock after cattle in rural areas (Ogundeji 2022: 591). During the 2015-2016 agricultural drought in South Africa, KwaZulu-Natal (KZN) farmers lost more of their cattle herds (43%) as opposed to goat herds (29%). The number of cattle remained stagnant three years after the drought, whilst goat numbers

recovered (Vetter, Goodall and Alcock 2020: 95). Goats are known for having low input requirements and being hardy (Soji and Muchenje 2017: 584; Mogala 2018: 9). The resilient nature of goats makes them a profitable enterprise capable of thriving despite climatic challenges and multiple environmental stressors that other livestock like cattle may not be able to recover from (Mataveia 2021: 157 and Nair *et al.* 2021: 2230).

Despite goat meat being a nutritious food source that is low in total fat, cholesterol, and kilojoules (United States Department of Agriculture 2001), consumption of goat meat and retail availability in South Africa still lags behind other countries (Mohlatlole, Dzomba and Muchadeyi 2015: 44). In rural communities of South Africa, goats are generally reared and slaughtered for religious or traditional ceremonies and not as a preferred meat source (Erasmus and Hoffman 2017: 72). Changes to unhealthy food preferences and consumption becomes more challenging as a person becomes older due to established eating habits, and adults tend to eat what they are used to and prefer, and not necessarily what would be better for their well-being (Boesveldt *et al.* 2018: 82). Several changes occur when adolescents transition from school to university, with one being the freedom of choice in the selection of the foods that are consumed, setting the trend for life-long food preferences which can either have a negative or positive impact on their overall well-being (Stok *et al.* 2018: 2).

Identifying and addressing the factors that make goat meat a less favourable protein choice is the starting point to improve the consumption of goat meat as a sustainable food source. The distinct odour/aroma of goat meat is a barrier to acceptance, thus developing value-added products similar to the ones that the mainstream consumer is familiar with, such as processed burger patties or sausages, is potentially likely to improve palatability and acceptance (Hathwar *et al.* 2012: 657; Ivanović, Pavlović and Pisinov 2016: 118; Mandolesi *et al.* 2020: 8). Hence, the focus of this study was to explore the factors that may prevent goat meat consumption and determine the potential for goat meat consumption among young adults.

1.3 Problem statement

Goat meat is a nutritious and sustainable food source that, unfortunately, is not preferred over other types of meat available in South Africa. The sensory properties (aroma, flavour and texture) of goat meat are one of the main barriers to goat meat acceptance. Goat meat is therefore generally not as appealing to consumers compared to other red meat sources (beef and mutton). Sensory properties are linked to the acceptance of a particular food, hence the

importance of addressing these properties for goat meat to be a viable food source in the South African context. Moreover, by addressing the sensory properties of goat meat, food security, sustainability and livelihoods will also be impacted as a demand for goat meat will have a ripple effect on other sectors. Therefore, the rationale of this study is centred around improving the sensory acceptability of goat meat as the core influencer of improving consumption of this sustainable food source for improved food security.

1.4 Aim of the study

This study aims to investigate the meat consumption preferences of young adults and create a goat meat lexicon to develop sensorially acceptable goat meat products to promote consumption of goat meat as a sustainable and nutritious food source.

1.5 Objectives

Objective 1: To determine the meat consumption preferences of young university adults.
Objective 2: To develop two processed goat meat products.
Objective 3: To analyse the microbial and nutrient content and to conduct shelf-life testing on the processed goat meat products.
Objective 4: To create a goat meat lexicon.
Objective 5: To evaluate consumer acceptability of the developed processed goat meat products.

1.6 Assumptions

- It was assumed that all participants were unbiased in their responses to the survey and sensory evaluation.
- It was assumed that the participants in the lexicon development followed the protocol/ instructions given prior to the tasting sessions.

1.7 Delimitations

- The study was limited to two universities in KwaZulu-Natal (KZN), the Durban University of Technology and University of Zululand during 2021-2022.
- Participants were only chosen from the University of Zululand and the Durban University of Technology; hence results cannot be assumed to be reflective of youth in general.

1.8 Knowledge gap addressed

Various research studies including a study conducted across 25 countries reported that sensory appeal is ranked as one of the most important dimensions influencing food choice (Cunha *et al.l* 2018: 32; Proserpio *et al.* 2017: 36). Background information on food preferences is needed to develop suitable products for the intended consumers. Current research focuses more on the physicochemical (Ferreira *et al.* 2022: 3, Kausar *et al.* 2021: 8 and Teixeira *et al.* 2017: 164) and sensory properties of goat meat which include its distinct aroma (Tshabalala *et al.* 2003: 563, Madruga 2010: 40; Idamokoro, Gunya and Aliber 2019: 2; and Ivanović *et al.* 2020: 215), flavour profile due to fatty acid content (Ripoll *et al.* 2019: 1261), and texture which is associated with being tough, or chewy (Mowa 2018: 19; Ngomane, Tsvakirai and Mlambo 2022: 4).

This study has taken a different approach, as the meat preferences of young adults were first identified to develop products that would be of interest and appeal to the intended target audience. In addition to being consumer-focused, this study has also contributed to the existing body of knowledge through the training of a sensory panel with the purpose of creating a lexicon for goat meat and this is the first lexicon to document goat meat attributes. This lexicon will assist product developers and innovators as it forms an effective communication tool and a guidance tool for new product development processes, quality control, and product improvement.

1.9 Conceptual framework

The study followed the conceptual framework outlined in Figure 1.1 which depicts the study objectives and the outline of research activities seen in Figure 1.2. Each chapter in this dissertation will focus on a specific objective.

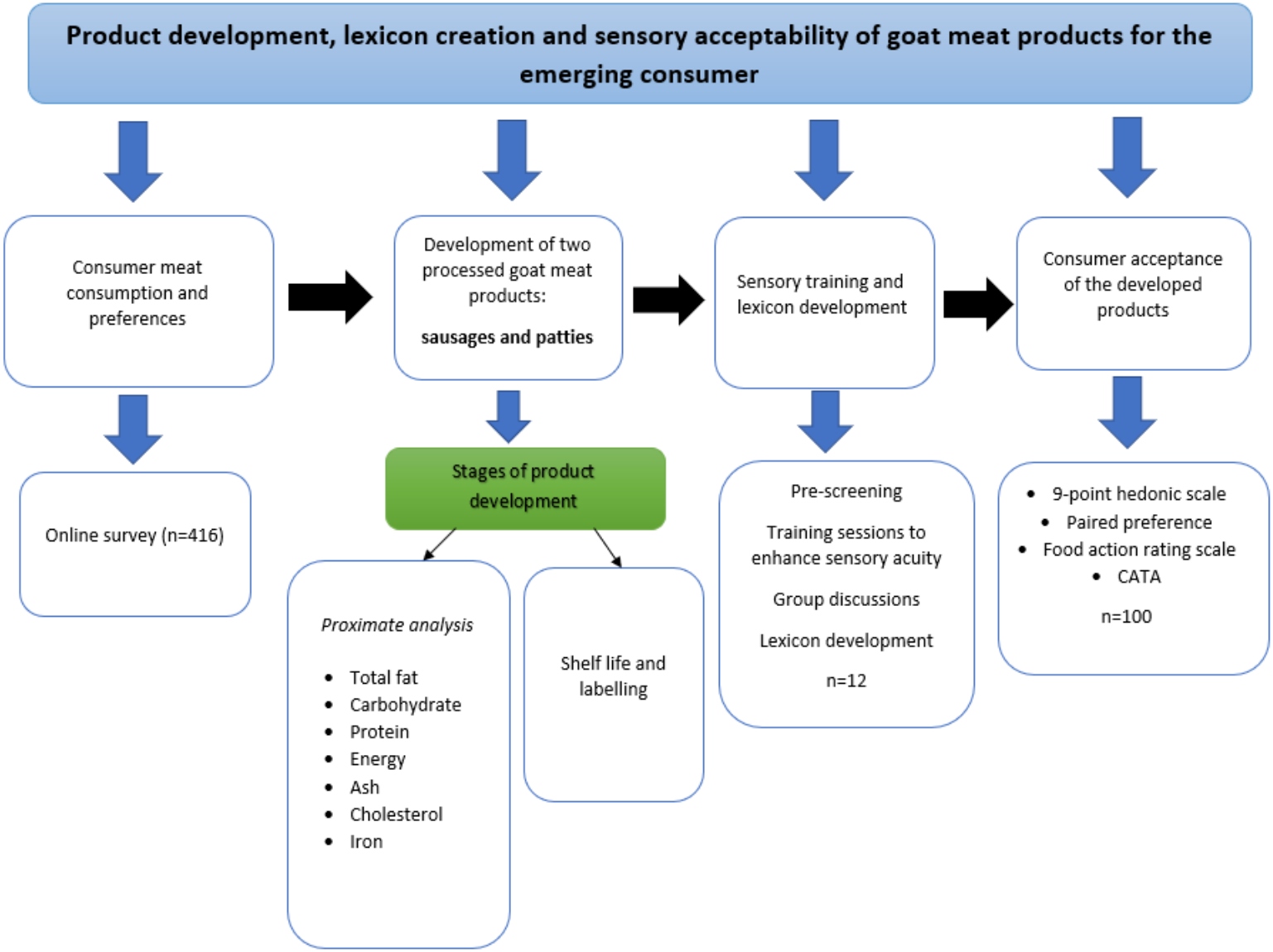


Figure 1.1: Conceptual framework of the study methodology

1.10 Outline of the project

Figure 1.2 provides the progression (flow) of the research project.

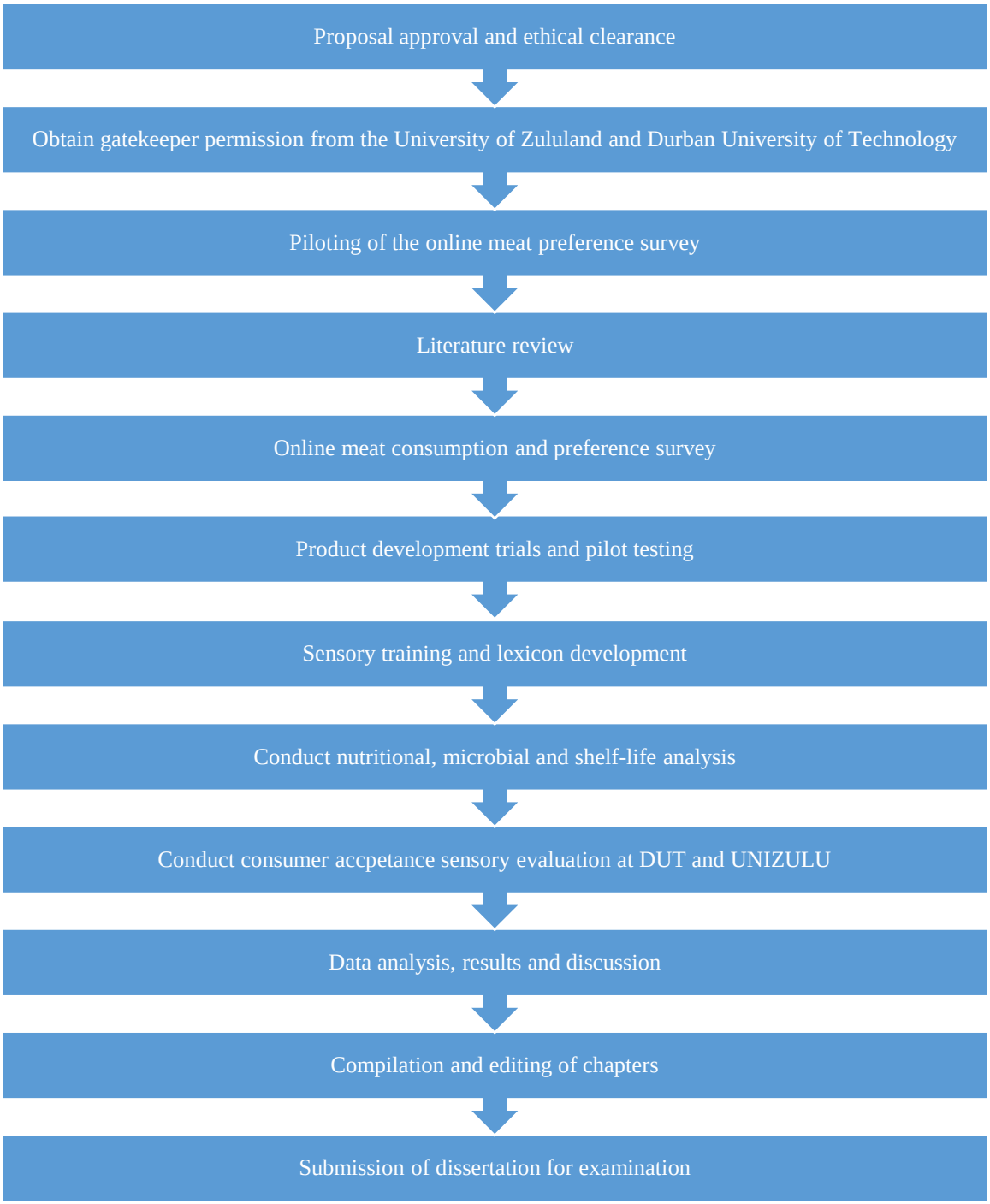


Figure 1.2: Outline of the research study flow

1.11 Structure of the dissertation

Chapter 1: Introduction

Aims, objectives and context of the research.

Chapter 2: Literature Review

Review of studies linked to the research topic.

Chapter 3: Young adults' meat preferences and potential for goat meat consumption

Methodology, results and discussion of objective one of the study.

Chapter 4: Product development of goat meat burger patties and sausages

Methodology, results and discussion of objective two of the study.

Chapter 5: Sensory training and lexicon development

Methodology, results and discussion of objectives three and four of the study.

Chapter 6: Consumer acceptance of goat meat sausages and burger patties

Methodology, results and discussion of objective five of the study.

Chapter 7: Critical overview, recommendations, and conclusion

Summary of the results and discussion, limitations, strengths, and recommendations for future research.

1.12 Conclusion

Chapter one has served as a preview for the research study. The conceptual framework provides a guide to the reader on the progression of the study to assist in understanding the objectives as they are unpacked in the subsequent chapters.

1.13 Referencing style

The referencing style used in this dissertation is according to the DUT Harvard referencing guide.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter aims to evaluate the relevant literature. It provides a broad overview of global and national food security within the context of sustainable food systems. The chapter then evaluates goat meat as a sustainable food source, reviewing the trends of consumption of goat meat globally and in South Africa. It also synthesises related literature on product development and sensory evaluation for the purpose of product development of goat meat products.

2.2 Global food and nutrition security status

The difficulties in eradicating hunger, food insecurity, and all forms of malnutrition continue to increase. The main drivers contributing to recent trends in food insecurity and malnutrition include conflict, climatic extremes, and economic slowdowns and downturns, as well as the high cost of nutritious foods. Moreover, the COVID-19 pandemic has brought to light the fragilities of the world's agri-food systems and when combined with societal disparities, world hunger and severe food insecurity continue to rise. In 2021, globally between 702 and 828 million people experienced hunger. The prevalence of undernourishment increased from 8.0 to 9.3 per cent from 2019 to 2020; however, it increased at a slower rate to 9.8 per cent in 2021 (FAO, IFAD, UNICEF, WFP and WHO 2022: xiv). The prevalence of hunger continues to reveal wide discrepancies throughout world areas. In addition to Africa, rises were also noted in Asia (+1.1 percentage points), and in Latin America and the Caribbean (+2.8 percentage points) (FAO, IFAD, UNICEF, WFP and WHO 2022: 10).

According to the 2021 Global Nutrition report (GNR), few countries are on track to meet the global nutrition targets by 2025 and poor diets and malnutrition need to be addressed sustainably to ensure a healthy future for people and the planet (2021 Global Nutrition report 2021: 13). To reduce the double burden of malnutrition and achieve global nutrition targets; bolder, more sustained and better coordinated action on nutrition that extends far beyond the nutrition community is required (2021 Global Nutrition report 2021: 13). The 2022 State of Food Security and Nutrition in the World report calls for the repurposing of agricultural

policies to make healthy diets more affordable suggesting that governments adapt resources to prioritise food consumption, and to incentivise sustainable production, supply, and consumption of nutritious foods (FAO, IFAD, UNICEF, WFP and WHO 2022: 87) (Figure 2.1). However, there has not been sufficient headway towards the goal of achieving food security for all. Clapp, Moseley, Burlingame and Termine (2022: 1) recently put the case forward for agency and sustainability that should be formally recognised as part of the dimensions of food security which is also illustrated in Figure 2.1. The ability of stakeholders to have a voice and make choices about their food systems is referred to as agency while the long-term resilience of a food system is referred to as sustainability (Clapp *et al.* 2022: 1).

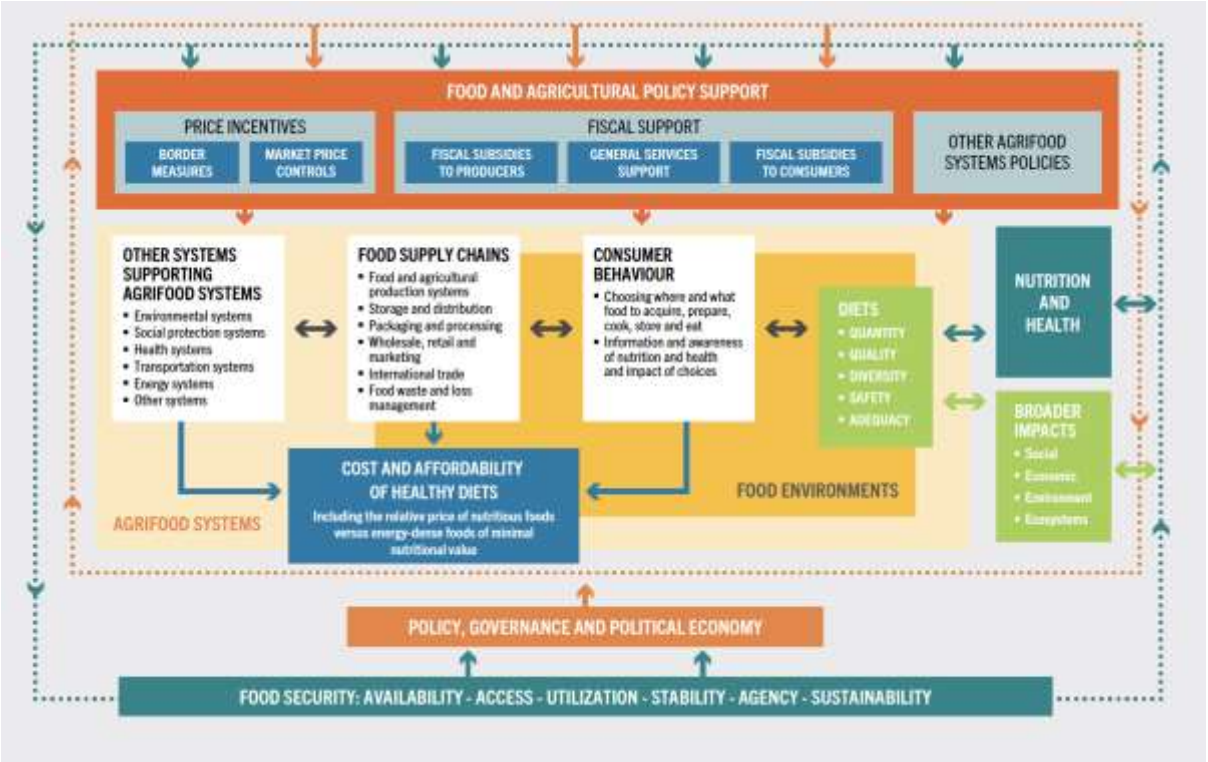


Figure 2.1: Agri-food systems to repurpose food and agricultural policy support (FAO, IFAD, UNICEF, WFP and WHO 2022: 5)

2.3 South Africa's food and nutrition security status

South Africa typically produces enough food and diverse food types; however, it faces a triple burden of malnutrition – undernutrition, micronutrient deficiencies, and overweight/obesity (FAO et al. 2022: 12). Whilst the country has developed food and nutrition security and sound agricultural policies, seven million South Africans experience chronic hunger, while 21 million people are overweight or obese (FAO *et al.* 2022: 14).

Major gains were made from 2002 to 2018, showing a downward trend, when 13.5 million people were food insecure (FAO *et al.* 2022: 15). Although self-reported hunger had reduced drastically, the impact of COVID-19 has altered these numbers as the protracted nature of the pandemic had contributed to the slow recovery of the level of household and child hunger to that seen before the pandemic (van der Berg, Patel and Bridgman 2022: 723) (Figure 2.2). The National Income Dynamics Study – Coronavirus Rapid Mobile Survey, (NIDS-CRAM survey) reported that 18 percent of households experienced moderate or severe hunger in 2020 (Bridgman, van der Berg and Patel 2020: 2). Moreover, according to a recent review by Govender *et al.* (2017: 16), the availability of and access to nutrient-dense, varied, and balanced diets were noted as major obstacles to achieving food and nutrition security as well as to improving human health and well-being.

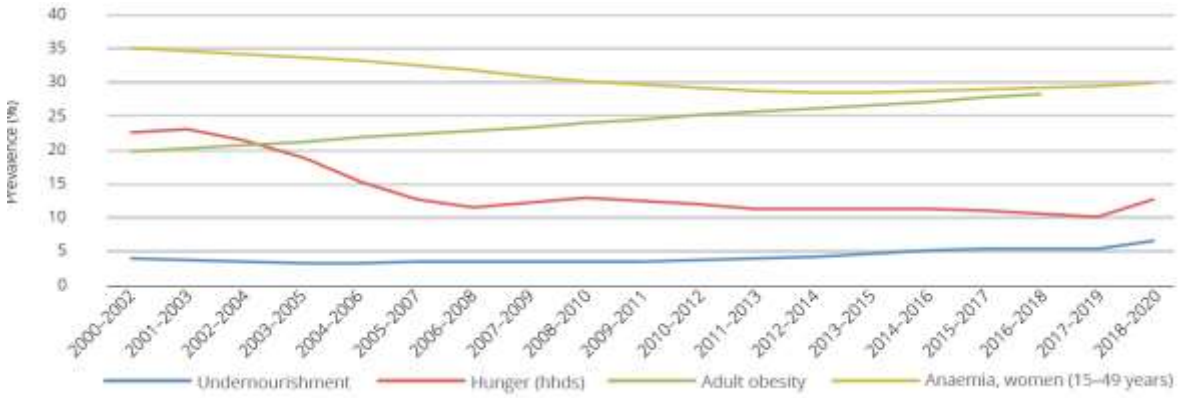


Figure 2.2: Food and Nutrition indicators (2000-2020) (FAO 2022 and STATS SA 2019)

A review of food and nutrition policies implemented in South Africa from 2002-2018, highlighted that most of the policies were written without consulting with relevant stakeholders, being the beneficiaries of the policies. Food systems play an important role in food and nutrition security, therefore any policy aimed at addressing food and nutrition security must have a multi-dimensional approach to be effective. The authors identified various contradictions when comparing policies, suggesting the need to review and restructure these policies in accordance with relevant stakeholders to avoid duplication and ensure clarity (Boatemaa, Drimie and Pereira 2018: 275).

The sustainable development goal 2 emphasises more than just meeting the need to address hunger; but also focuses on nutrition and sustainable agriculture. Diversification of farming practices and choice of both crops and livestock play an important role in addressing food security in Africa (Waha *et al.* 2018: 3366). Diet quality has been identified as the critical

link between food and nutrition security; however, a major challenge exists as healthy and nutritious foods are usually not affordable to the majority of the population (FAO 2020: 24). Proactive strategies to improve diversification include niche product markets that could promote diversification and food sources suited to environments that experience droughts (Waha *et al.* 2018: 3396). Various crops and livestock that are able to survive under challenging climatic conditions are regarded as coping strategies that could be adopted (Ngcamu and Chari 2020: 14).

2.4 Sustainable food systems

Food security and food sustainability are the two main paradigms in the discourse on food systems; however, they are frequently discussed independently in the scientific literature. This discrepancy makes it difficult to have a cogent conversation on sustainability transitions, which is essential to address the issues (environmental, social, economic, and health) brought on by conventional food systems (High Level Panel of Experts 2020: 9). It is commonly accepted that for food systems to be sustainable, long-term food and nutrition security must be ensured in terms of access and utilisation of food, and more recently agency and sustainability has been added as key dimensions (Clapp *et al.* 2022: 1). All the components of food systems must be efficient, robust, and sustainable to provide food and nutrition security for both the present and future generations (High Level Panel of Experts 2020: 9).

Sustainable development seeks to meet current human needs whilst preserving the environment so that these needs can be met by others in the future (Peacock and Sherman 2010: 70). According to Peacock and Sherman (2010: 70), several global trends are likely to impact food production systems, albeit in a negative or positive way. These include the rising costs of non-renewable energy, the increasing cost of grain, changes in the human diet, human and livestock population growth, and environmental degradation.

The food system continues to face issues such as rising greenhouse gas (GHG) emissions, dwindling ecosystems, and deteriorating biodiversity because of an increase in the amount of land and fresh water utilised to produce food for a growing population (Intergovernmental Panel on Climate Change (IPCC) 2019: 17). This brings to light that the way in which food is produced and consumed now is not sustainable (Steenson and Butriss 2020: 3). While some researchers and policy makers advocate for the shift to plant-based foods in an attempt to

reduce global warming and its associated consequences (Willett *et al.* 2019: 447; Aschemann-Witzel *et al.* 2021: 3119), the nutritional adequacy of plant-based food equivalents and the amount needed to replace animal source foods is of concern, especially in terms of protein quality and various micronutrients (iron, zinc, vitamin B12 and fatty acids) (Leroy and Cofnas 2020: 2764). Sustainable, low input requirements and resilient alternatives to animal sources of food such as insects and seaweed have been considered but acceptance of these alternatives is still in its infancy and barriers (both cultural and social) still need to be fully explored and tested for consumer acceptance (Anusha Siddiqui, Bahmid, Mahmud, Boukid, Lamri and Gagaoua 2022: 18).

2.5 Sustainable food production

The population of the world is currently around 7.7 billion and is predicted to reach the 10 billion milestone by the year 2050. This figure is expanding at a rate of about 1.07 percent per year (Worldometers 2019). There will be a strain on livestock production methods and products due to the rise in the sub-Saharan African population and the need to feed a growing population (Assan 2021: 3). Food supply needs to be adequate to meet the needs of the growing population; however, the agriculture and livestock demands have serious consequences for the environment. This has spurred discussion about all the factors that connect the ideas of food safety and sustainability, not only about food alternatives (Fasolin *et al.* 2019: 2).

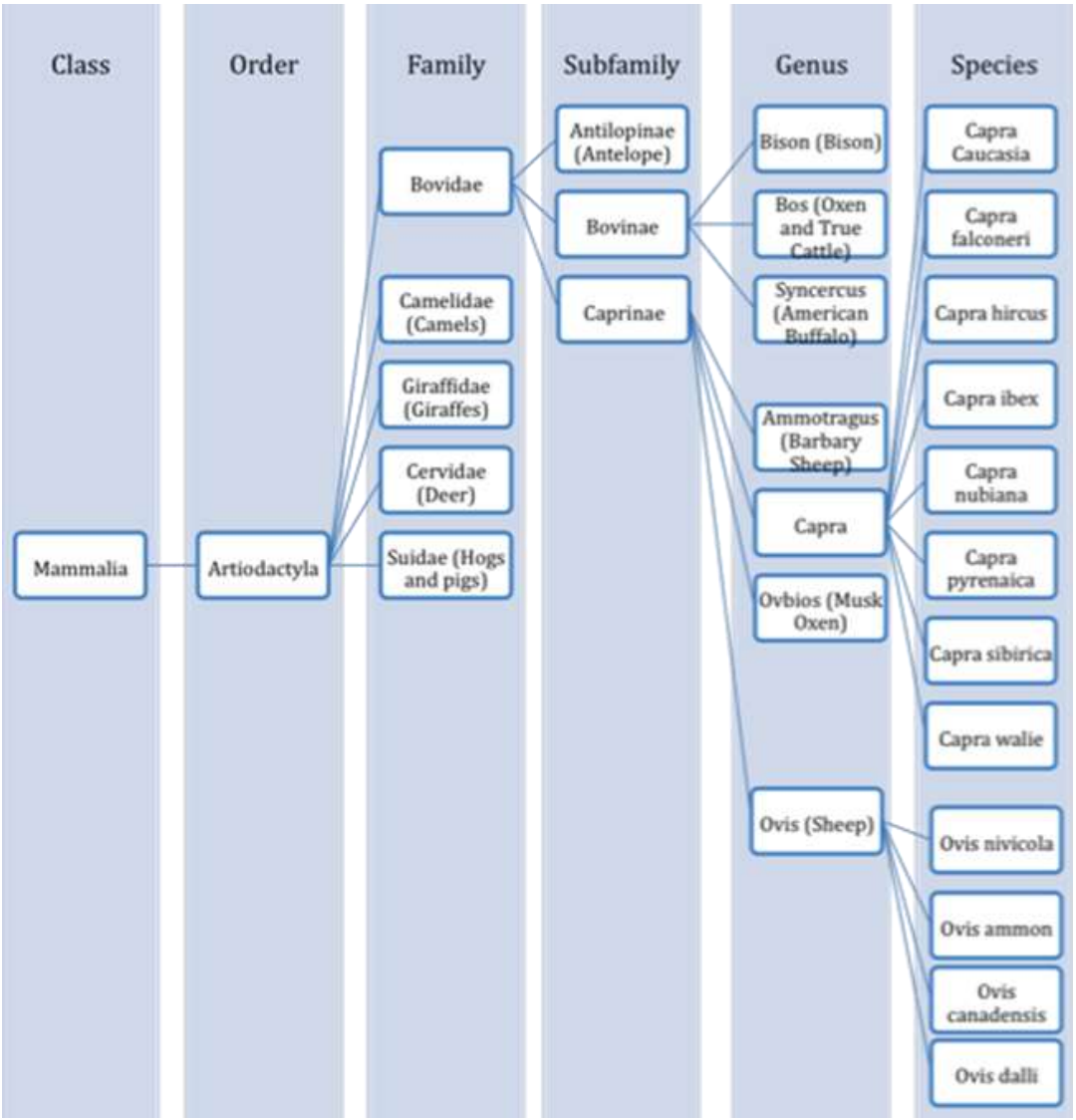
The concept of sustainable agriculture development is defined as “Agricultural development that contributes to improving resource efficiency, strengthening resilience and securing social equity/responsibility of agriculture and food systems in order to ensure food security and nutrition for all, now and in the future” (High Level Panel of Experts 2016: 29). This definition shows that agricultural development can only be considered as being sustainable if the importance of connecting production and consumption is acknowledged (Bilali *et al.* 2019: 4).

2.6 Goat meat as a sustainable food source

2.6.1 Goat classification

Goats (*Capra hircus*) are thought to be the second domesticated animal after dogs. It is also believed that the first goats arrived in Egypt around 5000 B.C. and thereafter spread south and west throughout Africa. African goats are classified into three families: Dwarf goats of West and Central Africa, Savannah goats of Sub-Saharan Africa, and Nubian-type goats of North Africa (Yami and Merkel 2008: 6). The taxonomy classification is depicted in Table 2.1.

Table 2.1: Taxonomy classification of *Capra hircus (*Capra hircus: the domestic goat 2022)



a) Nguni/Mbuzi

b) Boer goat

c) Kalahari red goat

d) Cape lob ear

e) Kunene goat

f) Savanna goat

g) Saanen goat

h) Angora

Image 2.1: Goat breeds in South Africa (Department of Agriculture and Forestry 2015: 2)

Indigenous breeds (Nguni/Mbuzi, Cape lob and Kunene) have been naturally selected for adaptability to harsh environments and are primarily used for meat production but are also important for cultural purposes (Image 2.1). Breeds that have been bred specifically for their meat production characteristics in South Africa include; Boer goats, Savanna goats, and Kalahari Red goats (Image 2.1) (Department of Agriculture and Rural Development (DARD) *et al.* 2018: 11). Dairy breeds are all imported, with the majority being Saanen and Toggenburg goats and the less popular Savanna goats. These are breeds that have been chosen for milk production and are used to make milk and processed milk products such as

cheese and yoghurt. These breeds are known to be vulnerable to diseases and parasites (Department of Agriculture and Rural Development (DARD) *et al.* 2018: 11).

2.6.2 Carcass classification and nutrient profile

In terms of the South African carcass classification system, animals that have no permanent incisors are classified as A-age class and are given better ratings as opposed to those that have several permanent teeth. Goats that are older than two years of age are referred to as chevon, and those younger than two years are known as cabrito (Louw 2022). Table 2.2 expands on the classification system used in South Africa.

Table 2.2: Classification of beef, lamb and goat meat carcass based on conformation, damage, and sex (Soji *et al.* 2015: 265)

Characteristic	Class	Class description	Comment
Age	A	No permanent incisors	Carcass whose head is not available for determination of age is deemed to be in class C
	AB	At least one but not more than two permanent incisor teeth	
	B	Has at least three but not more than six permanent incisors	
	C	Has more than six permanent incisors	
Conformation	1	Very flat	
	2	Flat	
	3	Medium	
	4	Round	
	5	Very round	
Damage	0	Undamaged	Classification considers damage in relation to locality, extent and depth of damage plus fat to meat to bone ratio
	1	Disturbed to a slight extent	
	2	Moderately disturbed	
	3	Is severely disturbed	
Sex			The carcass of a ram or a bull as well as of a *hamel, a *kapater or an ox showing signs of late castration of the A-, AB-, B- or C-age classes, are identified

* "hamel" and "kapater" refer to castrated male sheep and goats, respectively.

Meat quality is directly related to age of the animal, hence goats reared for meat should not be kept for longer than two years of age (Pophiwa, Webb and Frylinck 2017: 796). A comparative study of Boer and indigenous goat meat under delayed chilling conditions revealed that breed was not the main factor influencing the sensory properties of the meat, but rather the slaughtering technique and procedures impacted the meat quality (Pophiwa, Webb and Frylinck 2017: 796). This suggests that goat meat (both indigenous and improved) can be marketed as having acceptable eating qualities provided that slaughtering procedures are adhered to (Pophiwa, Webb and Frylinck 2017: 798). Goat carcasses are relatively smaller,

have a higher percentage of muscle, and lower percentage of bone and fat in comparison to sheep carcasses of the same age and gender (McMillin and Brock 2005: E58).

Factors such as the live weight of the goat (prior to slaughter), genotype, muscle, gender and diet influence the chemical composition of the meat (Madruga and Bressan 2011). Variations in the quality of goat meat are attributed to factors including age, gender and genetic groups (Casey and Webb 2010) whilst the older the animal is the less tender the meat (Webb and Casey 2010). Various methods can be used to increase the tenderness of goat meat post slaughter; these include carcass ageing, using electrical stimulation and blade tenderisation of the goat meat cuts (McMillin and Brock 2005: E59). Goat meat is known to have specific short chain fatty acids linked to goat meat flavour. Oxidised flavours which are unappealing develop faster in cooked goat meat as compared to meat sourced from other species (McMillin and Brock 2005: E59). In terms of nutrition, animal sources of food are rich in high biological value protein and contain other essential nutrients that promote well-being (Stajic and Pisinov 2021: 2). Nutritionally, goat meat is regarded as being superior to other red meats, due to the lower saturated fat and cholesterol content and it contains more polyunsaturated fatty acids than beef and lamb (Ivanović, Pavlović and Pisinov 2016: 112; van der Weele *et al.* 2019: 506). Goat meat is also reported to be a good source of group 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 (Kazhybayeva 2019: 239).

Table 2.3. The nutritional composition of goat and other meat sources per 85 g (United States Department of Agriculture 2001: 85; Mazhangara *et al.* 2019: 7)

Nutrient	**Goat**	**Chicken**	**Beef**	**Pork**
Kilojoules (kJ)	510	678	749	753
Fat (g)	2.6	6.3	7.9	8.2
Saturated fat (g)	0.79	1.7	3.0	2.9
Protein (g)	23	25	25	25
Cholesterol (mg)	63.8	76.0	73.1	73.1
Iron (mg)	3.1	1.5	2.9	2.7

Despite goat meat being a nutritious food source that is low in total fat, cholesterol, and kilojoules (Table 2.1) (United States Department of Agriculture 2001), consumption of goat meat and retail availability in South Africa still lags behind other countries (Mohlatlole, Dzomba and Muchadeyi 2015: 44). Approximately 63% of the goats in South Africa comprise indigenous veld goats, which contribute to the non-commercialised agricultural sector (Visser 2004: 25). Identifying factors that make goat meat a less favourable protein choice is key in addressing ways to improve the consumption of goat meat as a sustainable food source. Hence, the purpose of this study was to explore the factors that may prevent goat meat consumption and determine the potential for goat meat consumption among young adults.

In South Africa goats are generally reared and slaughtered for religious or traditional ceremonies in rural communities and not as a preferred meat source nor are they commercially marketed (Erasmus 2017: 72). Goats play an important role in African culture and are used not only for ceremonies but also in marriage negotiations, hence they are an important aspect of rural livelihoods. Even though goats are important in rural communities, the extent of their production and contribution to local economies is underestimated. Due to goat meat being utilised mainly for cultural/religious practices, consumption of goat meat seems to be specific to a select few communities. This niche target group and the sensory properties of goat meat (strong aroma) have impacted both the commercial availability and marketing efforts directed at increasing consumption of goat meat in South Africa (Soji and Muchenje 2017: 585).

2.6.3 Global goat meat consumption

The Southern African region is home to approximately 38 million goats, with 70% being reared under tradition management systems in local communities (Monau *et al.* 2020). In 2016, South Africa exported a total of 43 tons of goat meat per year which declined to a mere 1.2 tons in September 2018 with the majority of the meat being exported to Nambia (82%) (Mogala 2018). An overview of the distribution of goats and sheep worldwide is depicted in Image 2.2.

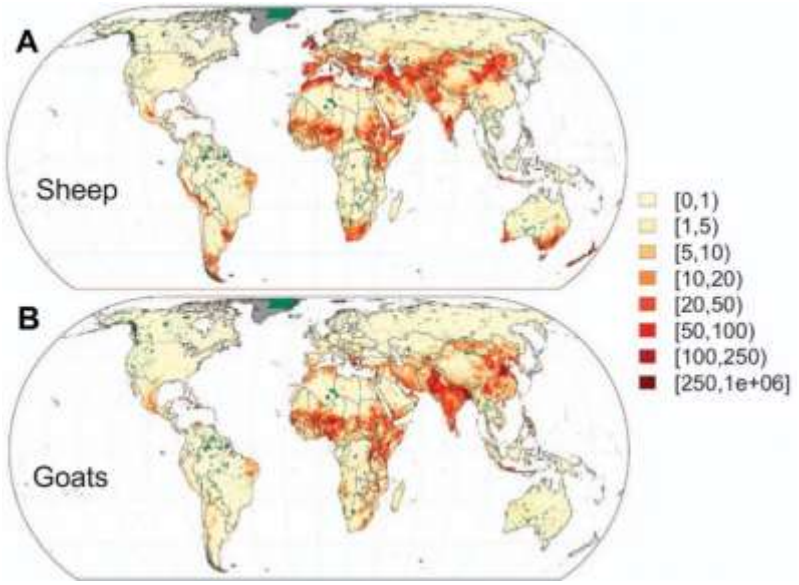


Image 2.2: Estimated worldwide distribution and density of sheep (A) and goat (B) heads per square kilometre in 2010 (originally by Gilbert *et al.* (2018: 9), adapted by Simões *et al.* (2021: 2).

Legend: Dark grey and dark green areas correspond to unsuitable and International Union for Conservation of Nature (IUCN) protected areas, respectively.

Similar to South Africa, in Zimbabwe, marketing of goats remains largely in the informal sector for cultural and religious purposes (Musara *et al.* 2013; Erasmus and Hoffman 2017). However, possible difficulties in maintaining a constant regulated supply to the formal sector could also be a barrier to chevon being widely available in the formal market. In addition, goats are mainly, if not solely, reared at a subsistence level as opposed to a commercial level. Awareness and support programmes need to be structured to expose farmers to the opportunities that exist for chevon in the commercial market (Musara *et al.* 2013). In Zimbabwe, cattle is regarded as a priority over goats due to the multipurpose uses, marketing and other positive associations with the meat as opposed to goat meat; however, there is a place for goats in the informal sector (Musara *et al.* 2013). Consumption of goat meat and sheep in Europe is lower than other meat types like chicken and beef (Mandolesi *et al.* 2020). 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 as opposed to red meat (Mandolesi *et al.* 2020).

In Brazil, goat rearing is practised mostly by small-scale farmers in areas with poor agricultural potential. Hence goat meat production plays an important socioeconomic role

especially in the Northeast region of Brazil (Madruga and Bressan 2011). In Brazil, uniformly followed quality standards like post slaughter handling and processing are not practised for goat meat production, which poses various challenges in the goat meat market (Madruga and Bressan 2011). Value addition through processing methods such as curing (Tolentino *et al.* 2017: 392, Oliveira et al. 2014: 460 and Teixeira *et al.* 2017: 164), salting, air drying and ageing (Teixeira *et al.* 2011: 56) and using goat meat to form nuggets (Kausar *et al.* 2021: 4) has been explored by other researchers.

Goat meat consumption in the United States has been focused on areas where specific ethnic populations consume goat meat as a traditional staple food; this includes various ethnic groups such as the Muslim, Latino, Asian, Afro-American, Haitian, and Eastern European groups (Pinkerton and McMillin 2013). Goat meat is becoming a more popular meat source in Serbia due to its unique taste and desired chemical composition (Ivanović, Pavlović and Pisinov 2016).

2.6.4 Goat meat consumption in South Africa

The Southern African indigenous goat breeds are well known for their resilience to disease and adaptability to rugged living conditions. These breeds comprise of Nguni, Tswana and Matebele which are large goats, as well as the East African goats which are smaller in size (Landim, Mashona and Malawian) (Monau *et al.* 2020). The adaptability of goats to thrive in semi-arid and arid environments makes them an excellent option as a food source that is both sustainable and nutritious (Cawthorn and Hoffman 2014: 8; Kaliber, Koluman and Silanikove 2016: 83).

According to a report by the South African Department of Agriculture, Forestry and Fisheries, South Africa produces less than 1% of goat population in the world (Mogala 2012). There are three main commercial goat breeds in South Africa: Boer, Savanna and Kalahari Red that are reared for their meat and skins. The term 'chevon' refers to meat from adult goats, whilst 'cabrito' is meat from young goats (Mogala 2012). Indigenous goats comprise approximately 63% of the goats in South Africa (Mogala 2012). Indigenous goat breeds are not favoured for their meat (small carcasses) nor the milk produced (low quantities) and as such, the Boer goat is the preferred breed for goat meat in South Africa. In 2012, the Eastern Cape (38%), Limpopo (19%), and KwaZulu-Natal (13%) have been

reported as the highest producers of live goats in the country. Goats are known for having low input requirements and being hardy animals (Soji and Muchenje 2017; Mogala 2018).

Religion, culture and consumer attitudes towards foods play a major role in the acceptance or rejection of food (Kearney 2010: 2801; Rana and Paul 2017: 157). In rural or low-socioeconomic communities, cultural and traditional beliefs play an even stronger role in the foods consumed, and the preparation methods used (Traoré *et al.* 2018: 64). These cultural and traditional barriers need to be identified and considered when venturing into new product development to increase the likelihood of acceptance and adoption of these products by consumers.

Goats play an important role in African culture and are used not only for ceremonies but also in marriage negotiations (lobola) hence they are an important aspect of rural livelihoods. Even though goats are important in rural communities the extent of their production and contribution to local economies is underestimated. Formal marketing of chevon is not done by rural and small-scale farmers as goats are often not regarded as being a profitable meat source due to various misconceptions. Hence, the availability of chevon in formal markets is scarce which directly influences consumption as consumers are not able to eat what is not readily available in the retail sector outside the scope of traditional events where goat meat is consumed (Soji and Muchenje 2017).

Hinduism is the primary religion practiced in India and followed by many South African Indians. Animal sacrifice has been a part of their culture; goats are sacrificed in respect of the Hindu deity Kali. In an interview with Singh, an expert in the field of cultural and Hindu religious studies (2022), it was noted that the cow is held high in status and is regarded as being one of the most sacred animals in Hinduism, and it is honoured by having statues erected in its reverence (Singh 2022). Animal sacrifice is offered to the fierce forms of the Hindu deity Kali. The main purpose of this sacrifice is to totally pacify the anger of this wrathful deity and seek her grace. According to Singh (20220), in the Hindu belief system, the spilling of blood is most necessary for purification and to appease the evil spirits. It is most necessary for the goat to be stress and injury- free prior to slaughter. It is also vital for the goat to be well rested during the 24-hour period before slaughter. Humane treatment of animal slaughter not only reduces unnecessary suffering, but also reduces loss of quality and value of the meat and animal by-products. Pre-slaughter handling is a major concern and

stress can be avoided by keeping the goats cool with adequate ventilation and avoiding overcrowding (Singh 2022). The slaughtering of goats for Hindu ritual purposes requires the instant killing of the animal in a single decapitating blow with a very sharp axe or sword. Other materials mainly used are hanging scales for drying the carcass and sharp knives for skinning it. It is necessary to hang the carcass in a cool dry place for at least 6 to 12 hours before skinning. Some people use vinegar to cleanse the meat once it is cut and to tenderise and neutralise the strong odour of the meat before cooking the meat in a curry (Singh 2022).

In the Muslim community, goats are slaughtered for cultural purposes (example Eid al-Aadha) using *Halal* slaughter methods (Aghwan and Regenstein 2019: 111). The Arabic word *halal* means permissible, and the rules of slaughter are based on Islamic law. The animal must be alive and healthy; a Muslim must perform the slaughter in the appropriate ritual manner, and the animal's throat must be cut by a sharp knife, severing the carotid artery, jugular vein and windpipe in a single swipe (Zainalabidin *et al.* 2019: 2; Farouk *et al.* 2014: 507). Cutting of the major blood vessels and the use of a sharp knife to perform one cut in *halal* slaughtering enables rapid bleeding resulting in higher amounts of blood loss and thereby reducing product deterioration and extending the shelf life of the meat (Farouk *et al.* 2014: 508; Ghani 2014: 508).

2.7 Goat meat market structure and value chain in SA

The majority of the goats marketed within South Africa are sold and purchased in the informal market through private transactions. Thus the informal market drives the South African goat industry (Mogala 2018). Goat meat only became available in a select few formal stores since 2010, as only a small percentage of goats were slaughtered at registered abattoirs complying with retail store standards. In 2004, a private company in the Western Cape undertook a marketing campaign to create awareness of chevon and its benefits. Goat meat was made available in various supermarkets in South Africa making it more accessible to the every-day consumer. Strategies such as these are necessary in improving awareness, acceptability and ultimately consumption of chevon. In rural communities, goats are seen as financial security rather than a saleable commodity hence a change in mindset is needed before goats can be viewed as a commercial enterprise in rural communities (Mogala 2018).

The nature of goat meat lends itself to the growing demand from consumers for a lean and nutritious meat source. In South Africa, the benefits of goat meat are however overshadowed by the misconceptions of the sensory properties of the meat that influence consumption and

overall acceptability (Pophiwa, Webb and Frylinck 2017). In South Africa, the goat meat industry is dominated by the popular Boer goat (an improved breed well known for producing meat) and other unimproved local breeds referred to as indigenous varieties (Malan 2000; Visser *et al.* 2004). Local indigenous goats are known by their geographical location and are favoured for displaying attributes of being resilient to harsh climatic conditions (Visser *et al.* 2004).

Goats are slaughtered mainly during cultural ceremonies. Hence, the selection process, slaughtering processing and preparation methods are specific to the ritual or ceremonial practices for that specific cultural/religious group (Mogala 2012; Soji and Muchenje 2017). Even though South Africa has a well-developed industry for the processing of animal products, little processing of goat meat is done and is usually only when the price of mutton is too high (Mogala 2012). Misconceptions, or strong beliefs surrounding chevon include that it should only be used for ceremonies, goats are pets and should not be eaten, other livestock such as beef and mutton are tastier, and that chevon has an unpleasant odour (Mogala 2018). Hence the need for awareness campaigns including live tasting sessions that must be used as means of promoting the consumption of goat meat as a low fat, nutritious meat source (Mogala 2018).

A case study to determine the consumer acceptability of chevon from indigenous goats revealed that meat from indigenous goats was acceptable to consumers on condition that the meat is sourced from goats that are between 1-2 years of age (Simela, Webb and Bosman 2008). The study also described the sensory properties of goat meat as being comparable to mutton, which is easily accessible in South Africa, but is, however, more expensive than goat meat (Simela, Webb and Bosman 2008).

2.8 Future goat meat market

Madruga and Bressan (2011) suggested that even though there is good growth potential for a goat meat market efforts need to be channelled to quality assurance and uniformity, data collection on consumer preferences, and determining the type of meat products and processing methods that should be used to promote consumption. Unlike other commonly consumed meats, goat meat is not widely exported but rather, consumed locally within communities of developing countries. The market structure for goat meat is also not well developed to promote the consumption of this meat (Skapetas and Bampidis 2016). The value

and acceptability of goat meat may be increased through production practices and meat processing (McMillin and Brock 2005: E59). Special considerations need to be taken into account when developing innovative food products using meat, as the composition of meat will influence the modifications that can be made to meet consumers' needs (Hathwar *et al.* 2012).

McMillin and Brook suggested that by increasing the availability of goat meat and introducing convenient goat meat products, the value and visibility of goat meat in consumer markets would be more pronounced (McMillin and Brock 2005: E60). Hathwar *et al.* (2012), suggested possible ways of altering the nutritional and functional properties of goat meat including; reducing the fat content, modifying the fatty acid and cholesterol levels, including natural antioxidants, and limiting the sodium chloride content, as well as the use of probiotics as in the case of fermented meats (Hathwar *et al.* 2012).

Whilst goat meat is not as easily available as beef and mutton in retail stores, goat milk value-added products such as cheese and yoghurt are available in selected outlets, with goat milk growing in popularity especially since goat milk is reported to have health benefiting substances and a lower risk of allergies, and is easier to digest compared to bovine sources (Verruck, Dantas and Prudencio 2019: 244; Idamokoro *et al.* 2019: 7).

2.9 Food product development

The success of innovative meat products requires coordinated efforts between various stakeholders involved in product development to ensure the nutritional, food safety and consumer acceptability aspects are considered prior to commercialisation (Hathwar *et al.* 2012). There is a potential role for supposedly 'healthier' processed meat products that would be beneficial to the public and the meat industry but on condition that these products are acceptable to consumers. Hence consumer feedback during the earlier stages of development is essential in mitigating the risk of product failure (Grunert *et al.* 2011; Hung, de Kok and Verbeke 2016; Shan *et al.* 2017a).

The American Meat Science Association's Lexicon Committee (AMSA) classifies meat food product development into two major categories based on the degree of preparation entailed, i.e. minimal processing and further processing (Seman *et al.* 2018: 128; Carr, Scheffler and Johnson 2017: 20). Under the 'further processing' category is the classification "raw, non-intact with added ingredients" which refers to products such as sausages and burger patties.

Meat products in this category have not been cured or heat treated (Seman *et al.* 2018: 128; Carr, Scheffler and Johnson 2017: 21).

The product development stages outlined in Image 2.3, serve as a guide to product developers that leads the way to commercialisation, which is usually the overall aim of product development.

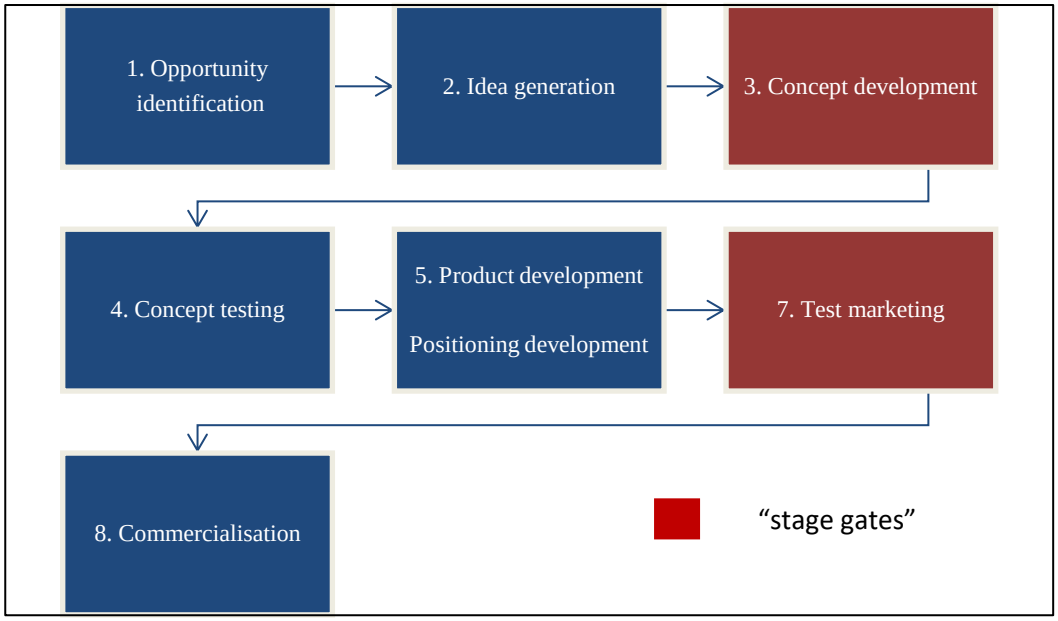


Image 2.3: Product development stages (Adapted from Food a Fact for Life 2009: 5)

The developmental and evaluative stages are the two basic stages involved in product development (Image 2.3). During the developmental stages (blue blocks), opportunities are sought out and ideas and concepts are created. Research incorporating consumer demands and the use of inventiveness is crucial at this stage. Evaluative stages (red blocks), often known as "stage gates" (Image 2.3), are essentially allocated to assess whether the following stage may proceed or not. This stage is crucial to the ultimate success or failure of a new product and calls for objective decision-making. During these phases, crucial queries such as "Is the company capable of producing the item?" and "Will the item live up to customer expectations?" are raised. Answering these questions typically requires conducting market research (Food a Fact for Life 2009: 9; Institute of Food Science and Technology (IFST) 2015).

2.10 Shelf-life and safety of processed meat products

Processed meat products refers to the qualities of fresh meat being modified by one or more procedures, resulting in a change in shelf life (i.e., extended) and sensory properties (appearance, aroma, taste and texture). Processing can be subdivided into primary processing (tenderisation, mincing, flaking, freezing and case-ready fabrication) other processing methods include curing, smoking, marinating, emulsifying, moulding and cooking (Madruga and Bressan 2011). Oat trim and oat gum has been reported to increase the tenderness and juiciness of ground goat meat products (Dawkins *et al.* 2001).

2.11 Sensory evaluation

Sensory evaluation is a "scientific discipline used to evoke, measure, analyse and interpret characteristics of both foods and materials when they are perceived by the senses of sight, smell, taste, touch and sound" (Stone, Bleibaum and Thomas 2020: 3). There are three main classes of sensory evaluation methods as depicted in Table 2.3 (Lawless and Heymann 2010: 5).

Table 2.4: Classification of test methods in sensory evaluation (Lawless and Heymann 2010: 5)

Class	Question of interest	Type of test	Panellist characteristics
Discrimination	Are products perceptibly different in any way?	"Analytical"	Screened for sensory acuity, oriented to test method, sometimes trained
Descriptive	How do products differ in specific sensory characteristics?	"Analytical"	Screened for sensory acuity and motivation, trained or highly trained
Affective	How well are products liked or which products are preferred?	"Hedonic"	Screened for products, untrained

'Flavour' is the term used to describe a combination of taste and aroma and is often a key factor in determining consumer acceptance of a food item (Maughan *et al.* 2012). Several studies over the years have explored the concept of meat flavour (MacLeod 1994: 6; Thompson 2004: 647; Campo *et al.* 2006: 303; Aaslyng and Meinert 2017: 113; Brand *et al.* 2018; 75; Pophiwa, Webb and Frylinck 2020: 4; Hall 2021: 67; Santos *et al.* 2021: 2).

2.11.1 General panel training

Panel training is an important aspect of descriptive sensory analysis. According to (Kemp, Hort and Hollowood 2018: 99), there are three main phases in training a panel to reach the required level of competency in descriptive analysis. However, the exact approach and time given to each phase will differ as per the chosen descriptive method. These phases are shown in Table 2.4.

Table 2.5: Phases in sensory evaluation training (adapted from Kemp, Hort, and Hollowood 2018: 99)

Phase	**Purpose**	**Objective**
Phase 1	Descriptive stage (qualitative)	To standardise the assessors' understanding and perception of the sensory attributes specific to the test set of products
Phase 2	Scale and rating stage (quantitative)	To develop the assessors' ability to rate each attribute intensity consistently.
Phase 3	Panel performance validation stage	To verify the assessors' ability to meet a required level of performance prior to the formal evaluation of the products.

2.11.2 Descriptive sensory analysis and techniques

According to Kemp, Hollowood and Hort, "Descriptive analysis is a method used to objectively describe the nature and magnitude of sensory characteristics" (Kemp, Hort and Hollowood 2018: 3). Descriptive analysis is a useful tool for the sensory evaluation of food as it enables objective, comprehensive and informative data to be obtained; it also provides valuable detailed product information to various organisations (Kemp, Hort and Hollowood 2018: 3).

There are several descriptive sensory techniques each with their own advantages and limitations. The Flavour Profile Method (FPM) was the first published descriptive sensory technique, followed by the Quantitative Descriptive Analysis (QDA) and the Spectrum^{TM} method. The QDA and Spectrum^{TM} methods are structured such that the analysis from individual panellists is collated to derive a panel average, as opposed to the group consensus

profile which is used for the FPM method (Drake and Civille 2003: 34). Refer to Table 2.5 for a summary of the different descriptive methods (Kemp, Hort and Hollowood 2018: 703).

Table 2.6: Summary of different descriptive sensory evaluation methods (Kemp, Hort and Hollowood 2018: 704)

Descriptive method	**Assessors**	**Description**	**Type of sensory language and references used**	**Limitations**	**Scales used**	**Panel training**	**Data analysis**
Texture Profile Method (TPM)	6-10 members	Used to assess the quality and intensity of a product's perceived texture and mouthfeel characteristics	•Technical •Comprehensive •Uses references	Many reference products were not available to researchers outside the UK	category, line and magnitude estimation scales	•Extensive •4–6 months (100 hours) •Panel leader •Checks on performance	None for consensus data •Quantitative data from TP uses analysis as for other profile based methods
Quantitative Descriptive Analysis (Tragon QDA)	Screened and trained panels of 8–15 assessors guided by a trained panel leader	Method uses statistical analysis to determine the components such as the appropriate terminology, procedures and panellists that are used in the process of evaluating the product	•Consumer based •Study specific •Uses only qualitative references	Difficulty in comparing results between panels and between laboratories. requires extensive training and was costly to set up and maintain	unstructured line scales and repeat evaluations Product/study specific scale based on range of sample intensities	•Min. 8–12 hours (2 weeks) •Panel leader is moderator •Validated performance	•ANOVA •Multiple range tests (e.g. Duncan, Tukey, LSD) •Correlation •Multivariate analyses

Descriptive method	**Assessors**	**Description**	**Type of sensory language and references used**	**Limitations**	**Scales used**	**Panel training**	**Data analysis**
Spectrum™ method	Panel of 12–15 assessors who received in-depth and specialized training	The Spectrum™ Method incorporates the rigor of the training and structure of the flavour and texture profile methods and uses a refined scale of over 150 points of discrimination	The use of reference products for anchoring attribute intensities purportedly reduced panel variability and gave the scores absolute meaning	Difficulties in developing, training and maintaining a panel, as it was often very time-consuming. difficulty in accessing reference products, as they were often unavailable to researchers outside the US	Universal, absolute numerical 150-point scale •Intensity references •Replication	•3–4 months per modality, e.g. flavour • Panel leader •Validated performance	ANOVA •Multiple range tests (e.g. Duncan, Tukey, LSD) •Correlation •Multivariate analyses
Free Choice Profiling (FCP) (rapid method)	20-30 untrained panel members	Is a quick and inexpensive method in which consumers are asked to both identify attributes in the sample and rate the liking and/or intensity of those attributes	Data generation was relatively quicker and potentially cheaper compared to conventional techniques. Assessors do not require training	Use of idiosyncratic words from consumers, such as 'cool stuff', and 'like mum's cooking', which made the interpretation of results difficult. Different number of descriptors generated by the consumers	Rating	None	•Generalised Procrustes Analysis (GPA) •Principal Component Analysis (PCA)

Descriptive method	**Assessors**	**Description**	**Type of sensory language and references used**	**Limitations**	**Scales used**	**Panel training**	**Data analysis**
Quantitative Flavour Profiling (QFP)	6-8 panellists- usually trained flavourists	Modified version of QDA. Assesses flavour characteristics using a predefined lexicon	Use of technical and non-erroneous terms from the experts	Highly technical language may be difficult to relate to consumer perceptions Restricted to flavour	Intensity is assessed by a trained panel using a line scale and end-of-scale intensity references	•Extensive •6 months •Panel leader •Validated performance	•ANOVA •Multiple range tests (e.g. Duncan, Tukey, LSD) •Correlation •Multivariate analyses

2.11.3 Tragon Quantitative Descriptive Analysis

This review will focus on the Tragon QDA method (the original QDA developed by Stone and Sidel, trademarked as Tragon QDA) as this technique was used in the research study. The central belief of Tragon QDA is that human sensory perception can be – and should be – measured, quantified and statistically analysed (Kemp, Hort and Hollowood 2018: 286; Nollet and Toldrá 2010: 150).

Objectives of the Tragon QDA method include;

- To provide a scientific method with measurable results
- To understand inherent perception as opposed to teaching it
- To produce an output directly generalisable to consumers
- To ensure the panel leader functions as a discussion facilitator
- To involve all sensory modalities and their interaction
- To be a cost-effective descriptive analysis technique
- To screen and train subjects in less than two weeks
- To provide multiple applications in product development, quality control and marketing (Kemp, Hort and Hollowood 2018: 288).

2.11.4 The phases and components of Tragon QDA

Considerations for the selection of participants:

- Participation should be entirely voluntary, with the option to withdraw at any time
- Personal information about all subjects should be kept private
- Any allergies or medical disorders that could affect the results of the test should be determined
- The potential panel member should have no prior technical knowledge of the products under test
- They should be average or above-average users of the product category selected for evaluation
- Potential panel members should have demonstrated sensory skill within the product category of interest (Kemp, Hollowood and Hort 2018: 293).

- *Pre-recruitment*: Potential panel members are pre-recruited by means of an interview/survey to determine their suitability for the screening process. The questions posed are to gauge the individual's availability, verbal eloquence, interest and comfort with participating in a group activity (Kemp, Hollowood and Hort 2018: 294).

- *Screening:* If the individual meets the requirements of the pre-recruitment, they then go through a series of 20 discrimination tests over the course of several sessions. Panel members are selected after basic screening tests which evaluate their ability to differentiate between basic tastes, aroma, colour and texture both in identification and intensity as well as their interest to participate (Drake and Civille 2003: 35; Maughan *et al.* 2012: 118). The tests are structured to cover the range of products in the category for which the evaluation is required, ranging from easy to difficult in nature. Individuals that score significantly above and beyond chance in the series of screening tests are regarded as having satisfactory sensory acuity and qualify to participate in the next phase. The screening process can be achieved in approximately 5–6 hours (over various sessions) with individuals that have no prior sensory evaluation experience (Kemp, Hort and Hollowood 2018: 293). After screening, about 8-12 panel members should be selected to generate the terms used to describe the product (Drake and Civille 2003: 35; Kemp, Hort and Hollowood 2018: 294).

- *Panel orientation:* The orientation is led by the facilitator who introduces the general concepts of language development, describing their sensations and perceptions of the product category (Silva, Binduhewa and Subodinee 2014: 84; Pereira *et al.* 2015: 57). The duration of the orientation should not exceed 20 minutes (Kemp, Hort and Hollowood 2018: 294).

- *Product sample selection for lexicon development*: Products are carefully selected by the panel leader to ensure the range of differences within the product array of interest has been provided to the panel (Kemp, Hort and Hollowood 2018: 295).

- *Panel facilitator/moderator:* The facilitators role is to provide the schedule of activities and work with the panel members to help them develop the common

vocabulary that will describe the products of interest along with a specific evaluation protocol. The panel leader facilitates the session but does not contribute to the generation of the descriptors and each descriptor is allocated a definition for clarity (Kemp, Hort and Hollowood 2018: 295). The facilitator requires the panel members to arrive at their own conclusion and agreement about whether a reference clarifies a specific sensory experience. The panel members are actively engaged in the solution, rather than being passive receivers (Meilgaard, Civille and Carr 2015: 180).

- *Panel training:* Upon completion of the orientation, the language development process begins as a group activity. Panel members are provided with an appropriate amount of product for evaluation, starting with the product sample that is typical for the product category or the 'golden standard'. Each panel member is asked to separate their perceptions into categories such as 'before usage' (visual, aroma etc.), 'during usage' (application, flavour, mouthfeel, etc.) and 'after usage' (Silva, Binduhewa and Subodinee 2014: 84; Kemp, Hollowood and Hort 2018: 258-259). Once each panel member has written down his/her individual perceptions, the panel leader will call on each assessor to describe what they have written, tracking each response on a white board. This process of evaluating and identifying suitable terms to describe each attribute is repeated for three or four products that best represent the range of products in the product category being investigated, whereby, typically 90% of the words needed to describe the product category would have been generated (Silva, Binduhewa and Subodinee 2014: 84; Kemp, Hollowood and Hort 2018: 258-259).

- *Lexicon development:* The panel members then practise scoring products using an unstructured graphic rating scale. They then compile a comprehensive list of words (lexicon) to describe the product array and the specific procedures for their evaluation that is most typical for the category of interest. In addition, the subjects decide upon appropriate anchor words for each scale (such as 'weak' to 'strong' or 'slightly' to 'very') (Kemp, Hollowood and Hort 2018: 324). The panel leader uses the list of words to create definitions for each attribute score, based on input from the panel so that the final definitions represent a true group consensus. The definitions are always present in the data collection sessions so that assessors can be reminded of the meaning of each attribute (Kemp, Hollowood and Hort 2018: 324).

- *Scale usage:* The panel members practise their scoring and discuss their perception on the scale. Each member establishes their own scale location for samples included in the practise session. It is not expected, or necessary, that all subjects perceive or score the low-intensity product at the same exact scale location. In training sessions where subjects scores are distributed over an unusually large-scale range, those scores are shown (e.g. on a white board) and the panel discusses whether that range is consistent with their perception. The panellists decide for themselves whether their score represents what they perceive. It is important to note that a highly variable scale more typically reflects product variation as opposed to panel inconsistency (Meilgaard, Civille and Carr 2015: 154)

- *Duration and number of sessions*: The duration of each session is approximately 90 minutes, and it may be necessary to have more than one session to describe three or four products because of the physical nature of the category (Kemp, Hort and Hollowood 2018: 294). Generally, 8–12 hours of group discussions over about five sessions is required to establish a comprehensive vocabulary to describe all aspects of the product. Generally, 40-50 attributes are sufficient to cover all modalities in a product category (Kemp, Hort and Hollowood 2018: 295).

- *Panel calibration:* The process of calibrating the panel involves a series of practice ratings of products to improve confidence and to test the panels abilities. Each session involves evaluating products of which the data is recorded on a line scale score card. Panellists are required to make a mark on the line scale to indicate their response. The data on the score card is then analysed using a ruler/ computerised system and is then graphically represented using a web plot (Drake and Civille 2003: 35; Meilgaard, Civille and Carr 2015: 180).

- *Pilot testing and validation of lexicon:* Prior to the pilot test, the panel leader presents the procedures, definitions, and rating scales of each attribute, where usually four products from the category are selected. The pilot test is conducted to evaluate individual performance and to determine whether the panel is using the sensory attributes in a similar way. The testing is done in individual sensory booths with four

replications whereby all samples are presented in the same order for each participant. The collected data is analysed with one- and two-way ANOVA. Based on results of the pilot test, the panel is reconvened to discuss attributes and products in which the panel leader seeks clarification of the definitions or evaluation methods or both (Kemp, Hort and Hollowood 2018: 297).

- *References*: The QDA method employs qualitative references only when the panellists require additional clarification on an attribute. The references used could be for complex finished products, less complex products, or individual ingredients. When clarity on an attribute is required, qualitative references should be used. However, using quantitative references with assigned intensity values is not recommended for this method (Kemp, Hort and Hollowood 2018: 297).

- *Statistical analysis:* The primary statistical analyses for Tragon QDA, as with the original QDA, include analysis of variance (one-way and two-way), multiple range test (Duncan, Tukey, LSD) correlation, and multivariate analysis. Each subject's individual data is analysed to determine whether that subject is satisfactorily contributing to product discrimination (Meilgaard, Civille and Carr 2015: 180).

2.11.5 Advantages and criticisms of Tragon QDA

Tragon QDA utilises a consumer behaviour approach, which is intended to use words that are similar to what consumers would use to describe a product category, to understand their sensitivity to differences they may perceive, and to understand how changes to a product may influence a consumer's perception. As such, the language used by the panel is common, everyday language that is easily understood by both the product development team as well as by marketing. The time frame for the QDA approach is estimated to be four weeks from start to finish (recruitment, screening, training and evaluation of products within the selected category) (Kemp, Hort and Hollowood 2018: 305). A vast standardised reference library or the calibration of panel members with subjective numeric values is not required for this method, which is both a costly and time consuming process; in addition, there is no scientific data to support assigned numerical values or the process thereof (Kemp, Hort and Hollowood 2018: 305).

The Tragon QDA method requires replications of the testing, which is seen as a time-consuming and costly process, this is necessary for the outcome to be scientifically sound and the results to be acceptable. Also, in some instances a technical language is viewed as being superior to consumer language. Whilst this is debatable, there is value in panellists understanding the consumer language as they are the ultimate audience for which products are being developed, hence their perceptions of a product provide valuable input in the product development process (Kemp, Hort and Hollowood 2018 2018: 305).

2.11.6 Lexicon development

Descriptive sensory evaluation methods like QDA are used to develop a lexicon. A lexicon is defined as "a set of standardised vocabularies developed by highly trained panellists for describing a wide array of sensory attributes present in a product" (Drake and Civille 2003: 34; Lawless and Heymann 2010: 234). In developing the lexicon, the panel's first source of terminology is generally the wide sample set or frame of reference that is available. Several products that cover the widest range of sensory attributes within the category need to be evaluated (Drake and Civille 2003: 34). Table 2.6 shows a comparison of the different descriptive analysis methods used in sensory evaluation.

Table 2.7 Overall comparison of key features of traditional descriptive analysis methods (Kemp, Hort and Hollowood 2018: 685)

Method	**Assessors**	**Type of sensory language and references used**	**Scale and measurement**	**Panel training**	**Data analysis**
Consensus method	Minimum 4-6 Screened Trained	Technical Comprehensive Uses references	Typically, 1-15 May use intensity references Consensus results	Yes Extensive >100 hours (4-6 months) Panel leader Checks on performance	None
Flavour profile method (FPM)/ Texture profile method (TP)	6-10 Screened Trained	Technical Comprehensive Uses references	FP scales (e.g., 4, 7 points) and consensus results TP rating scales Might use consensus or collect individual measurements	Yes Extensive 4-6 months (100 hours) Panel leader Checks on performance	None for consensus data Quantitative data from TP use analysis as for other profile-based methods
Spectrum™ Method	12-20 Screened Trained	Technical Comprehensive Uses references	Universal, absolute numerical 150-point scale Intensity references Replication	Yes Extensive 3-4 months modality, e.g., flavour Panel leader Validated performance	ANOVA Multiple range tests (e.g. Duncan, Tukey, LSD) Correlation Multivariate analyses
Quantitative flavour profiling (QFP)	12-16 Screened Trained	Technical Comprehensive Uses references	Unstructured line scale Anchor products Replication	Yes Extensive 6 months Panel leader Checks on performance	ANOVA Multiple range tests (e.g., Duncan, Tukey, LSD) Correlation Multivariate analyses

2.11.7 Consumer sensory evaluation

Consumer perceptions about reformulations of processed meat products play an important role in whether the product is regarded as acceptable or not. Even though a product possesses several benefits, it is not guaranteed that it would be accepted by the consumer market (Shan *et al.* 2017b: 83; Kallas, Vitale and Gil 2019: 2). Consumers are the final link of the production chain, hence understanding the factors that influence preference, behaviour and perception about meat and meat products should be considered. In doing so, the meat sector would be able to better satisfy consumers' expectations (Font-i-Furnols and Guerrero 2014: 362).

Consumers are mainly informed about meat and meat quality through mediums such as adverts, information campaigns, product brands and labels. This information, coupled with other intrinsic and extrinsic factors, influences the consumers' purchasing decision and intent to pay (Font-i-Furnols and Guerrero 2014: 362). Font-i-Furnols and Guerrero (2014: 364) argue that the consumers' decision-making process is influenced by various factors of which include the sensory properties of meat, and psychological and marketing aspects. Hence these factors need to be considered as integrated components and not viewed in isolation (Kallas, Vitale and Gil 2019: 2). A study investigating the potential for beef offal to be used in the development of sausages concluded that a formulation using 34% beef offal could be used to develop sensory acceptable sausages, with the authors intended target audience being the local ethnic black community in South Africa, more especially those from lower income groups as meat sausages containing offals are relatively cheaper when compared to other available sausages (Magoro *et al.* 2012: 36).

Continuous development and improvement in food product quality is essential to ensuring consumer demands are met hence, focus on enhancing the organoleptic properties of food is important to both achieving industry goals of profits and meeting consumer satisfaction (Teixeira *et al.* 2020: 14).

2.12 Conclusion

Sustainable food systems and production are essential to meet the needs of the growing population. As such, sustainable and resilient food sources including goat meat can be part of the solution to meet the demand for an increased food supply. In promoting sustainable food sources to address food security, consumer acceptance cannot be ignored and thus forms an

integral component of developing and promoting sustainable foods. The next chapter will report the first objective of the research study: young adults meat preferences and the potential for goat meat consumption.

CHAPTER THREE: YOUNG ADULTS' MEAT PREFERENCES AND POTENTIAL FOR GOAT MEAT CONSUMPTION

3.1 Introduction

This chapter will explore phase one of the study, which was to determine young adults' meat preferences and potential for goat meat consumption. The methodology, results and discussion for this phase of the research will be presented in this chapter.

3.2 Methodology

3.2.1 Study design and sample population

A cross-sectional study design was used to collect data for the current investigation (phase one of the whole study). The target population included students from two universities (Durban University of Technology and University of Zululand). Durban University of Technology (DUT) is situated in an urban setting in Durban, KwaZulu-Natal with food outlets located on the university premises and within proximity to formal food outlets (Image 3.1), whilst the University of Zululand (UNIZULU) is in a rural setting, in KwaDlangezwa, KwaZulu-Natal with limited access to food outlets, with the nearest formal food outlet situated 16km away (Image 3.2).

The number of students at both universities at the time of the study were 60 000, hence a minimum sample size was determined at 383 using a 95% confidence level and 5% margin error (Taherdoost, 2017: 238; University of Zululand 2020 and Durban University of Technology 2021). The sample size was rounded off to 400 to allow 200 participants (50%) from each university. Stratified random sampling was applied to obtain the sample size. The potential participants were stratified by year level and an email inviting the students to complete the online survey was sent to every seventh student that appeared on the list.

Image 3.1: Durban University of Technology (Google maps 2022a)

Image 3.2: University of Zululand (Google maps 2022b)

3.2.2 Recruitment strategy

Phase one of the study involved recruiting students from UNIZULU and DUT to participate in the online survey on meat preferences and potential for goat meat consumption (Figure 3.1). Prior to recruitment, gatekeeper permission was requested and obtained from both universities (Appendix A1 and A2). Access to student email addresses was obtained from the Dean of Students for each university in compliance with the Protection of Personal Information Act (POPIA) (Appendix B1 and B2). The researcher was supplied with a list of email addresses (excluding students' personal information) for students registered in the different faculties at each university. The email sent out included a brief description of the study and a hyperlink with embedded consent forms (Appendix C) and the ethical clearance certificate for the study (Appendix D). Students were required to tick a checkbox indicating consent and willingness to participate in the survey prior to completing the survey. Due to the response rate being poor (less than 10% of the students that were emailed participated), the researcher referred again to the email list and then emailed every fourth student that appeared on the list. The survey was open for a period of four months, and during this time, 416 participants responded. Participation in the online questionnaire was entirely voluntary and anonymous, with the right to withdraw at any time from the survey. In addition, POPIA was taken into consideration in all communication with potential participants.

a) Eligibility criteria for the online survey:

- All registered students from all year levels of study from the University of Zululand and Durban University of Technology during the period of 2021-2022.

- Students between the ages of 18 and 30 years old.

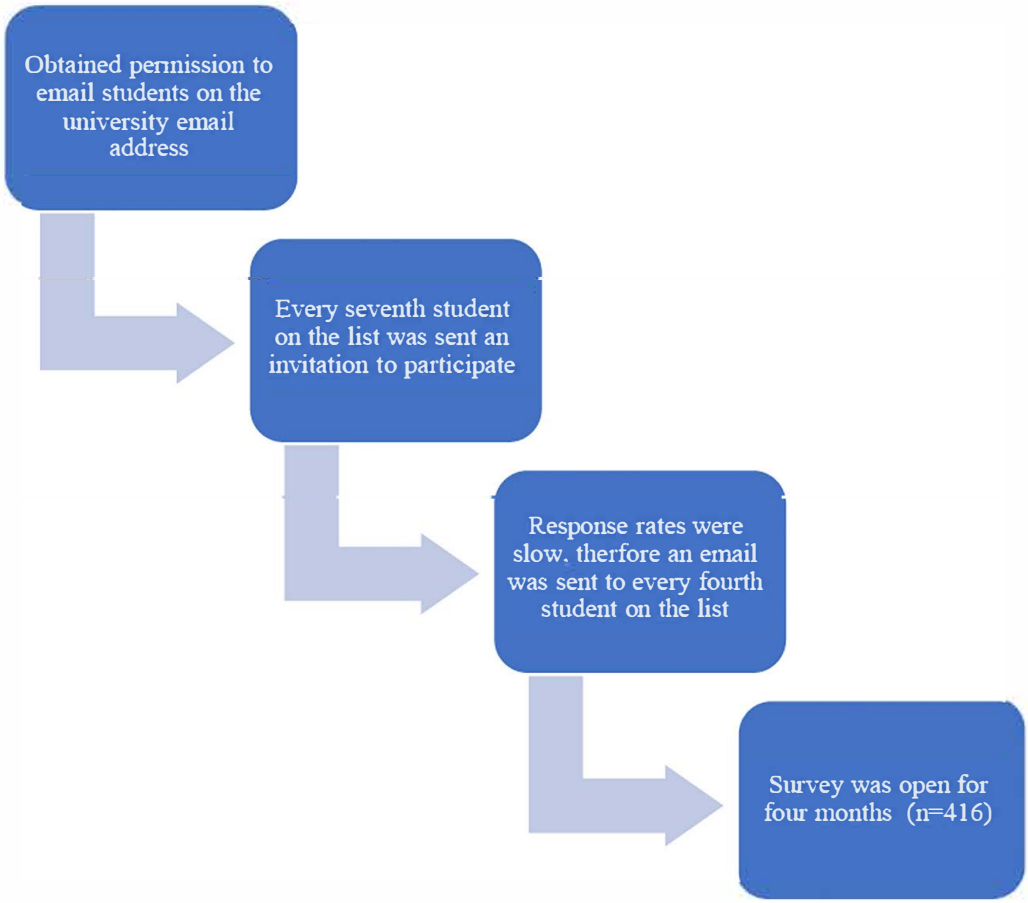


Figure 3.1: Recruitment strategy

3.2.3 Development, piloting, and administration of online survey

A questionnaire for the meat preferences and meat consumption was designed and reviewed by the research team using Microsoft™ office forms. The layout of the questionnaire included an introductory paragraph followed by five sections: demographics, general meat consumption, frequency of consumption, processed meat consumption, goat meat consumption and willingness to purchase goat meat (Appendix E).

The online questionnaire was piloted prior to being administered to the sample population (Appendix F). The piloting process involved sharing the questionnaire with ten participants representative of the intended sample population who were excluded from the main survey. The participants indicated consent by selecting the tick box and then proceeded to answer the survey. In addition to the survey questions, specific questions relating to the clarity, order of

the questions and an option to include comments were included. Results of the pilot survey indicated that all participants were able to understand the questions and the flow/ order of the questions was suitable. There were no recommendations for changes or improvements to the survey.

The final questionnaire link was then sent to students' university email addresses using blind carbon copies (bcc). The questionnaire was open for four months, during which a sample of 416 was obtained and the questionnaire was then closed.

3.2.4 Ethical considerations

This study was granted approval by the Durban University of Technology Institutional Research Ethics Committee (IREC): IREC number: 071/21 (Appendix D).
All emails sent to potential participants were blind carbon copies to ensure anonymity. The letter of information describing the nature of the study, requirements to participate and protocols to ensure anonymity was maintained throughout the duration of the study was included as a hyperlink. Ethical approval was also included as a hyperlink under the description of the online questionnaire and informed consent was attained through a checkbox at the start of the survey. No personal information in terms of contact details was required. Restrictions were applied to the online questionnaire to allow students to answer the survey only once. Participation in the online questionnaire was voluntary and anonymous with the right to withdraw at any time from the survey. Participants' responses were password protected and shared only with the research team (researcher, research assistant and supervisor).

3.2.5 Data analysis

Data was checked for correctness and completeness prior to statistical analysis. The Statistical Package for Social Sciences (SPSS®) version 28.0 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 of the response options were selected significantly more/less often than the others. The binomial test was used to test whether a significant proportion of respondents selected one of a possible two responses.

3.3 Results and discussion

The results for the online meat preference survey and potential for goat meat consumption which was completed by 416 participants are represented in the form of graphs and tables as depicted below.

The demographic profile of the students that completed the online survey is represented in Table 3.1 below.

Table 3.1: Demographic profile of participants (n=416)

Demographics		**Frequency (n)**	**Percentage (%)**
Gender	Men	133	32
	Women	283	68
Race	African	387	93
	Indian	25	6
	White	1	0.2
	Coloured	3	0.7
Age (years)	18-20	141	33.9
	21-24	185	44.5
	25-27	53	12.7
	28-30	37	8.9

From the total of 416 participants, 211 (51%) were from the DUT and 205 (49%) were from UNIZULU. Most of the participants were African (93%), mainly women (68%), and most participants fell within the 18-20 years old (33.9%) and 21-24 years old (44.5%) age cohort. Mostly African (93%) participants responded, followed by a few Indian (6%), coloured (0.7%) and white (0.2%) participants. Findings in this study report that there were no significant differences in the consumption frequency between the rural and urban universities, hence data was combined and reported as such. The demographic results in terms of race were representative of the student population at both sites with 90% of students registered at DUT and 99,95% of students at UNIZULU being of African descent (DUT 2021 and UNIZULU 2020).

The student's meat consumption in terms of type and frequency is represented in Table 3.2.

Table 3.2: Meat consumption by university students (n=416)

	Frequency	Chicken	Beef	Pork
DUT 211(%)	Not at all	1 (0.5)	23 (10.9)	79 (36.0)
	1-2 times a month	17 (8.1)	58 (27.5)	91 (43.1)
	3-4 times a month	41 (19.4)	65 (30.8)	28 (13.3)
	>4 times a month	152 (72)	65 (30.8)	16 (7.6)
UNIZULU 205(%)	Not at all	4 (2.0)	8 (3.9)	61 (29.8)
	1-2 times a month	11 (5.4)	52 (25.4)	102(49.8)
	3-4 times a month	31 (15.1)	75 (36.6)	22 (10.8)
	>4 times a month	159 (77.6)	70 (34.1)	20 (9.8)
Combined	Not at all	5 (1.2)	31 (7.5)	137 (32.9)
	1-2 times a month	28 (6.7)	110 (26.4)	193 (46.4)
	3-4 times a month	72 (17.3)	140 (33.7)	50 (12.0)
	>4 times a month	311 (74.8)	135 (32.5)	36 (8.7)
	X^2	571.635	73.288	159.135
	Df	3	3	3
	P value	<.001*	<0.001*	<0.001*

*Indicates significance at the 95% level

The findings from Table 3.2 indicate that a significant proportion of participants consumed chicken more than four times a month, consumed beef more than three times a month and consumed pork at most twice a month ($p<0.001$). Lamb and mutton were excluded from the options in the survey as these are more expensive meats (Agri handbook digital 2022).

a) Goat meat consumption

Most of the participants (78,6%) reported consuming goat meat; however, the frequency of consumption was much lower in comparison to chicken, beef, and pork. The findings from Table 3.2 indicate that a significant proportion of participants consumed chicken more than four times a month. This is consistent with results from a previous study on food consumption in South Africa, which reported a significant increase in meat consumption with chicken being the most consumed protein (Ronquest-Ross, Vink and Sigge 2015: 3). Chicken is also widely available, easily accessible and a relatively cheap protein source (Pilusa, Belete and Baloi 2020: 845). Meat is a core component of the South African diet as shown in the significant consumption of chicken (more than four times a month) and beef (more than three

times a month). However, chicken consumption precedes beef, mainly due to affordability (Schonfeldt and Hall 2013: S67; Erasmus and Hoffman 2017: 73). The current (2022) comparative cost of chicken, beef and pork shows that the average price per kilogram of meat placed chicken (R52.99) as the cheapest, then pork (R62,00), beef (R85.00) and lastly, mutton/lamb (R109,00/R129,00) being the most expensive type of meat (Checkers Hyper Retail Store 2022). Results indicated that young university students frequently consume chicken and beef which are readily available and accessible in formal markets.

b) Processed meat consumption

In terms of processed meats (Table 3.3), participants reported a preference for sausage which highlights the potential for developing processed goat meat value-added convenience products to increase consumption directed at the youth consumer segment. However, certain questions revealed that the participants' intent to purchase processed goat meat were not entirely convincing, reflecting that product development alone would be insufficient in promoting consumption and other strategies needed to be used concurrently.

Questions pertaining to the consumption of processed meats were also included in the online survey. Results of the type of processed meats the students eat are represented in Table 3.3 below.

Table 3.3: Processed meat consumption (n=416)

Processed meats	DUT n=211 (%)		UNIZULU n=205 (%)		Combined n=416 (%)		
	Yes	**No**	**Yes**	**No**	**Yes**	**No**	**p-value**
Biltong	47 (22.3)	164 (77.7)	26 (36.0)	179 (87.3)	73(17.5)	343 (82.5)	<.001*
Burger	113 (53.6)	98 (46.4)	88 (42.9)	117 (57.1)	201 (48.3)	215 (51.7)	0.524
Sausage	160 (75.8)	51 (24.2)	156 (76.1)	49 (23.9)	316 (76)	100 (24)	<.001*
Meatballs	35 (16.6)	176 (83.4)	31 (15.1)	174 (84.9)	66 (15.9)	350 (84.1)	<.001*
Polony	113 (53.6)	98 (46.4)	119 (58)	86 (41.9)	232 (55.8)	184 (44.2)	.021*

*Indicates significance at the 95% level

Table 3.3 depicts the consumption of processed meat: a significant 76% of participants consumed sausage ($p<0.01$), whilst a significant 56% reported consuming polony ($p=.021$).

Meatballs and biltong (salted dried meat) were not as commonly consumed, with a significant percentage of participants reporting not consuming these items ($p<0.01$). Other processed meats such as viennas and frankfurters were not included in the survey.

According to the NOVA classification, foods are categorised into four groups, with the fourth group being ultra-processed foods which contain additional ingredients and processing to improve palatability, convenience, and extended shelf life (Monteiro 2019: 9). Processed meats are commonly consumed in South Africa; these are usually cheaper than unprocessed meat options and generally high in sodium, flavourings and preservatives to increase the product shelf-life, and for convenience and acceptability (Cluff *et al.* 2017: 144 and Peters *et al.* 2017: 405). Processed foods contain high amounts of sugar, fat and or salt which contribute to lifestyle health conditions such as obesity, hypertension and cardiovascular disease, thus high consumption of these foods compromises an individual's health status (Popkin and Ng 2021: 5). A study in a rural community in South Africa reported processed meat as being the most popular lunch option for teenagers (Abrahams *et al.* 2011: 1754). In the current study, a significant 76% of the participants consumed sausage, whilst a significant 56% reported consumed polony, which is a cured and cooked meat that contains meat trimmings and off-cuts. Meatballs and biltong were not as commonly consumed, with a significant percentage of participants reporting not consuming these items. This is possibly due to the cost factor as these products do not have added meat extenders in the product formulation and seemingly, are not a common food choice among students (Abrahams *et al.* 2011: 1755; Cluff *et al.* 2017: 145; Jones *et al.* 2017: 746). Even though processed foods may not have the same nutritional value as unprocessed foods, there is a demand for convenience foods thus creating a market for these products (Dhir and Singla 2019: 5). Products such as sausages and burger patties can be formulated to use alternative fats or other ingredients to improve the nutritional profile (Serdaroğlu 2021: 1).

The reasons for consuming goat meat can be seen in Figure 3.2.

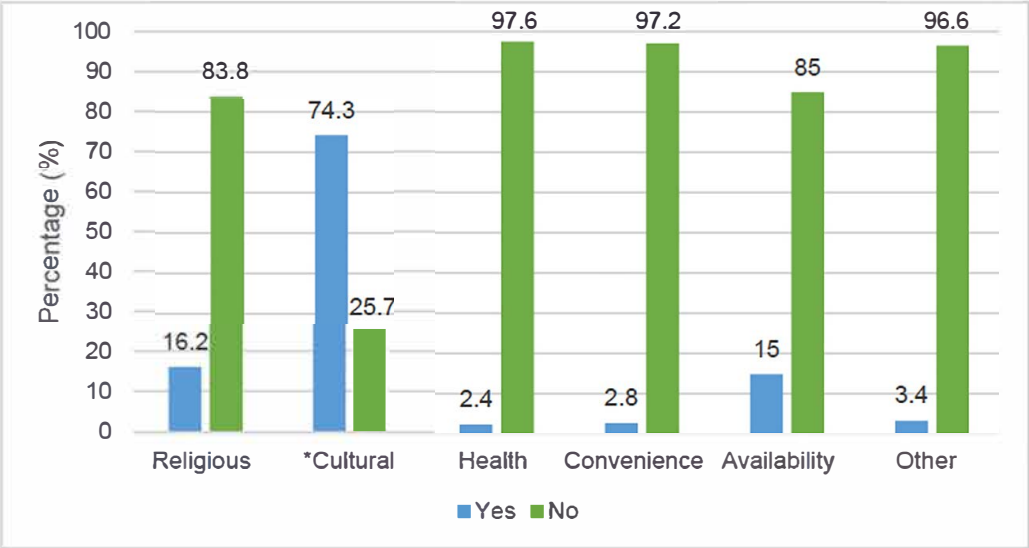


Figure 3.2: Reasons for consuming goat meat (n=327)

Figure 3.2 reports the reasons for consuming goat meat. A total of 327 participants indicated that they consumed goat meat, of which a significant 74.3% of participants consumed goat meat due to cultural/ceremonious reasons. Religious reasons (16.2%) and availability (15%) were the second and third most predominant reasons for eating goat meat.

c) Justification of goat meat consumption

The main reason for consuming goat meat was due to cultural practices, which require the slaughtering of goats for various cultural and religious reasons. Similar results were found in a study where a significant percentage of participants reported eating goat meat for cultural purposes (Mazhangara *et al.* 2019: 7; Erasmus 2017: 8).

Slaughtering of goats in African communities is done at childbirth, marriages and funerals (Qekwana *et al.* 2017: 422). In the Muslim community, goats are slaughtered for cultural purposes (example Eid al-Adha) using *Halal* slaughter methods (Aghwan and Regenstein 2019: 111). Similar sacrifices are done in the Hindu community, goats symbolize ideas relating to abundance, modesty, success, free spirit, and resilience. Animal sacrifice is a ritual killing and the offering of an animal is believed to appease the divine power of the Goddess Kali (Singh 2022).

Reasons for consuming goat meat and lamb were reported in a qualitative study in Europe, which highlighted goat and lamb were consumed due to the perceived health benefits and lower environmental impact (Mandolesi *et al.* 2020: 1106). These results are quite different in comparison to results in this study, where a very low percentage acknowledged that consumption of goat meat was due to its health benefits. The marketing and promotion of goat meat needs to be addressed both in South Africa and internationally, as the mixed

perceptions about the benefits and limited availability of goat meat in retail stores pose two challenges that restrict consumption (Kaur 2010: 42 and Mandolesi *et al.* 2020: 1107). A recent study conducted in South Africa among university students supports results from international studies that confirm the intrinsic attributes of goat meat as a means of promoting its consumption and market development (Ngomane, Tsvakirai and Mlambo 2022 :2). The study by Ngomane, Tsvakirai and Mlambo (2022: 3), also suggests a possible solution for increasing the marketing of goat meat through highlighting its product value and social impact for improving livelihoods and food security as the collective benefits of goat meat. Figure 3.3 depicts the reasons for not consuming goat meat (n=89) as given by the survey participants.

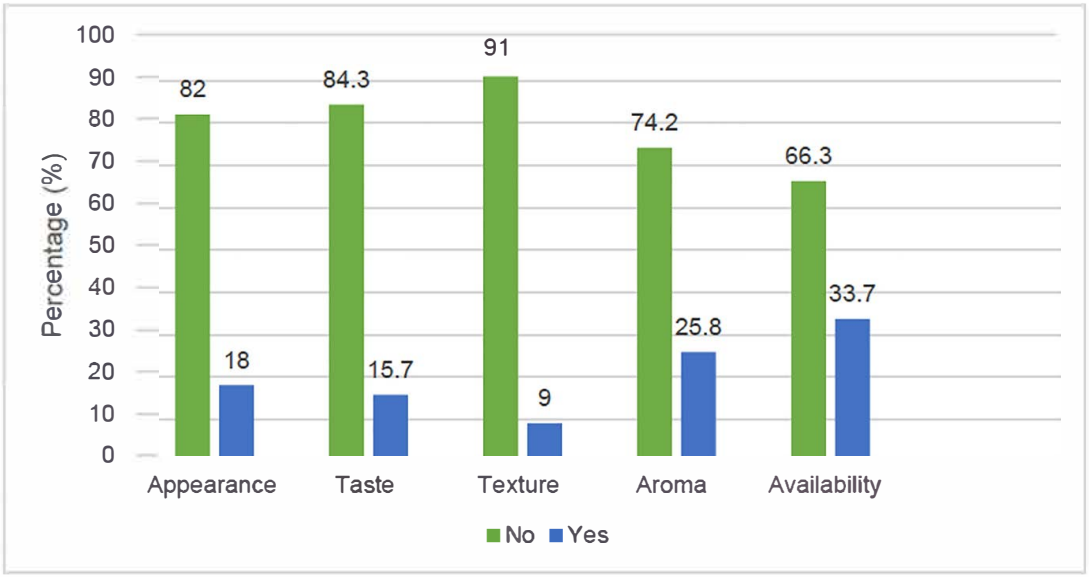


Figure 3.3: Reasons for not consuming goat meat (n=89)

Figure 3.3 depicts the reasoning of those that do not consume goat meat (n=89). Lack of availability (33.7%) and aroma (25.8%) were the main reported reasons for not consuming goat meat.

Goat meat has similar aroma compounds that are present in beef and lamb, except for glycine and fructose which are reported to be present in higher concentrations and which could be responsible for the distinct aroma (Madruga 2010: 513). These factors that influence consumption can be addressed by creating awareness and improving accessibility through supply chains in conjunction with product development to mask the undesirable sensory characteristics (Hartmann and Siegrist 2017: 13; Idamokoro, Gunya and Aliber 2019: 2 and Hegde 2020: 31). In SA, goat meat is not as readily available and accessible in formal

markets as in other countries and consumption of goat meat, as depicted in Figure 3.2, was found to be mainly due to cultural reasons whereby the meat was readily available for consumption, hence availability poses a barrier to consumption (Soji and Muchenje 2017: 584).

Participants' willingness to purchase goat meat and milk products is depicted in Figure 3.4.

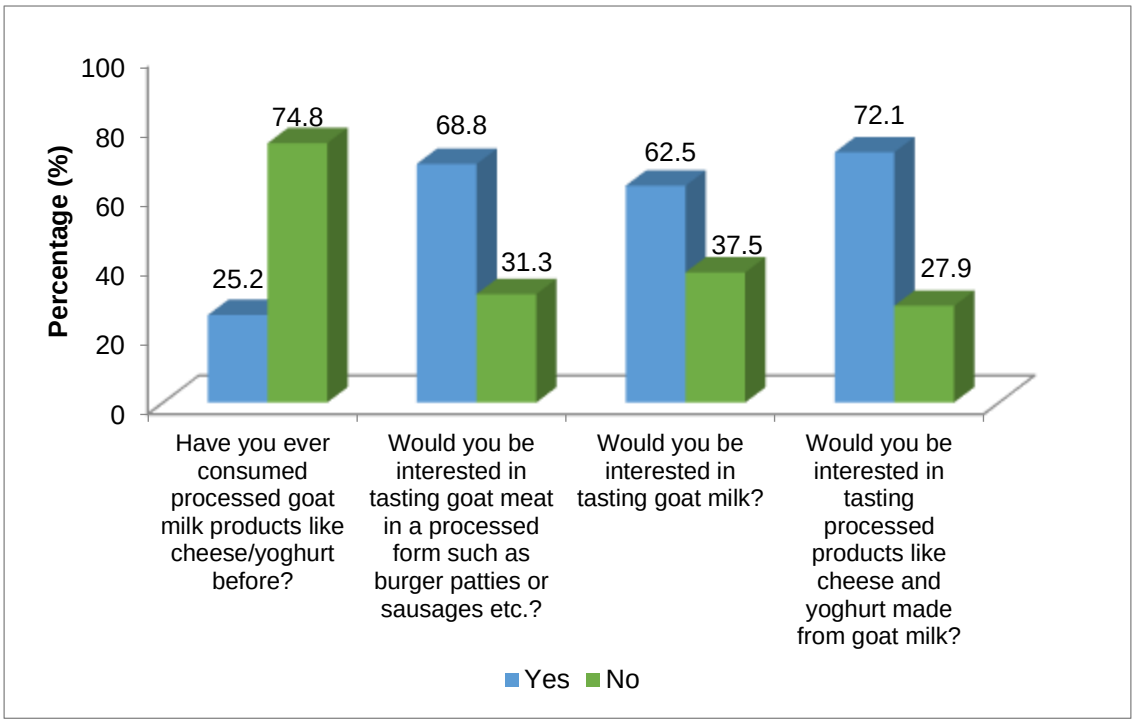


Figure 3.4: Willingness to purchase goat meat and milk products (n=416)

The intent to purchase goat meat and milk products is depicted in Figure 3.4. Most participants reported having not consumed goat milk products before (74.8%); however, there was interest in tasting these items (72.1%) and other processed goat meat products (68.8%). In South Africa, goat milk is mainly sourced from small-scale farmers, hence goat milk is not as accessible in retail stores compared to cow's milk (Yangliar 2013: 76). Even though goat milk is not as popular as cow's milk, processed goat milk products such as cheese and yoghurt are available at speciality stores/ health food retailers for on average R32,99 per litre compared to the average price of cow's milk which is R25,99 per litre (Woolworths 2022). In terms of age, some studies have shown that younger consumers have more interest in purchasing functional or innovative foods compared to older consumers (Armstrong Farley, Gray, Durkin 2005: 707; Kraus, Annunziata, and Vecchio 2017). These findings may be due to people younger in age being more adventurous in terms of innovations which is reflected

in the results of the current study. According to Rogers' Diffusion of Innovation Theory (Rogers 2003: 231), two classifications, "innovators" or "early adopters" are denoted as being younger in age and having a high professional status, income or educational level. In contrast, results from a study conducted on farmers' perceptions and willingness to consume goats' milk in the Eastern Cape, SA indicated that farmers older than 60 years were more interested in consuming goat milk compared to other age groups (Idamokoro 2019: 4). The author suggests that due to previous exposure to goat milk this age group was more willing to incorporate it in their diet (Idamokoro 2019: 4). Possible reasoning for those that did not show interest in consuming goat milk/products could be due to the organoleptic properties which were also found to be barriers in another study (Idamokoro 2019: 4).

Participants' interest in consuming goat meat in a formal setting is represented in Figure 3.5.

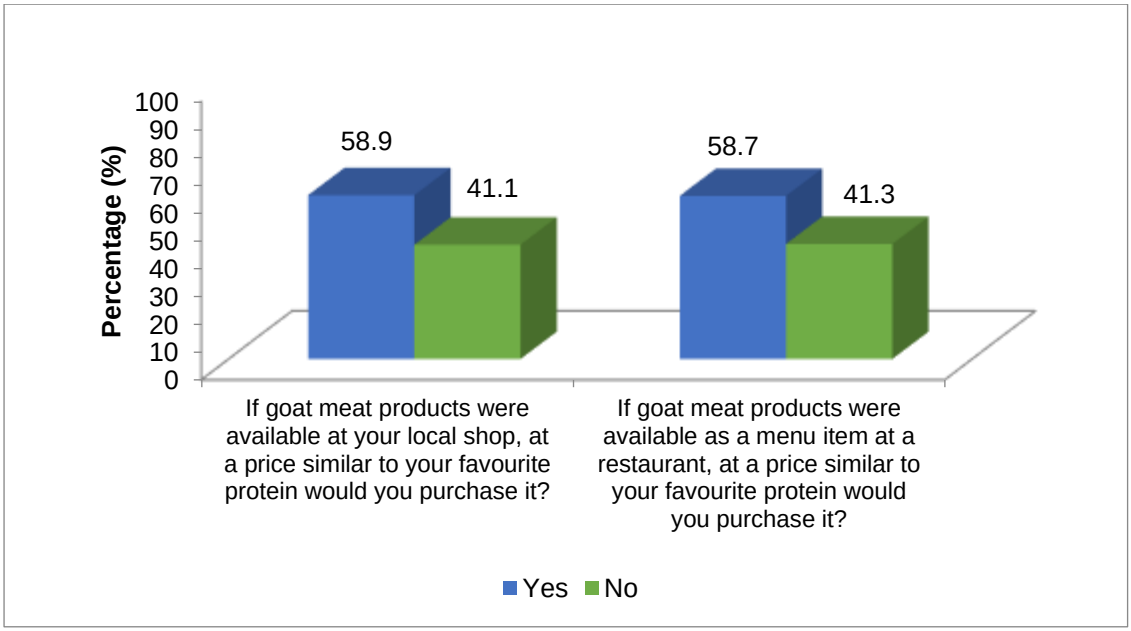


Figure 3.5: Interest in consuming goat meat in a formal setting (n=416)

Participants' interest in consuming goat meat in a formal setting (Figure 3.4) revealed that if price was not a factor, some would be interested in purchasing goat meat from their local shop (58.9%), and some would purchase goat meat products in a restaurant setting (58.7%). The food basket report by the National Agricultural Marketing Council (NAMC) reveals that food prices in SA have been a challenge for South Africans, with the cost of food in general not being affordable for most people (National Agricultural Marketing Council 2022). Red meat is an expensive commodity with an increase of 13.9% inflation on a year-on-year basis (National Agricultural Marketing Council 2022). However, value addition through processing

cheaper cuts can improve the palatability and increase the rand value of the products made. When posed with a question on interest in consuming processed goat meat products (58,9%) and if goat meat were available as a restaurant item (58,7%), there was no clear indication that participants would choose goat meat as the preferred protein if they were given an option in a formal market setting. Moreover, even though the majority had eaten goat meat before, the willingness or choice to eat it may have been influenced by cultural and traditional practices as opposed to preference. A systematic review on consumer perceptions and behaviour regarding sustainable protein consumption revealed consumer reluctance to change to alternative meat consumption in terms of reducing or substituting meat (insects) was low (Navarrete-Molina *et al.* 2020: 3). This drives the case for goat meat, which has been reported as having several benefits in terms of sustainability including the animals' feeding practices (which does not compete with vegetation that can be used for human consumption), maintenance of biodiversity as goats are browsers rather than grazers, and require low use of non-renewable energy (Peacock and Sherman 2010: 71; Griggs *et al.* 2013: 306).

Even though there is good growth potential for goat meat, marketing efforts need to be channelled to quality assurance and uniformity, data collection on consumer preferences, and determining the type of meat products and processing methods that should be used to promote consumption (Madruga and Bressan 2011: 40). Unlike other commonly consumed meats, goat meat is not widely exported but is rather consumed locally within communities of developing countries. Export of goat meat in South Africa was reported as 115 719 kg in 2013 which dropped to 2383 kg in 2019, showing a steady decline (Mogala 2018: 7). The market structure for goat meat is also not well developed to promote the consumption of this meat (Skapetas and Bampidis 2016: 2). The value and acceptability of goat meat may be increased through production practices and meat processing (McMillin and Brock 2005: E59). Stajic and other authors have reiterated that goat meat could be used to develop meat products that are acceptable to 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. The use of spices and seasoning could also improve the sensory acceptability by masking the undesirable sensory attributes of goat meat (Stajic and Pisinov 2021: 2; Ivanovic et al. 2016: 53 and Leite *et al.* 2015: 115). 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 (Hathwar *et al.* 2012: 654; Ivanović *et al.* 2020: 221).

3.4 Conclusion

This phase of the study acknowledges that goat meat is not widely available and accessible in formal settings in South Africa. Young adults prefer other meat types as opposed to goat meat due to the various barriers to consumption that were reported in this chapter. There is potential for goat meat consumption to increase; however, careful consideration needs to be given in ensuring the accessibility, marketing, and promotion of goat meat to encourage consumption. One approach to increasing the consumption of goat meat is through appropriate product development.

CHAPTER FOUR: PRODUCT DEVELOPMENT OF GOAT MEAT PATTIES AND SAUSAGES

4.1 Introduction

The focus of this chapter is to report on the product development phase of the study. Results from chapter three indicated the potential to increase the consumption of goat meat through product development of value-added convenience products in a format acceptable and familiar to consumers. The products of interest consumed by most of the participants as reported in the results of the meat consumption survey included burger patties and sausages. Hence, the development and testing of goat meat patties and sausages is presented in this chapter.

4.2 Methodology

4.2.1 Study design

This phase of the study (second investigation) followed the scientific experimentation research design involving laboratory work for the product development and analysis for the various parameters that were tested on the developed products.

4.2.2 Ingredient selection

The formulation of the goat meat burger patty and sausage was done through a series of product development trials with focus on the odour and texture of the products as these two attributes were reported as not being sensorially appealing to consumers in the meat consumption and preference survey. Boer goat meat from goats younger than 18 months sourced from a reputable abattoir based in KwaZulu-Natal was used for the development. A selection of ingredients known for their distinct aroma and used widely in meat preparation were included in the recipe formulations to mask the unappealing odour associated with goat meat. This included the use of garlic powder (Woolworths), onion powder (Woolworths), ginger powder (Woolworths) and white pepper powder (Robertsons). These ingredients are widely available and were selected to allow the replication of products developed and ensure ease of preparation. The powdered version of these ingredients was used due to the longer shelf life. Iodised salt was also included in the formulation as part of the seasoning blend. The specifications of the ingredients are documented in Table 4.1. Different ratios of the

individual spices were added to the sausage and patty formulations to improve the flavour of the goat meat.

Table 4.1: Sensory properties of the ingredients used

Ingredient	Appearance	Aroma	Texture	Image
Garlic powder	Light beige powder	Fresh, strong aroma, typical of garlic	Loose flowing powder	
Onion powder	Light beige powder	Fresh, aromatic, typical of onion	Loose flowing powder	
Ginger powder	Light beige powder	Fresh, aromatic, typical of ginger	Loose flowing powder	
White pepper powder	Whitish/grey powder with black specs	Characteristic of white pepper, intense and Aromatic	Loose flowing powder	

Ingredient	Appearance	Aroma	Texture	Image
Iodised salt	White	No distinct aroma	Fine granules	
Cereal flakes (Butchers rusk)	Cream	No distinct aroma	Coarse flakes	
Sodium metabisulphite	White	No distinct aroma	Fine granules	
Freddy Hirsch natural sheep casings (canning 26)	Cream/ off white	Pungent odour	Casing strands with hollow cavity	

4.2.3 Processing method

a) Preparation of goat meat mince

Boer goat meat (flank, leg and shoulder in relative proportions) sourced from a goat less than two years of age was rinsed with potable water, deboned, and chopped into small pieces approximately 3cm in size to facilitate the mincing process. No additional fat was added to the meat, only the intramuscular fat was used. These cuts of meat selected are usually used to prepare mince (Bon Appetite 2022). The chopped meat was covered and set aside in the freezer for 15 minutes until well chilled and firm. Using chilled meat prior to mincing is

recommended as the fat and meat which is softer at room temperature hardens and is more easily passed through the mincing blades (Bon Appetite 2022). The chilled meat was then passed through an electric stainless steel countertop mincer/meat grinder (Model TT-22) using an 8mm mincing plate (Image 4.2, 4.3 and 4.4). The mincer was purchased from Caterquip in Durban, KZN. Minced meat has a higher microbial load due to the additional handling and increased surface area and thus requires the addition of a preservative such as sodium metabisulphite, which is a common preservative, to increase shelf life (do Nascimento 2021: 2). Sodium metabisulphite (SMBS), the commercially produced salt of sulphurous acid, is a preservative used to extend the shelf life of meat products such as fresh sausages and burgers (Feiner 2006: 90).

Image 4.1: Mincing plate (8mm)

Image 4.2: Mincing plate (6mm)

Image 4.3: Electric mincer

Image 4.4: Mincing the goat meat

b) Development of goat meat burger patty

Formulation 1 of the patty involved adding seasoning to the mince which was mixed in a Kenwood stand mixer to ensure even distribution and allow for a cohesive mixture to form (Image 4.5). No additional fat was added to the meat, only the intramuscular fat was used. The seasoned meat mixture was then passed through the mincer using a 6mm plate (Image 4.2). A calibrated digital kitchen scale was used to weigh 100g portions of the mixture which were then formed into patties (100mm) using a manual patty press machine purchased from Caterquip Durban, KwaZulu Natal, which is depicted in Image 4.5 (Model: HF-100). Due to handling, the patties were soft, hence they were then placed onto a tray, covered, and left in the fridge until chilled prior to frying. Differences in the formulations are depicted in Table 4.2.

Image 4.5: Kenwood stand mixer

Image 4.6: Manual patty press

d) Development of goat meat sausage

Chilled goat meat was passed through an electric stainless steel countertop mincer/meat grinder (Model TT-22) using an 8mm mincing plate. The mince was then passed through the mincer again using an 6mm plate for a finer grind required for sausages. The finely ground mince was left in the fridge to chill, whilst the seasoning and cereal flakes, which was sourced from a reputable industry supplier (Freddy Hirsch Cape Town, South Africa) were prepared. To prepare the cereal flakes (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, mixed thoroughly using a stainless-steel spoon and then the cereal flake mixture was added and the mince was mixed once more using a Kenwood™ stand mixer.

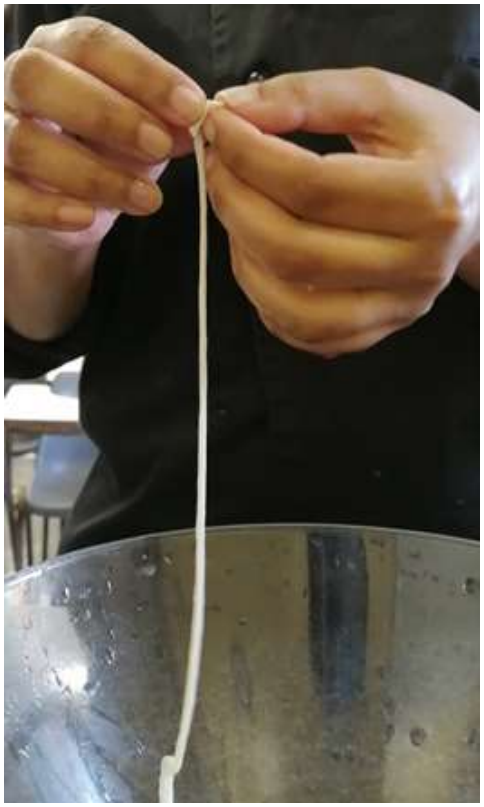


Image 4.7: Rinsing sausage casing

Image 4.8: Manual sausage filler

The sausage mixture was then filled into size 26mm sheep casing (Freddy Hirsch, Cape Town South Africa). Prior to filling, the casing, which is coated in kosher salt as a preservative, was soaked in tepid water for 20 minutes. The casing strands were separated, and each strand was gently filled with water to rinse the inside of the casing (Image 4.7). This treatment removes the salt and the casing wall becomes more elastic, as the collagen fibres absorb water (Heinz and Hautzinger, 2007: 250; Wijnker 2009: 199). Sheep casing is more fragile as opposed to hog casing; hence care was taken not to rupture or tear the casing as that would affect the filling of the sausages (Gunn *et al.* 2022: 02). A manual sausage filler (7lt capacity), with a 26mm nozzle purchased from Caterquip Durban, KwaZulu Natal was used to fill the sausage mixture into the casing (Image 4.8). To fill the casing, the hand bar for the sausage filler was turned at a consistent speed to prevent air pockets from forming inside the casing during filling.

Once filled, the sausages were formed into links (Image 4.9) 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 prior to cooking.

Image 4.9: Sausage links formed and packaged for chilling

4.2.4 Cooking method

a) Goat burger patty

Different methods can be used to cook burger patties which include pan frying and grilling using a griddle pan. For this study, the patties were shallow fried, as this is the cooking equipment that students, who are the intended target audience would normally use for food preparation (Brown 2011: 105). A dry heat cooking method involving preheating a Teflon coated non-stick frying pan which was placed over medium heat was used (Brown 2018: 105) Image 4.10. To the preheated pan, 10ml of vegetable oil (sunflower) was added for the frying process, and no additional water was added in the cooking process (Brown 2018: 105). Sunflower oil was used as it can withstand high temperatures due to its high smoke point temperature of 210°C, which is required for frying (Bastida and Sánchez-Muniz 2015: 226). The temperature range required for frying was 150-200°C (Gertz 2014: 669). The patty was carefully placed onto the pan and allowed to cook for 5 minutes on either side with a total of 10 minutes cooking time. The patty developed browning on either side due to the Maillard reaction and caramelisation which is distinctive of the frying process (Bastida and Sánchez-

Muniz 2015: 228). The internal temperature of the patty once cooked was recorded as 72°C, with the minimum temperature being 71°C as per the recommended food safety guidelines (Phang and Bruhn 2011: 1709) Once cooked, the patty was placed on a paper towel to allow the excess oil from the cooking process to drain. The cut patty samples were then served to the panellists in glass jars with metal lids to ensure the volatile compounds were olfactible (Rodriguez *et al.* 2022: 39).

Image 4.10: Frying the goat meat burger patty

b) Goat sausage

Sausages are usually fried or prepared on an open grill (braaied) (Singh *et al*., 2015: 546; Adam and Abugroun 2015: 14). In this study, the frying method which was used for the burger patty was adopted as it is a quick and convenient cooking method. The sausages were fried in 10ml of sunflower oil over medium heat for a total of 12 minutes, with 6 minutes cooking time per a side (Image 4.9). 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), the sausages were evenly browned, and each sausage was removed and placed onto a paper towel to allow the excess oil from the cooking process to drain.

Image 4.11: Frying goat meat sausages

The weights of the uncooked and cooked sausages and patties were recorded (Boles and Swan, 1996). The cooking yield was calculated using the formula mentioned below. This was to determine the mass lost during the cooking process.

$$\text{Total cooking loss \%} = \frac{\text{Calculated mass of raw sausage- mass of cooked sausage}}{\text{Calculated mass of raw sausage}} \text{ X } 100\%$$

4.2.5 Sensory evaluation

Pilot sensory evaluation was conducted with 10 students from the Durban University of Technology to gauge feedback on the acceptability of the formulations that were developed prior to consumer acceptability being conducted with the intended sample size (n=100).

The following eligibility criteria was used:

- All students registered from all year levels of study from the Durban University of Technology in the 2021-2022 academic year
- Students between the ages of 18 and 30 years old
- Students without food-related allergies/ intolerances
- Students who were willing to consume goat meat

To prepare the samples for sensory evaluation, each burger patty was cut into six equal wedges to ensure a sample that was representative of the patty in its entirety (outer edge and inner part of the patty). Samples were placed in shallow glass containers with metal lids and placed in Bain Marie water bath and were kept warm until serving (Tshabalala *et al.* 2003: 564). The samples were then coded using random 3-digit numbers and placed on a serving tray along with a cup of water, a plain cracker, a score card, a pencil, and an eraser (Image 4.13).

Image 4.12: Sensory evaluation setup

Image 4.13: Sensory session layout

Potential participants who met the requirements of the eligibility criteria were invited to evaluate the developed patties. A 9-point hedonic scale and paired preference test was used to gauge feedback from the participants (Appendix G). The setup for the sensory evaluation was done in a well-ventilated room where participants were seated spaced away from each other using privacy screens (Image 4.12). The instructions given to the participants were as follows:

a) In front of you are coded samples
b) Please taste each sample and indicate on the score card how you would rate each sensory attribute
c) Please be honest in your response
d) Please rank the order in which you prefer the samples in first, second and third place
e) You may include comments on the score card

4.2.6 Food safety considerations

In keeping with food safety requirements stated in the R638 legislation (South African Department of Health 2018:1-38) and best practices for food preparation, the following protocol was maintained throughout the food product development process.

- All meat products were stored in the refrigerator to slow down the growth of micro-organisms.
- Food handlers involved in the product development were fully attired in a chef's uniform (closed shoes, chef's coat, apron, and hair net) and maintained the correct hand washing procedure at 30-minute intervals and before and after handling raw and cooked meat.
- All surfaces were disinfected using a food grade disinfectant prior to and after the product development.
- All equipment used was washed using hot soapy water prior to and after use.
- The recommended cooking temperatures were observed to ensure items were safe for consumption.
- Participants involved in the sensory evaluation were informed that goat meat was used in the development of the products, and those who experienced allergies were excluded from the tasting sessions.

A Hazard Analysis and Critical Control Point (HACCP) flow chart was developed to depict the critical control points that may be of concern and compromise the food safety of the products (Al-Zuhairi 2016: 178).

4.2.7 Legislation and labelling requirements in South Africa

Legislation pertaining to animal source foods (ASF) sausages and patties in South Africa has recently been updated. The Agricultural Product Standards Act, 1990 (Act no. 119 of 1990, Regulation 2410) **"**Regulations regarding the classification, packing and marking of certain raw processed meat products intended for sale in the Republic of South Africa" (updated 22 August 2022), provides specific requirements that need to be met for a product to be marketed in South Africa (Department of Agriculture, Land Reform and Rural Development 2022: 7). According to this legislation, the goat patty formulation meets the minimum requirements necessary to be classified as a 'burger/patty/hamburger'. Since the only meat used in the formulation is from the goat species, the product would be labelled as 'Goat

burger patty' (Department of Agriculture, Land Reform and Rural Development 2022: 7). Results from the nutrient testing indicated the fat content was between 4-6% per a 100 g product; this was within the >5% to ≤10% fat content, hence the wording 'lean/trimmed' can be used to express the fat content. The goat meat sausages meet the minimum requirements of classification according to 'raw species' as they contain 90% of meat (minimum requirement is 75%) and no additional fat, other than intramuscular fat was used in both formulations (maximum no more than 30%) (Department of Agriculture, Land Reform and Rural Development 2022: 11).

4.2.8 Reduction of experimental errors

- The same equipment and measuring instruments were used in all formulation trials
- The same brand of ingredients was used for all formulations
- Samples were uniformly cut and served to participants
- All samples were served at the same temperature and the same serving vessels were used

Table 4.2: HACCP plan for goat meat burger patties

Critical Control Point	PRP/ GMP	Significant Hazards	Critical Limits for each Preventive Measure	Monitoring				Corrective Actions
				What	How	Frequency	Who	
	Purchasing	Biological Pseudomonads and lactic acid bacteria (LAB)	Store meat with ice packs to maintain temperature of 2°C - 4ºC whilst transporting	Temp. control	Digital thermometer	Once when destination for storage is reached	Researcher	Reject meat in the temperature range above 4°C
CCP1 Deboning		Physical Bone	Meat must be manually checked prior to being minced	Meat deboning	Manually checking there are no bones	Once, prior to mincing	Researcher	Reject meat and rework for animal feed
	Chilling	Biological Pseudomonads and lactic acid bacteria (LAB)	Meat must be stored between 0°C- 4°C	Temp. control	Digital thermometer	Prior to placing in the freezer	Researcher	Reject meat and discard
	Handling	Biological Staphylococcus aureus	Washing and sanitising of hands and equipment	Handwashing & equipment washing/ sanitising	Physically washing hands and equipment	Before, during and after meat handling, after use of ablution facilities and before entering lab.	Researcher Research assistant	Sign in for every wash
CCP2 Cooking		Biological	Cook to 72°C	Temp. control	Digital thermometer	After cooking	Researcher	If internal temperature is below 72°C, cook until 72°C is reached

Table 4.3: HACCP plan for goat meat sausages

Critical Control Point	PRP/ GMP	Significant Hazards	Critical Limits for each Preventive Measure	Monitoring				Corrective Actions
				What	How	Frequency	Who	
	Purchasing	Biological Pseudomonads and lactic acid bacteria (LAB)	Store meat with ice packs to maintain temperature of 2°C - 4°C whilst transporting.	Temp. control	Digital thermometer	Once when destination for storage is reached	Researcher	Reject meat in the temperature range above 4°C
CCP1 Deboning		Physical Bone	Meat must be manually checked prior to being minced	Meat deboning	Manually checking there are no bones	Once, prior to mincing	Researcher	Reject meat and rework for animal feed
	Chilling	Biological Pseudomonads and lactic acid bacteria (LAB)	Meat must be stored between 0°C- 4°C	Temp. control	Digital thermometer	Prior to placing in the freezer	Researcher	Reject meat and discard
	Handling	Biological Staphylococcus aureus	Washing and sanitising of hands and equipment	Handwashing & equipment washing/ sanitising	Physically washing hands and equipment	Before, during and after meat handling, after use of ablution facilities and before entering lab.	Researcher Research assistant	Sign in for every wash
CCP2 Cooking		Biological	Cook to 72°C	Temp. control	Digital thermometer	After cooking	Researcher	If internal temperature is below 72°C, cook until 72°C is reached

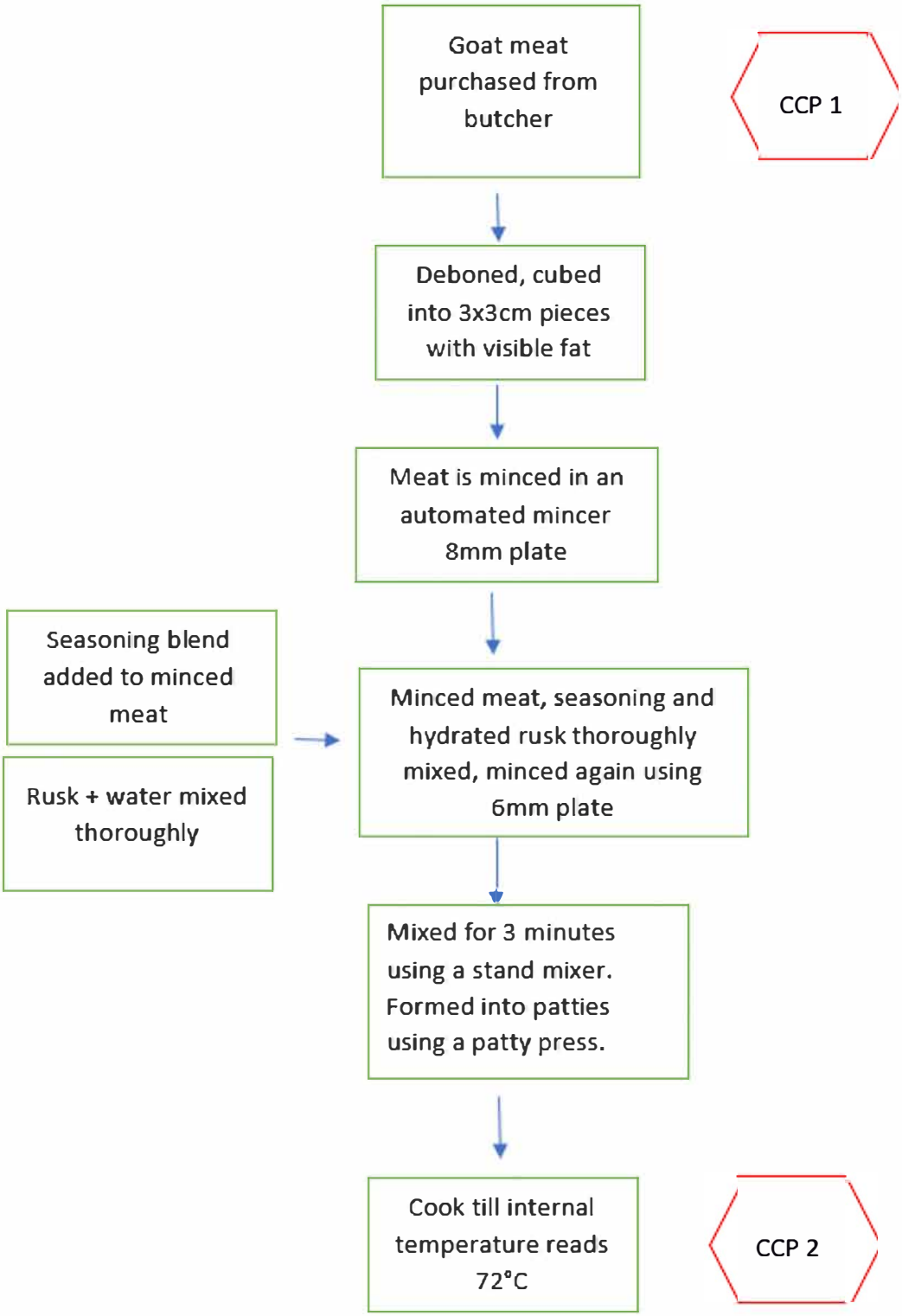


Figure 4.1: HACCP flow diagram for goat meat burger patties

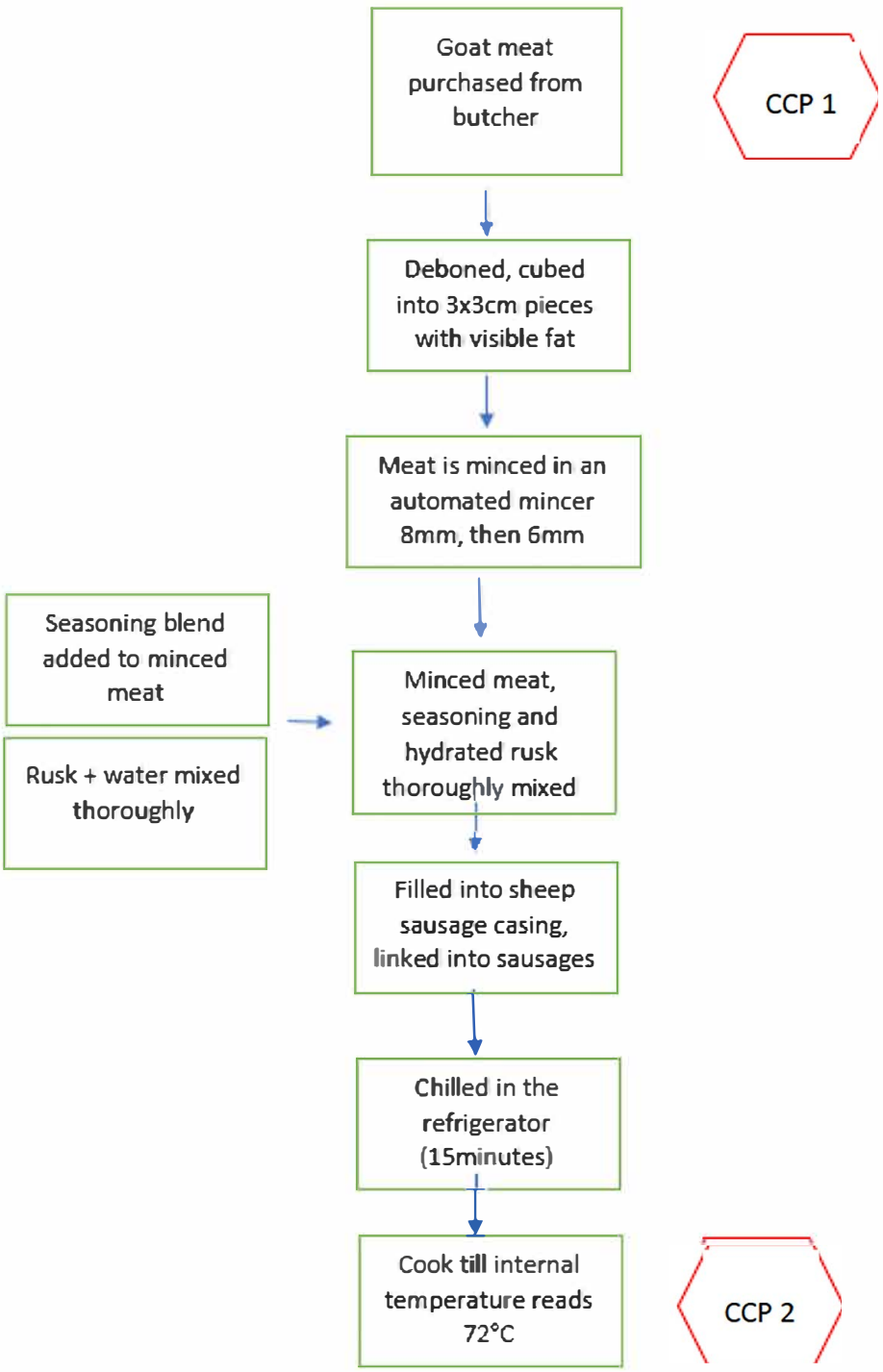


Figure 4.2: HACCP flow diagram for goat meat sausages

4.2.9 Microbiological testing

Microbiological testing was conducted on both the sausage and burger patty. The samples were prepared on the same day they were sent for testing. All samples were packaged in polystyrene trays that were cling-wrapped and placed in a cooler box with ice packs to maintain a temperature of 4°C to maintain the cold chain. A 120 g sample of each product was sent to Food Technology Laboratory at the Durban University of Technology be analysed for coliform bacteria, total viable aerobic count, yeast and mould. Proximate analysis and microbial analysis were conducted at accredited laboratories using verified methods of analysis to ensure reliability of the results presented.

Methods according to the microbial examination of foods were used

• 10 g meat sample diluted aseptically with 90 ml sterile distilled water

• Serial dilutions plated out onto agar plates, using the pour plate technique.

• Violet red bile agar was used for coliform bacteria, potato dextrose agar for yeast and mould, and plate count agar was used for total aerobic bacteria.

4.2.10 Proximate analysis

A 100 g sample of both the sausage and patty were sent to two accredited laboratories to analyse the following parameters using the methods described below.

Table 4.4 Methods used for proximate analysis for the goat sausage and patty

Proximate analysis	**Method**
Moisture	Oven Drying
Protein	Buchi app. Note no. 3xxOO1en- Kjedahl method
Total Fat	Soxhlet method
Ash	AOAC 942.05 (Ash furnace)
Total Carbohydrates	By Difference
Iron	NMKL No.:186
Cholesterol	AOAC International Vol 78 methods

The quantity of protein present in the sausage and patty was determined using the Kjedahl method which was calculated by digesting the products in a strong acid which results in a release of nitrogen that is determined by a suitable titration technique. The remaining amount

of protein is calculated from the nitrogen concentration of the food (BUCHI Labortechnik AG 2013: 1).

Fat content of the two goat meat products were calculated using the Soxhlet method, which uses a solvent to extract the fat from the sample, the fat that remains is then weighed (Shin and Park 2015: 972). The carbohydrate content was calculated by difference, the approximate carbohydrate value was determined by subtracting the measured protein, fat, ash and moisture from the total weight (Oxford Reference 2020: 1).

4.2.11 Shelf-life testing and packaging

Sensory shelf-life testing was conducted over a five-day period with the 30 g of cooked samples packaged in clear tubs with air-tight lids. The samples were checked daily, and the appearance and odour were recorded to determine the acceptable storage period for the cooked products.

4.3 Data analysis

Data collected from the product development trials was reported in the tables below.

4.4 Results and discussion

Results for the product development (recipe formulations) and sensory evaluation of the formulations will be presented in this section.

Table 4.5: Goat meat patty formulations

Ingredients	**Formulation 1**	**Formulation 2**	**Final product upscaled**
Goat meat, leg	**100 g**	**150 g**	**1 kg**
Goat meat, flank and rib	**150 g**	**100 g**	**750 g**
Goat meat, shoulder	**100 g**	**100 g**	**750 g**
Garlic powder	0.65 g	0.65 g	11.5 g
Onion powder	0.40 g	0.40 g	10 g
Ginger powder	0.40 g	0.40 g	3.75 g
White pepper powder	0.60 g	0.60 g	10 g
Salt, iodised	3 g	3 g	14 g
Cereal flakes (butchers rusk)	-	-	60 g
Ice cold water	-	-	125 g
Sodium metabisulphite	-	-	2 g
Recipe yield	**3 patties (100 g x 3)**	**3 patties (100 g x 3)**	**25 patties (100 g x 25)**
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.	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.	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.	Using the 8mm grinding plate, place the chilled meat into the mincing funnel to mince.	Using the 8mm grinding plate, place the chilled meat into the mincing funnel to mince.
Step 3	Once the mince is formed, add the seasoning ingredients, and mix thoroughly to combine	Once the mince is formed, add the seasoning ingredients, and mix thoroughly to combine	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 prior to cooking.	Using a 100mm manual patty press, shape the minced meat mixture into patties. Allow the patties to chill in the fridge for 10 minutes prior to cooking.	Using a 100mm manual patty press, shape the minced meat mixture into patties. Allow the patties to chill in the fridge for 10 minutes prior to cooking.
Cooking method			
Step 1	Add the sunflower oil to a preheated frying pan.	Add the sunflower oil to the preheated frying pan.	Add the sunflower oil to the preheated frying pan.
Step 2	Place the patty in the pan and allow to cook for 5 minutes on either side before turning, with a total of 10 minutes cooking time. Internal temperature must be 72°C.	Place the patty in the pan and allow to cook for 5 minutes on either side before turning, with a total of 10 minutes cooking time. Internal temperature must be 72°C.	Place the patty in the pan and allow to cook for 5 minutes on either side before turning, with a total of 10 minutes cooking time. Internal temperature must be 72°C.
			Raw weight:100 g **Cooked weight: 85 g** **Cooking loss: 15%**

The formulations used in the development process are depicted in Table 4.5. Ratios of the meat cuts and the addition of butcher's cereal flakes were the two notable changes made after feedback from the pilot sensory evaluation. Goat meat is lean in nature and has a lower fat content compared to other ruminants (Ivanović, Pavlović and Pisinov 2016: 113). The addition of the cereal flake mixture was to retain moisture and prevent the patty from being dry after cooking. Cereal flakes commonly known as 'butchers rusk' are used in processed meat formulations and the functionality of the product is diverse, from serving as a meat extender, to retaining product moisture and improving mouthfeel (Ranken 2000: 137). The formulation meets the requirements of the South African 'Regulations governing the composition and labelling of raw Boerewors, raw species sausage and raw mixed-species sausage' (R 2718 -Regulation for Boerewors and Sausage) as it contained a minimum of 75% total meat content (Department of Agriculture, Land Reform and Rural Development. 2022: 4).

Table 4.6: Goat meat sausage formulation

Ingredients	**Formulation***	**Final product**
Goat meat, leg	400 g	1 kg
Goat meat, flank	300 g	750 g
Goat meat, shoulder	300 g	750 g
Garlic powder	4.5 g	11.5 g
Onion powder	4 g	10 g
Ginger powder	1.5 g	3.75 g
White pepper powder	4 g	10 g
Salt, iodised	15 g	20.5 g
Sodium metabisulphite	-	2 g
Cereal flakes (butchers rusk)	30 g	75 g
Ice cold water	50 g	125 g
Sheep casing (26mm)	0.5 m strand (1m)	1 strand (1m)
Recipe yield	**11 sausages**	**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.	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.	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.	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.	Once the mince is formed, add the seasoning ingredients and cereal flakes mixture. Mix thoroughly to combine.
Step 6	To prepare the sausage casing, soak in tepid water to remove all residual salt that coated the casing as part of the packaging and preservation.	To prepare the sausage casing, rinse thoroughly with tepid water to remove all residual salt that coated the casing as part of the packaging and preservation.
Step 7	Using a manual sausage filling machine with nozzle size 26mm	Using a manual sausage filling machine with size 26mm sheep

	and 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.	casing, fill the goat meat mince into the casing. Once the casing is filled, twist the sausage into 8cm portions and link.
Cooking method		
Step 1	Add 10ml of oil to a preheated frying pan.	Add 10ml of oil to a preheated frying pan.
Step 2	Place the sausage in the pan and cook for 6 minutes per side over medium heat, whilst constantly moving the sausage to preventing sticking. Sausage is cooked when internal temperature is 72°C.	Place the sausage in the pan and cook for 6 minutes per side over medium heat, whilst constantly moving the sausage to preventing sticking. Sausage is cooked when internal temperature is 72°C.
	Raw weight: 60 g **Cooked weight: 45 g** **Cooking loss: 15%**	**Raw weight: 60 g** **Cooked weight: 45 g** **Cooking loss: 15%**

*The first formulation received results above the minimum threshold, so no further formulations were tested.

The goat meat sausage formulation (Table 4.6) involved using the same ratio of meat as the burger patty, however the meat was ground to a medium size (using an 8mm and then 6mm mincing plate), as opposed to the coarse ground mince (8mm mincing plate only) used for the patty. Medium ground mince was required due to the width of the sheep sausage casing (26mm) to prevent the casing from rupturing. The first formulation prepared received acceptable results during the pilot sensory evaluation, hence no further formulations were developed.

Table 4.7: Pilot sensory evaluation results for the goat meat products using a 9-point hedonic rating scale (n=10)

	Average scores		
	Formulation 1	**Formulation 2**	**Formulation 3**
Goat meat patty			
Appearance	7.3	7.4	7.4
Aroma	7.6	7.6	7.8
Flavour	6.6	7.9	7.9
Texture	6.8	7.0	7.6
Goat meat sausage			
Appearance	8.7	-	-
Aroma	8.5	-	-
Flavour	8.2	-	-
Texture	8.5	-	-

Hedonic rating scale: Like extremely=9, dislike extremely=1

Sensory evaluation was conducted after each formulation was prepared. All samples were evaluated using a 9-point hedonic rating scale which is commonly used to assess consumer preference and acceptability (Lim 2011: 738). The first formulation received positive feedback; however, comments from the panel included 'It feels a bit chewy but tastes nice', hence the recipe was reformulated to reduce the amount of flank which has more connective tissue and increase the amount of shoulder and leg meat (Brown 2018: 147). The cooking methods most suited to the flank include moist heat preparation for prolonged periods of time or using acidic mediums like lemon juice/yoghurt to break down the connective tissue (Brown 2018: 148). Even though the connective tissue was manually broken down using a mincer, the ratio of flank to the other cuts of meat needed to be adjusted (average of the hedonic tests in a table- for acceptability). Results for the pilot sensory evaluation are depicted in Table 4.5. An average score of 6.5 was regarded as being acceptable for each sensory attribute, and even though this was achieved for the first formulation, comments from the panellist indicated further improvements could be made.

Feedback from the students was essential in the developmental process as changes needed to be made after each trial to improve palatability. Results from the trials are depicted in Table 4.6, which shows that formulation 2 was rated as displaying acceptable sensory attributes with the average score for each attribute above 7.0 for the 9-point hedonic rating scale.

Once the ratio of flank: leg: shoulder meat was adjusted the recipe was prepared again (formulation 2) with the intent to improve the texture of the patty and reduce the chewiness experienced by the previous sensory panel. A group of ten students were recruited to evaluate formulation 2 and the results received were positive, showing that a higher percentage of students found the formulation to be acceptable.

The results reflected that formulation 2 for the burger patty was above the minimum acceptable threshold levels as all attributes were rated a score of 7.0 or higher for the 9-point hedonic rating scale test. The same ratio of meat used for the patty was also used to formulate the goat meat sausage, therefore, the first formulation received acceptable scores for all sensory attributes (score of 8.2 or higher), hence no further formulations needed to be explored.

Below is a summary of the results based on the respective testing methods utilised.

Table 4.8: Proximate composition of goat meat burger patties and goat meat sausages per 100g

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

Results from the proximate analysis showed that both the sausage (26.88 g) and the burger (31.57 g) were high in protein. The total fat content for each sample was less than 10 g per a 100g portion and met the requirement of containing a minimum of 75% total meat (Departmen of He 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 both burger patties and sausages (Department of Health 2017: 3). Other studies on goat meat patty and sausage 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 (Amaral *et al.* 2020: 133; Adam 2022: 2; Ko *et al.* 2021: 98; da Silva *et al.* 2021:

2). However, per a 100 g, comparing the total fat (14.5 g) and protein (15.9 g) content of beef patties to the goat meat patties, the goat meat patties were lower in fat (4.05 g) and higher in protein (31.57 g) (Woolworths online 2022). The goat meat sausage was also nutritionally superior in terms of total fat and protein content compared to beef sausages. Beef sausages per 100 g samples, contained more total fat (20.9 g) and less protein (14.7 g), compared to goat meat sausages (6.08 g) and protein (26.88 g) (Woolworths online 2022).

Results for the microbial testing is presented in Table 4.9.

Table 4.9: Microbiological results

Analysis	**Goat burger 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

Coliform counts were very low and well within acceptable range for both samples. Yeast and mould counts were very low and total bacterial counts were low and well within acceptable range. The results are in accordance with the Foodstuffs, Cosmetics and Disinfectants Act, and regulations governing microbiological standards for foodstuffs and related matters (Department of Health 2002: 4), and both products are suitable for consumption.

Table 4.10: Results for the sensory shelf-life analysis of cooked goat meat burger patties

Attribute	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**
Visual appearance	Brown- charred	Brown/charred	Brown/charred	Brown/charred	Brown/charred
Odour	Meaty aroma with savoury notes	Meaty aroma with savoury notes	Meaty aroma with savoury notes	Meaty, with a slight rancid odour	Mild rancid odour associated with spoilage

Table 4.11: Results for the sensory shelf-life analysis of goat meat sausages

Attribute	Day 1	Day 2	Day 3	Day 4	Day 5
Visual appearance	Brown/charred	Brown/charred	Brown/charred	Brown/charred	Brown/charred
Odour	Meaty aroma with savoury notes	Meaty aroma with savoury notes	Meaty aroma with savoury notes	Mild rancid odour associated with spoilage	Mild rancid odour associated with spoilage

The shelf-life testing done by the researcher and research assistant revealed that the optimum storage time in the fridge for the cooked products was between one to four days for the patty (Table 4.10) and one to three days for the sausage (Table 4.11). These results are aligned to the storage recommendations issued by the United States storage of cold food chart (Foodsafety.gov 2022). Oxidation of the fats present in meat is recognised as one of the main causes of minced meat spoilage resulting in off-flavours and odours (Moudache, Nerín, Colon and Zaidi 2017: 98; Mouafo, Mbawala, Tanaji, Somashekar and Ndjouenkeu 2020: 1). The changes identified in both patty and sausage samples could be attributed to lipid oxidation. Costing of the formulations of both products is depicted in Table 4.12.

Table 4.12: Ingredient costing for the goat meat patty and sausage

				Goat patty		Goat sausage	
Brand	**Source of price**	**Ingredient**	**Cost**	**Qty used**	**Cost**	**Qty used**	**Cost**
Incoso Goat meat	Incoso goat	Goat meat	R130.00/kg	2.5 kg	R325.00	2.5 kg	R325.00
Woolworths	Woolworths	Garlic powder	R28.99/55g	11.5 g	R1.99	11.5 g	R1.99
Woolworths	Woolworths	Onion powder	R26.99/55g	10 g	R1.57	10 g	R1.57
Woolworths	Woolworths	Ginger powder	R26.99/45g	3.75 g	R1.48	3.75 g	R1.48
Robertsons	Checkers	White pepper	R37.99/50g	10 g	R2.34	10 g	R2.34
Cerebos	Checkers	Iodised salt	R19.99/500g	13.96 g	R0.56	20.5 g	R0.82
Freddy Hirsch	Freddy Hirsch	Cereal flakes (butchers rusk)	R554.99/20kg	60 g	R1.66	75 g	R2.08
Freddy Hirsch	Freddy Hirsch	Sausage casing	R186.99/26 strands	-	-	1 strand	R7.19
Lab supply chemicals	Reflecta Chemicals	Sodium metabisulphite	R69.26/500g	0.6 g	0.001	0.6 g	0.001
		Portions		25 patties		30 sausages	
		Total cost		R334.60		R342.47	
		Per portion		R13.38		R11.42	
		Per kg		R133.84/ kg		R137.99/ kg	

The price of free-range beef burgers (85% meat) is R176.99 per kilogram at Woolworths, which is more expensive than the price per kilogram of the goat meat patties, whereas free range beef boerewors (a type of sausage commonly eaten in South Africa) per kilogram costs R139.99 (October 2022). The price of beef per kilogram is R109.99 compared to lamb (R180.00/kg) and goat meat (R130.00). Due to a lack of demand from consumers resulting in a lack of supply, goat meat is not readily available in South Africa which has an implication on the selling price. Even though beef is cheaper and has an established market, there is a marginal price difference for the sausage price for a product that has not penetrated the retail market, indicating the potential (prices obtained from Woolworths South Africa online 2022).

4.5 Conclusion

The stages in product development (opportunity identification, idea generation, concept development testing, and product development) were followed to develop two goat meat products that were sensorially acceptable to the identified target market. Through various analysis and testing and basic costing it can be concluded that both products have potential in the retail market. However, market analysis and feasibility studies would need to be conducted prior to commercialisation.

CHAPTER FIVE: SENSORY TRAINING AND LEXICON DEVELOPMENT

5.1 Introduction

Sensory evaluation is a critical component of the product development process. Objective two of the study involves training a sensory panel that is equipped to develop a goat meat lexicon. This section describes the methods utilised in the recruitment, training, and development of the lexicon for goat meat.

5.2 Methodology

5.2.1 Recruitment strategy

Participants involved in the third investigation (sensory training and lexicon development) were recruited by means of emails sent to students registered in the Department of Consumer Sciences (undergraduate and postgraduate) from the DUT. This site was chosen as the demographic profile at DUT, which was reported in chapter 3 was more diverse compared to the University of Zululand. These students have undergone basic sensory evaluation training throughout their qualification and are familiar with a variety of food products hence, suitable candidates for the lexicon development phase of the study.

Participants were also made aware that a token of appreciation in the form of airtime would be given to each participant as gratitude for their contribution to the study. In addition, successful participants that completed the training were also awarded a certificate for completing training as a sensory panellist.

5.2.1.1 Eligibility criteria for trained panel for lexicon development

- All students registered, from different year levels of study from the Department of Consumer Sciences, Durban University of Technology during the 2021-2022 academic year.
- Students between the ages of 18 and 30 years old.
- Students must be willing to sample different meats (beef, goat and mutton) cooked to different degrees of doneness (medium to well done).

- Students without food-related allergies/ intolerances.

5.2.2 Pre-screening recruitment

In addition to the eligibility requirements outlined in the selection criteria, a link to a pre-screening online survey was sent to potential candidates to gauge their suitability for this study. Questions specific to this study included whether the participant would be willing to eat goat meat and other red meat products. Other more general questions enquired on the student's availability, interest, known allergies and willingness to participate in the training were also included.

5.2.3 Pre-screening sensory tests

A total of 18 participants met the requirements for the pre-screening survey and were invited to attend a pre-screening sensory evaluation session. This was done to determine the participants' sensory acuity and suitability to undergo the sensory evaluation training to become a trained panellist (Appendix H).

A series of tests including vision (colour blindness), taste (ability to detect different tastes) and odour (recognition of odour) were completed by the participants. Only 13 participants met the minimum requirements outlined in Appendix H and were invited to participate in the sensory evaluation training.

5.2.4 Sensory evaluation training

A comprehensive training manual was developed as the tool which was used to screen and prepare potential candidates to serve as trained panellists for the lexicon development phase of this study (Appendix I). The development of the manual involved extensive reviewing of various International Organisation for Standardisation (ISO) documents pertinent to sensory evaluation and training which included ISO 8586 (2012), ISO 13299 (2016) and ISO 11035 (1994). In addition, manuals that other researchers have utilised in their studies were also reviewed. The various sources were then utilised as part of compiling the manual which was used in this study.

After a series of pre-screening tests (Appendix I), the candidates who met the minimum requirements of sensory acuity outlined in the training manual were invited to undergo a series of sensory evaluation training sessions. Each session focused on a specific aspect of sensory evaluation and exposed the candidate to group discussion afterwards to improve their

sensory evaluation skills. The duration of each training session was between 2-4 hours depending on the nature of the tests and the number of samples used. Considerations such as limiting the number of samples and allowing candidates breaks in-between evaluations were taken to prevent sensory fatigue.

The first three days of the training workshop focused on introducing the candidates to the different testing methods, exposing them to food grade samples to heighten their sensory acuity and to provide them with an opportunity to describe the sensory properties of the items evaluated from their perspective. The three training workshops were then repeated the following week to determine whether the candidates were able to yield consistent results in their ability to evaluate the samples. The nature of Quantitative Descriptive Analysis (QDA) requires candidates to be able to provide consistent results, hence the training was done in duplicate.

After each of the training workshops, the score cards used by the candidates were collected and analysed to determine the candidates' suitability (ability to meet minimum sensory acuity requirements) to participate in the lexicon development aspect of the study. Pictures of some of the sensory setup trays and assessors completing the evaluation are captured as Images 5.1 to Image 5.3

5.2.5 Sample preparation

Sample preparation for the pre-screening tests and workshop 1-3 was done in accordance with ISO 8586 guidelines; however, these guidelines were modified to suit the needs of the study. All flavour (taste and odour) samples were sourced from reputable food grade chemical supply companies. Some of the sensory evaluation sessions utilised food products or ingredients, which were sourced from local retail stores. Instructions for the sample preparation and serving order are documented in detail in the training manual (Appendix I).

5.2.6 Panel performance

The quantitative descriptive analysis (QDA) method requires panellists to provide consistent results after repeat exposure to a stimulus, hence each test was done in duplicate one week after the first session. Panellists who were unable to demonstrate consistent results for more than one session were excluded from the sensory panel due to non-conformance. The QDA method (Tragon QDA), which was used in this study, focused on self-calibration whereby a panellist can provide consistent results (Kemp, Hort and Hollowood 2018: 119).

Three core concepts essential for the reliability of data include repeatability, agreement, and discrimination between the panellists (ISO 8586). The panel's performance for each descriptor will be reported on. When repeatedly evaluating the same stimulus, the collected measurements must be as close as possible to each another.

Agreement between the panellists measures the homogeneity of the responses obtained for the same stimulus by the different tasters. This characteristic results from the fact that the panel, consists of several sub-units of independent measurements which are the panellists (Kemp, Hort and Hollowood 2018: 119).

5.3 Training workshop 1: Detection & discrimination of intensities of a stimulus

Training workshop 1 was designed based on ISO 8586 recommendations. A triangle test was used whereby one substance at a time was tested. Two samples of water and one sample of the test substance were presented to each participant on a tray (Appendix I). Panellists evaluated seven trays in total with one evaluation done at a time. A triangle test score card was used to complete the evaluation by identifying the odd sample on each tray. This test was done to determine whether participants were able to detect a stimulus. An example of the score card for the triangle test used is depicted below.

Scorecard

Triangle Test: Taste detection

Tray number …… Panellist number ……

In front of you are three coded samples, two are the same and one is different.

Starting from the left, taste the samples and circle the one that is different from the other two. You may re-taste the samples. You must make a choice.

_____ _____ _____

Figure 5.1: Score card for taste detection test

The next test used was to determine panel members ability to discriminate between different levels of intensity of a stimulus. Tests for discrimination between levels of intensity of a stimulus use the ranking test procedure according to ISO 8587. The tests were carried out using stimuli for taste, odour (very small amounts), texture (mouth and hand), and colour. The protocol involved panellists receiving four samples having different intensities of the

substance which were presented in a random order to each panellist, who were then required to place the samples in order of increasing intensity (Appendix I). An example of the score card used for the odour intensity ranking test is depicted below (Figure 5.2).

Scorecard

Intensity Ranking Test for Odour

Tray number …… Panellist number…….

You are provided with the following samples for odour evaluation labelled as:

Please take a sniff of each sample initially in this order and then smell and re-smell them in any order, until you can place them in front of you from left to right in order of increasing intensity.

When you have done this, write the sample codes in the boxes below in order of increasing intensity:

Lowest			Highest

→

Figure 5.2: Score card for intensity ranking test for odour

Panellists were also required to demonstrate their ability to rank odours according to the degree of intensity, ranging from lowest (less intense) to highest (most intense). The descriptive training workshop allowed the panellists an opportunity to use descriptive words to explain odour and textural stimuli, which is a key aspect of developing the lexicon in the next phase of the study.

5.4 Training workshop 2: Tests for descriptive ability

Training workshop 2 was also structured based on IS0 8586 guidelines. The purpose of descriptive tests was to determine panellists' ability to describe sensory perceptions. Two tests are usually used, one covering odour stimuli and the other textural stimuli. The protocol involved each person evaluating 10 olfactory stimuli. The set included samples which were easy to recognise and others which were not as common. The method for preparing the

samples is described in Appendix I. Only five samples were served at a time to prevent sensory fatigue. Participants were required to evaluate each of the 10 samples according to the score card in figure 5.3.

Score card

Odour identification and description test

Tray number…… Panellist number…….

Place an x in the appropriate column and complete the following questions

Sample no.	**Do you perceive an odour?**		**Do you recognise this odour?**		**Name of smell, description, or association**	**Comment**
	Yes	*No*	*Yes*	*No*		

Figure 5.3: Odour identification and description test score card

The texture description test required assessors to use descriptive words to explain the texture that they felt best described the sample being evaluated. The textural stimuli that were evaluated included 14 samples. Samples were prepared and served according to Appendix I. The score card used to collect the responses is depicted in Figure 5.4.

Score card

Texture description test

Tray number…… Panellist number…….

Write the word/s that you think best describe the texture of each of the samples presented

Sample no.						
Word that describes the texture of the sample						

Figure 5.4: Score card for texture description test

5.5 Training workshop 3: Recognition of differences in texture and scales

The purpose of training workshop 3 was to familiarise participants with unstructured and semi structured line scales and show them how to correctly use line scales. A series of samples were evaluated using line scales. Using a line scale is subjective, and participants have different ranges in which they evaluate a sample on a line scale. Quantitative Descriptive Analysis (QDA) focuses more on individual performance as opposed to panel performance; hence the objective was more to detected consistency between evaluating samples in duplicate as opposed to consistency in responses among participants. An example of an unstructured line scale which was used in the training is depicted in Figure 5.5. The procedure for preparing and serving the samples is documented in Appendix I.

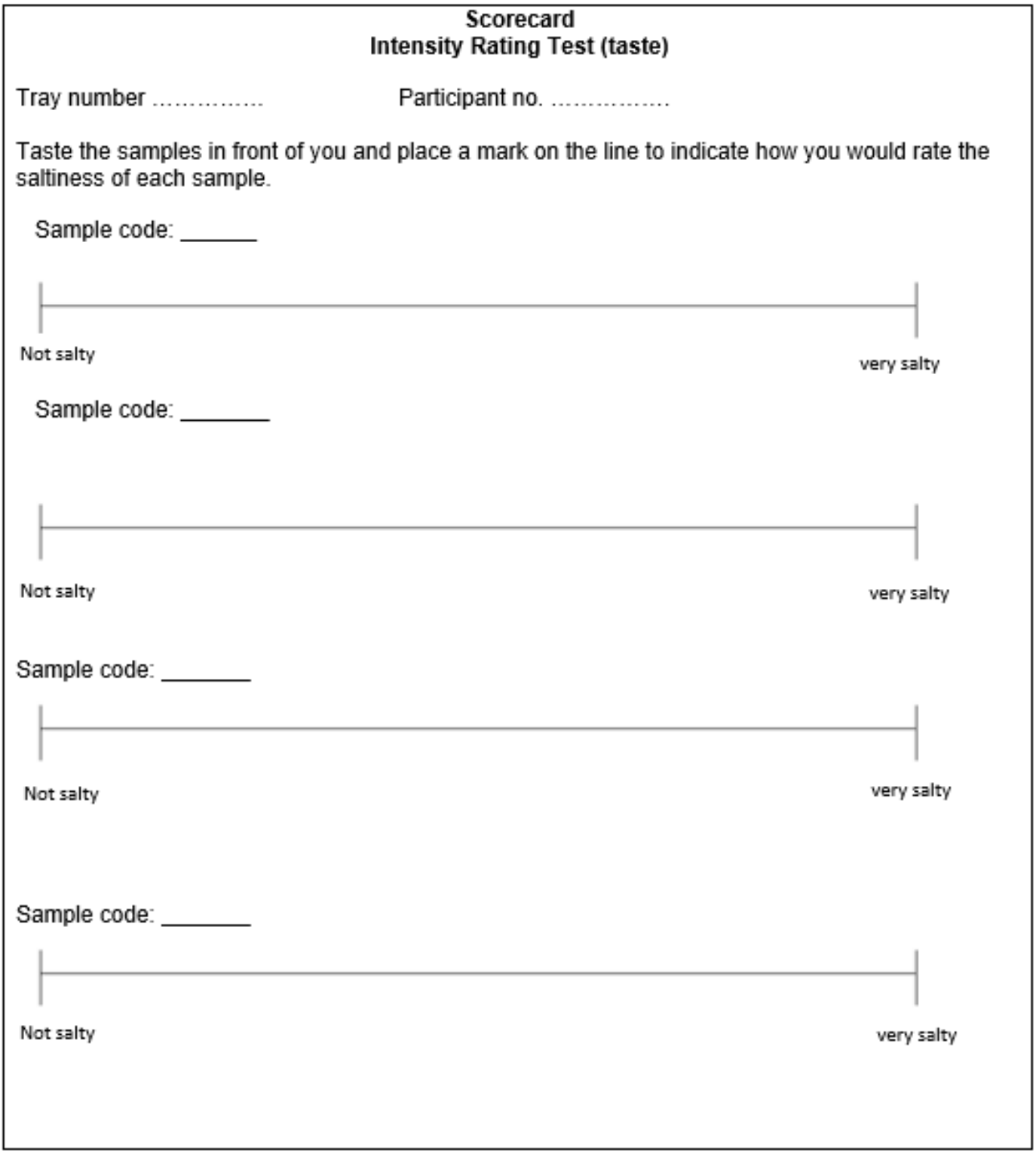


Figure 5.5: Unstructured line scale used for the taste intensity rating test

Image 5.1: Tray setup for texture description test

Image 5.2: Panellist completing the texture description test

Image 5.3: Panellist completing the odour identification test

5.6 Lexicon development

Once the panel had completed the sensory training and displayed sensory acuity, the next phase of the study, which was lexicon development occurred. This involved a series of five phases and open discussions to determine the terms and definitions most suited to describing a comprehensive range of goat meat attributes. Each phase took approximately one to two hours to complete with adequate breaks in between to avoid sensory fatigue. Detailed procedures and protocols are documented in Appendix I.

Part 1 Panel orientation: The orientation was led by the researcher who introduced the general concepts of language development and describing their sensations and perceptions of the product category (Silva, Binduhewa and Subodinee 2014; Pereira *et al.* 2015). The duration of the orientation was 15 minutes, keeping in mind that a maximum of 20 minutes is recommended (Kemp, Hort and Hollowood 2018).

Part 2 Generation of attributes: Upon completion of the orientation, the language development process started as a group activity. Panel members were required to evaluate goat meat samples from different areas of the carcass that were prepared using different cooking techniques.

The cooking methods and detailed procedure is depicted in Table 5.1.

Table 5.1: Cooking methods used to prepare samples for attribute generation

Cooking method	**Procedure**	**Cuts of meat**
Braising	An aluminium pan was placed on the stove over medium heat and 15ml of sunflower oil was added to the pan. The meat was placed in the pan when the oil was hot enough and seared for 2 minutes on each side. After browning, the sample was removed from the pan and placed in a vessel with 500ml de-ionized water, which was then set over high heat. The heat was kept high until the water began to boil (5 minutes), then it was reduced to medium, and the sample was left to simmer for 30 minutes with the lid on.	Neck, shoulder Cubed 25 mm x 25 mm
Boiling	The meat cuts were placed in a cast iron pot with 500ml of water and allowed to boil until cooked.	Shank, leg Cubed 25 mm x 25 mm for stew
Air-fried	Pre heat the air fryer to 200°C for 3 minutes. Spray the meat with vegetable oil and place in the air fryer basket. Reduce the temperature to 180°C and cook for 5 minutes, turn and cook for a further 5 minutes.	Loin and leg chop 25mm thick
Roasting	The oven was set on 'bake' with both top and bottom elements on and allowed to preheat to 180°C. The sample was placed in a roasting pan on a wire aluminium rack (fat side up if there was a fat side). The roasting pan (with the rack) was placed in the oven and cooked to different degrees of doneness, e.g. medium (60°C), medium to well done (65°C) and well done (71°C).	Leg, shoulder Shoulder shank Leg 500g, 50mm thick
Warmed over flavour – microwave	Once the samples were cooked to the varying degrees of 'doneness', they were wrapped in aluminium foil and refrigerated for 24 hours. After that time, the samples were reheated in a microwave oven (2 min on high power; model- Midea 700 Watts). The sample was heated until an internal temperature of 60°C was reached.	Leg (roasted), rib chop (braai) neck (braised)
Grilling-outdoor (braai)	A disposable mini braai (Ignite Disposable Picnic Barbeque) was used, and the coal was allowed to burn for approximately 10 mins. The meat sample was then placed on the grill and was turned every 4 mins until the internal temperature (68°C) was reached.	Loin chop and leg chop 25mm thick

Panellists were sent a link to a Microsoft survey form (Appendix J) which was structured with questions to allow each panel member to type as many words as they could think of to describe the various sensory attributes of the samples presented to them. Once each panel member had submitted their responses for all the samples, an online application called 'free word cloud generator' (https://www.freewordcloudgenerator.com/) was used to graphically represent the responses. The word cloud depicts words that are repeated multiple times in larger font than words that only appear once. Hence, the larger the word, the more common the response from the participants. This process of evaluating and identifying suitable terms to describe each attribute was repeated for the four goat meat samples that best represented the range of goat meat attributes. Thereafter, open discussions among the panellists were used to decide which attributes were most useful in describing the various samples. These terms were then voted upon and vetted by the panellists for use with goat meat products. Through the open discussion repetitive words or words that were not a true reflection of the samples were removed from the lexicon.

Part 3 Scaling of attributes: The panellists decided upon appropriate anchor words for each scale (such as 'weak' to 'strong' or 'slightly' to 'very') for the words that were generated. The facilitator then used the list of words generated to create definitions for each attribute scored, based on input from the panel so that the final definitions represent a true group consensus. The panel also discussed what the appropriate protocol would be for the evaluation of each attribute and this protocol was verified in the pre-test to determine the accuracy and relevancy of the steps documented. Panel members understood and agreed on the use of the scale and the anchors for attributes.

Part 4 Pre- test and panel performance: The purpose of the pre-test was to allow the panel to complete a practice session to evaluate the products and to improve their confidence in using the developed lexicon. The session involved each panellist evaluating two samples using different cooking methods (grilled and boiled) which were tested in duplicate, the data was recorded on a 10cm semi-structured line scale. Panellists were required to make a mark on the line scale to indicate their response. The data on the score card was then captured in Excel and graphically represented using a radar plot (Drake and Civille 2003: 35).

Part 5 Main test using lexicon: Prior to the main test, the researcher presented the procedures, definitions, and rating scales of each attribute. Six portions representative of the goat meat carcass were selected of which average ratings were calculated. The main test was

conducted to check individual performance and to determine whether the panellists were using the sensory attributes in a similar way. The testing was done in duplicate by individual panel members- with all samples being presented in the same order for each participant. A semi-structured line scale was used ranging from 0 to 10. The collected data were analysed with the one- and two-way Analysis of Variance. Based on the results of the pilot test, the panel reconvened to discuss attributes and products which required clarity and agree on the final lexicon.

5.7 Results and discussion

5.7.1 Training workshops

A series of three training workshops were done in duplicate for repeatability (ISO 8586 2021: 2). The minimum requirements for a person to be regarded as a trained panel member are documented in Appendix I. Nine of the panellists who had undergone the training met the minimum requirements according to ISO 8586 (2012: 9-12) and were therefore allowed to proceed with the lexicon development phase of the study.

5.7.2 Lexicon development

5.7.2.1 Generation of attributes

The words generated through the evaluation of the different goat meat samples through group discussion and consensus, are depicted below in a word cloud for the various attributes (Figure 5.6).

Figure 5.6: Word cloud generated for the appearance of a goat meat sample prepared using different cooking methods

The words generated for the appearance of the sample spanned a broad range of descriptors reflective of the diverse cooking methods that were used to prepare the samples. The range of descriptors included words associated with a negative (dry and fatty) and positive (juicy, evenly browned, glossy) connotation. Cooking methods and temperatures (degree of doneness) have a direct impact on the extent of colouration obtained (Ruiz-Carrascal *et al.* 2019: 4).

Descriptive words for the aroma of the goat meat samples are depicted in Figure 5.7.

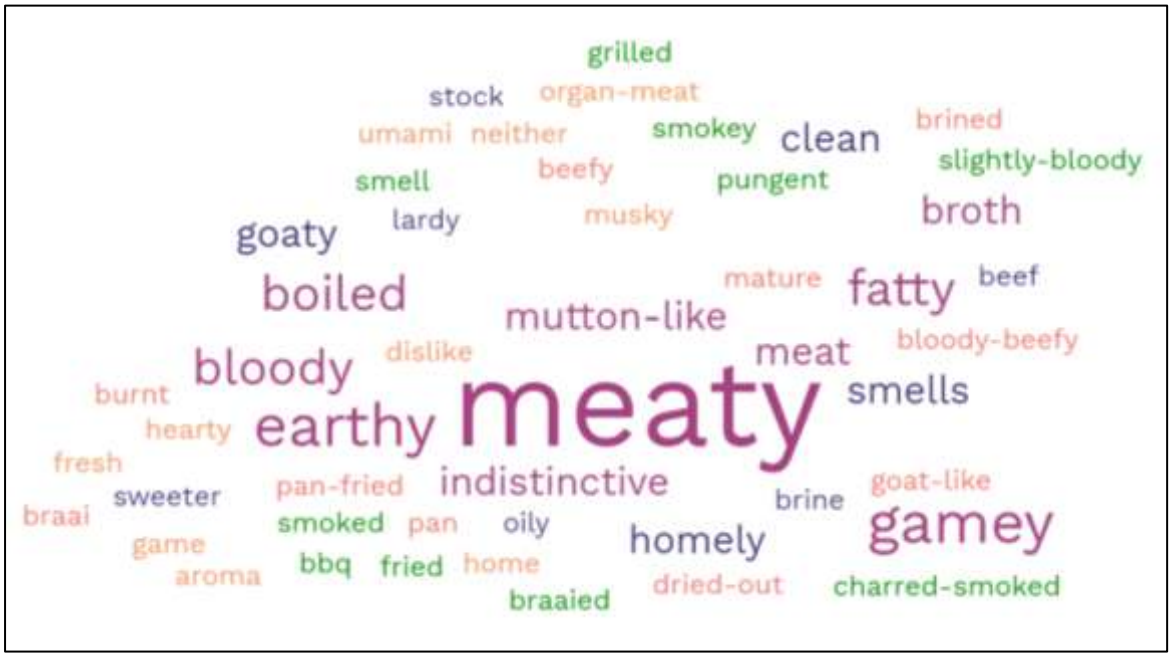


Figure 5.7: Word cloud generated for the aroma of a goat meat sample prepared using different cooking methods

During the cooking process an increase in temperature leads to a change in the aroma of the samples being prepared (Yu *et al.* 2017: 141). The goat meat samples that were prepared using dry heat cooking methods (roasted, braaied and air fried) evoked different aromatics (charred-smoky, smoked, BBQ), whilst moist heat preparation generated terms associated with ‘boiled’, ‘musky’, and ‘stock’.

Goat meat flavour of samples prepared using different cooking methods are represented in Figure 5.8.

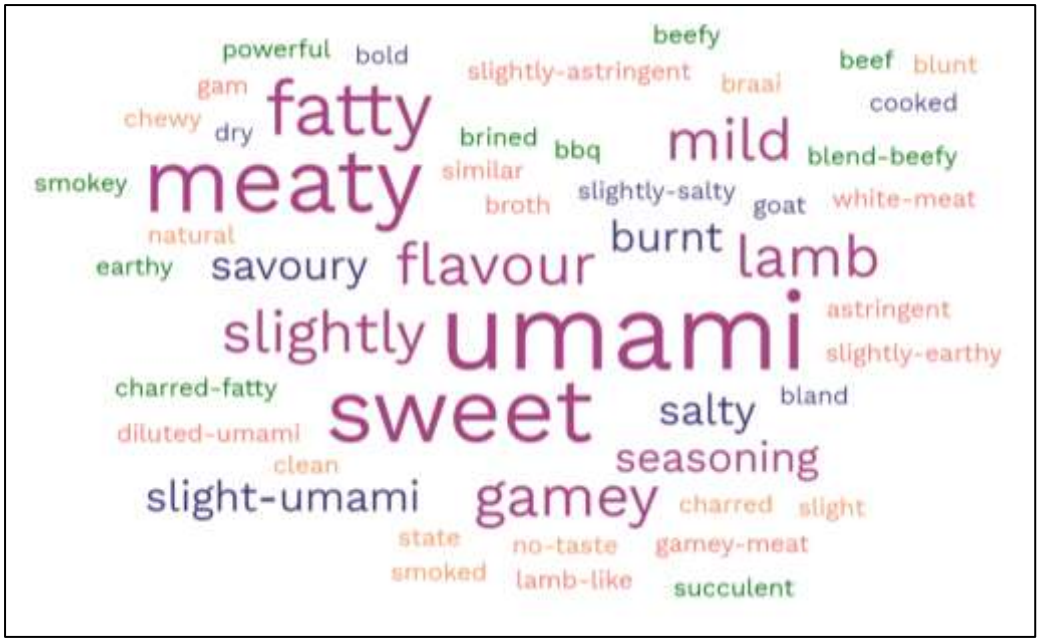


Figure 5.8: Word cloud generated for the flavour of a goat meat sample prepared using different cooking methods

The panellists associated words such as ‘gamey’, ‘meaty’, ‘umami’ and ‘sweet’ with the samples prepared using different cooking methods. These terms were also used to describe other red meats such as lamb and beef; however, there are noticeable differences depending on the feed and age of the animal (Prache, Schreurs and Guillier 2021: 4).

The words used by assessors to describe the texture of the goat meat samples are represented in Figure 5.9.

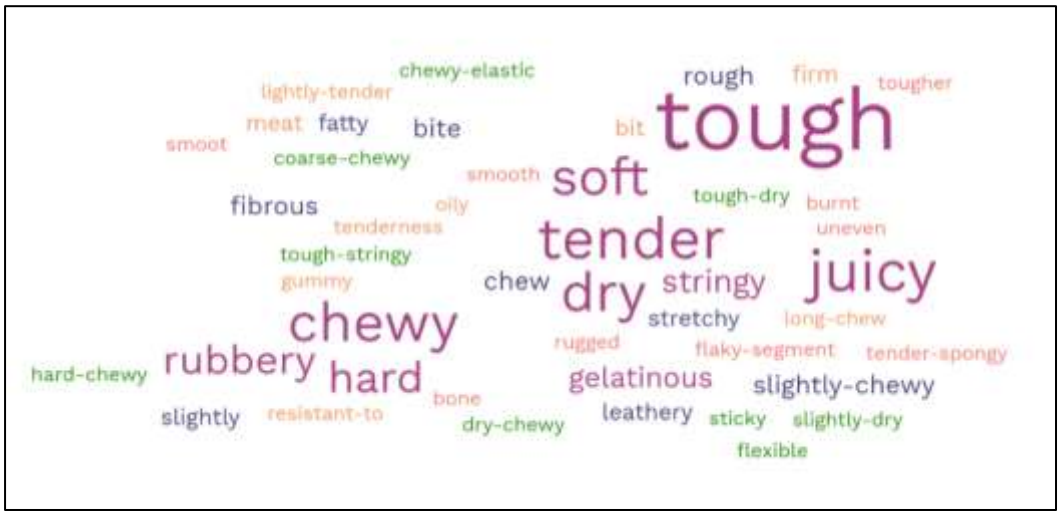


Figure 5.9: Word cloud generated for the texture of goat meat samples prepared using different cooking methods

Texture of meat can be influenced by various factors including the animal's age, species, slaughtering processes, and cooking methods (time and temperature). The degree of cooking varied with the cut of samples that were cooked to different temperatures to achieve a broad scope of terms. Texture terms for the different goat meat cuts and cooking methods ranged from tender and juicy to chewy and tough. Tougher cuts of meat like the flank are usually cooked for prolonged periods using moist heat cooking methods like sous vide and boiling (Ruiz-Carrascal *et al.* 2019: 1 and Brown 2011: 100).

5.7.2.2 Pre-test lexicon

Results of the pre-test were intended to inform the facilitator of the appropriateness of the words generated during the brainstorming/ attribute generation session. The words included in the final lexicon were able to capture the full range of descriptors for each of the sensory attributes as shown in Figure 5.10 to Figure 5.15. The visual appearance of the samples was within the range of colour descriptors (pink-brown, brown-grey) and the presence of fat (marbling) and the degree of colouration due to cooking (caramelisation). The term 'lean' was not representative of either sample; however, during the discussions with the panel, a consensus agreement was reached that the term 'lean' should be included as it encompasses the visual presence of fat, i.e. the opposite of marbling.

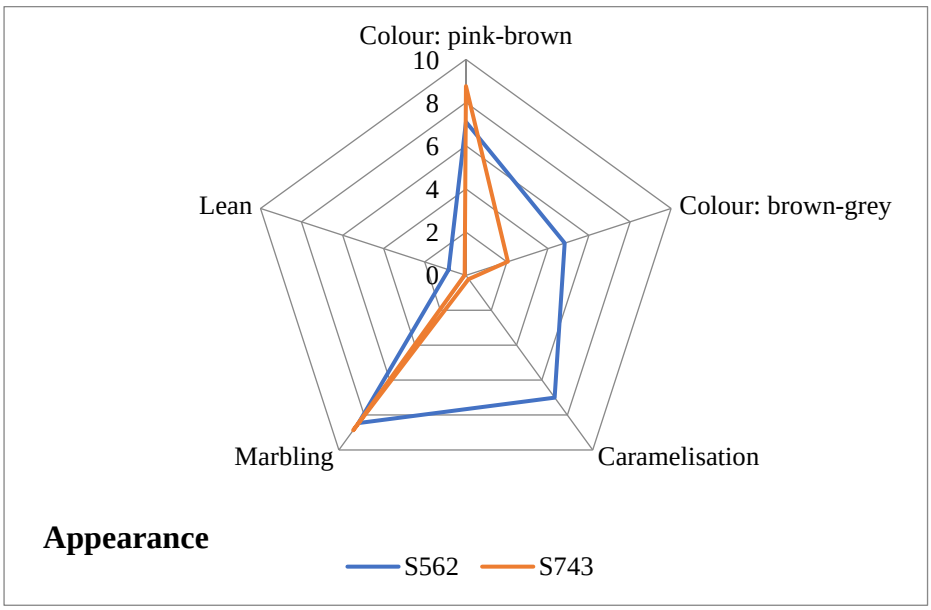


Figure 5.10: Comparison of ratings for the appearance of grilled goat meat (S562) and boiled goat meat (S743) samples

The ratings for the aroma of the two goat meat samples prepared using different cooking methods is shown below in Figure 5.11. The boiled sample was rated as having a distinct 'boiled'aroma, whilst the grilled sample was associated with 'smoky' notes.

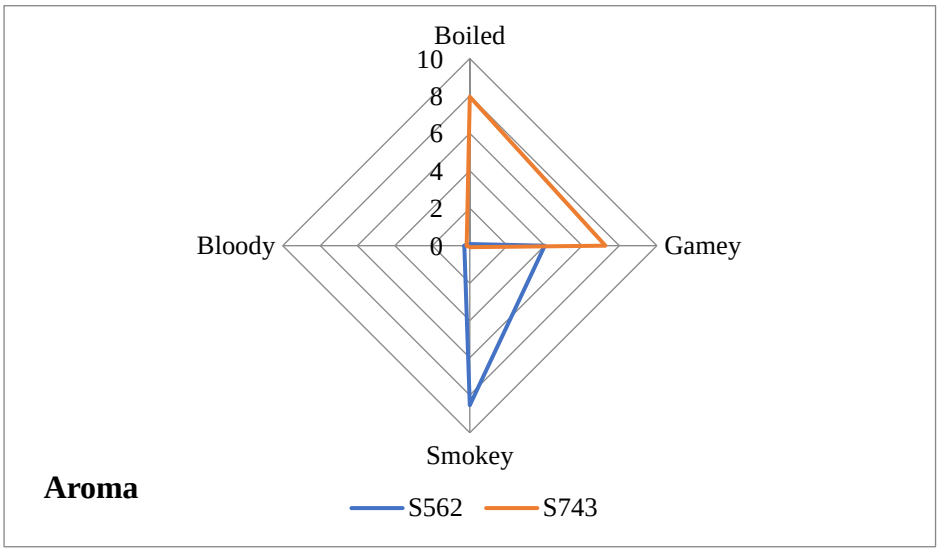


Figure 5.11: Comparison of the ratings for the aroma of grilled goat meat (S562) and boiled goat meat (S743)

The flavour profile of both samples ranged between four terms; with 'meaty' being used to describe the boiled samples and 'charred' for the grilled sample. Cooking methods can alter the flavour of foods and enhance the natural flavour profile of the ingredient being cooked. The grilled sample was rated as displaying a 'charred' flavour which is due to the Maillard reaction, which affects both colour (appearance) and the flavour of food (Liu *et al.* 2020: 382). Grilling is a dry heat cooking method that is a catalyst for caramelization which contributes to the appearance, aroma and flavour profile of the goat meat. Savoury (umami) flavour notes were more prominent in the grilled sample as opposed the boiled sample. Even though the term 'irony' was not detected in both samples the panellists highlighted that depending on the degree of cooking, i.e., rare or medium to well done, the meat would then display flavour profile identified as having iron/metallic notes due to the presence of blood.

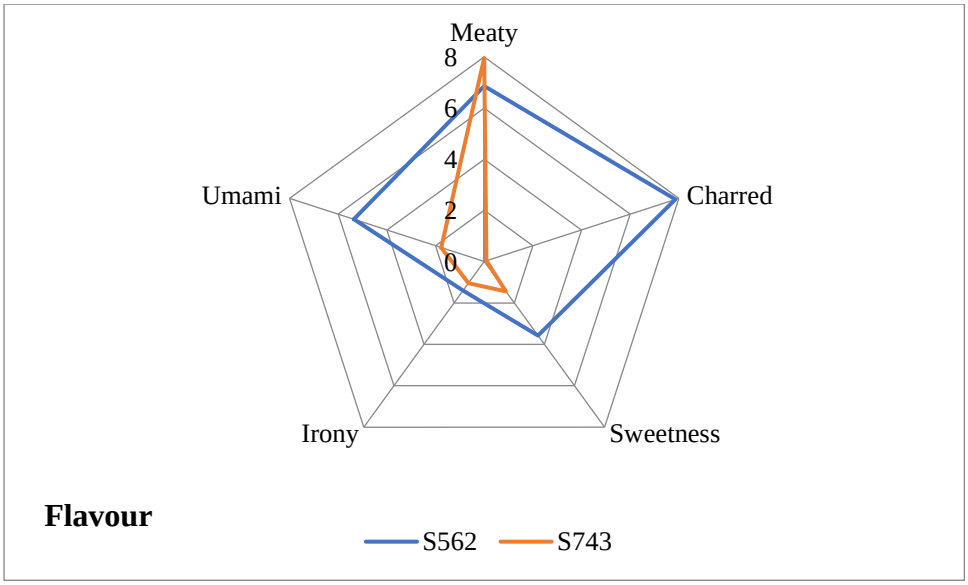


Figure 5.12: Comparison of the ratings for the flavour of grilled goat meat (S562) and boiled goat meat (S743)

Comparing the texture of the grilled and boiled goat meat samples, the sample prepared using the boiling cooking method (moist heat) was juicier and more tender than the grilled sample. Goat meat, especially from older animals (more than 34 weeks of age), is often regarded as tough (fibrous and chewy) thus implying a longer cooking time compared to other ruminants (Borgogno *et al.* 2015: 2; Ngomane 2022: 4).

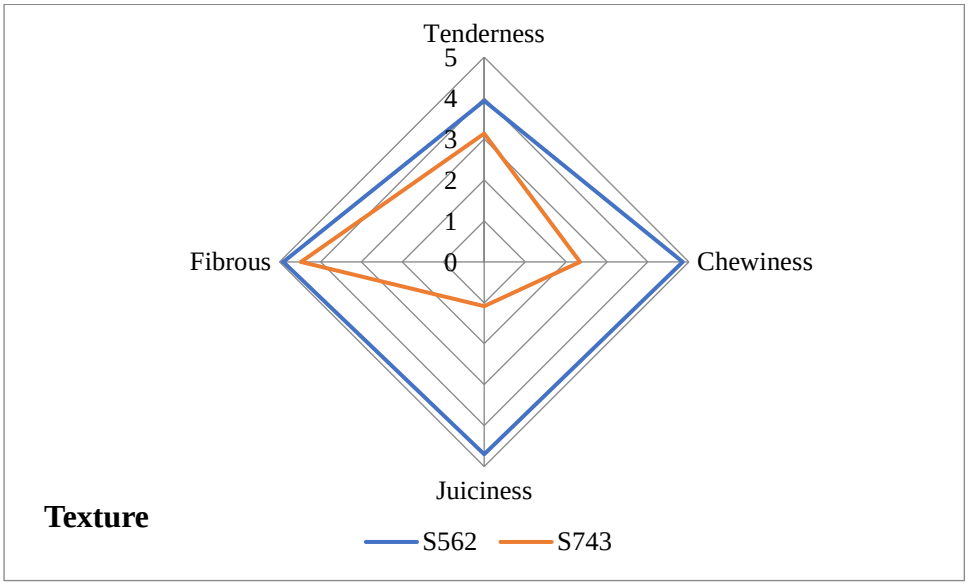


Figure 5.13: Comparison of the ratings for the texture of grilled goat meat (S562) and boiled goat meat (S743)

5.7.2.3 Main test lexicon

Results of the main test provided an indication of whether panel members were able to provide similar ratings for the sample being evaluated. Figure 5.14 shows that assessors chose similar ratings for the aroma of the goat meat samples, with the terms 'boiled' and 'gamey' given a higher rating as opposed to the other descriptors.

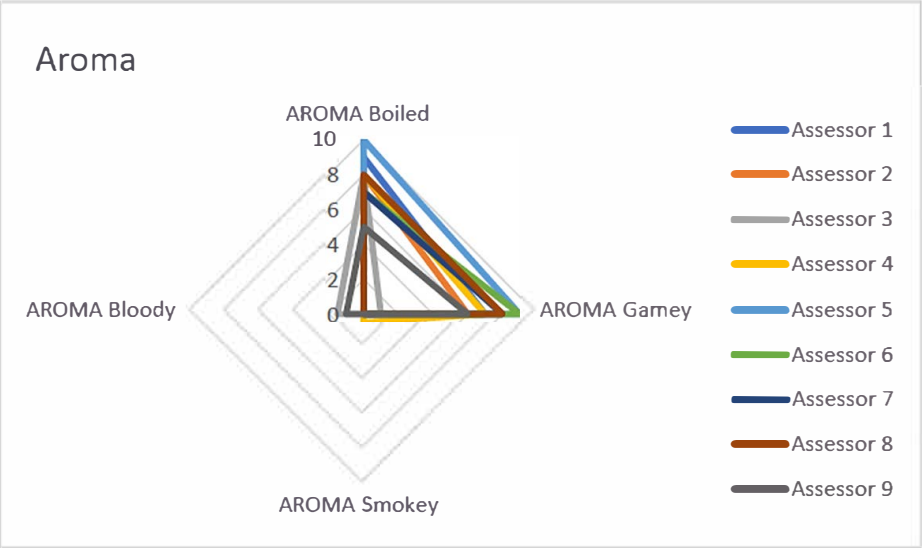


Figure 5.14: Panellists' average ratings for the aroma of goat meat

The appearance attribute was rated as ranging more on the upper end of the scale i.e. 'brown' as opposed to 'pink' and 'lean' for the samples. Assessors also scored similarly for the appearance attribute.

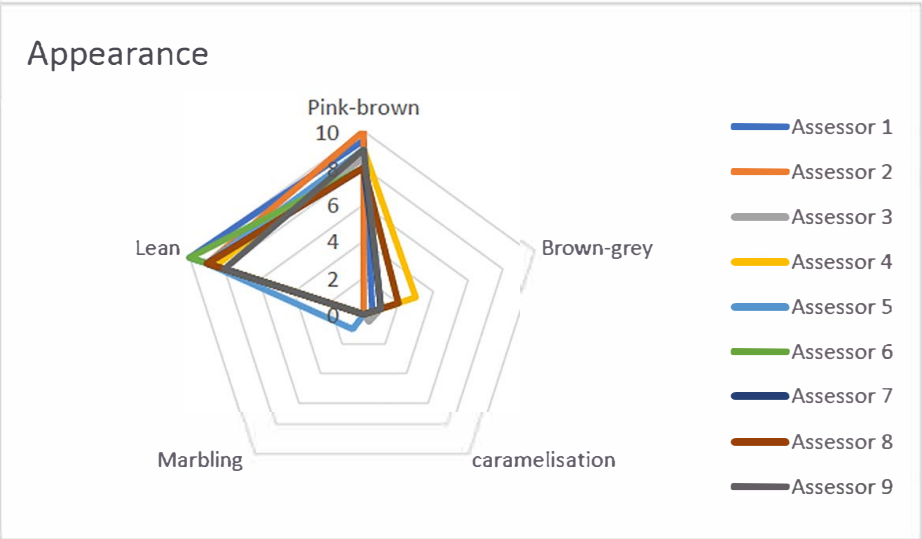


Figure 5.15: Assessors, average ratings for the appearance of goat meat

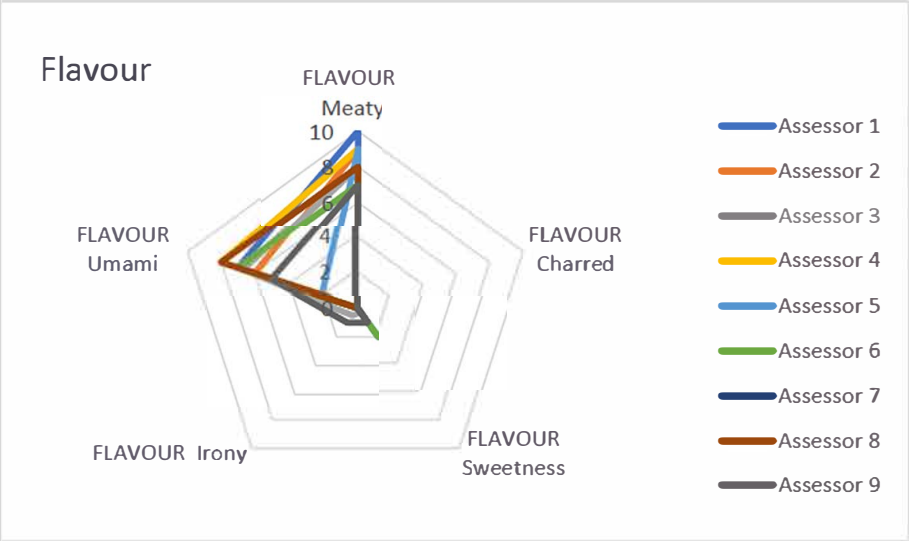


Figure 5.16: Panellists' average ratings for the flavour of goat meat

The flavour terms 'meaty' and 'umami' were scored high for the goat meat samples. Similar ratings were given by all assessors, except for assessor 6, who scored the term 'sweetness' 2 points as opposed to all other assessors who scored sweetness between 0 to 1.5 points on a 10-point line scale.

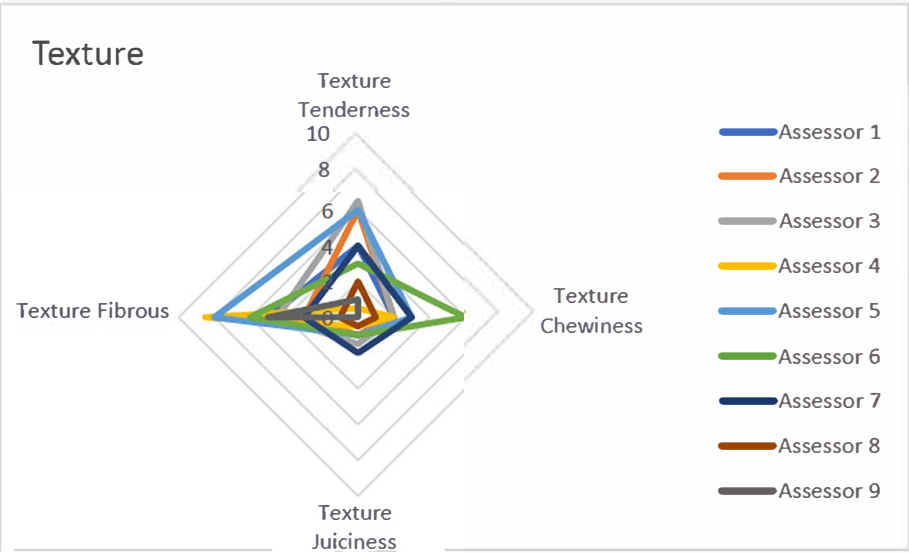


Figure 5.17: Panellists' average ratings for the texture of goat meat

In terms of texture, most of the assessors scored the goat meat as being 'chewy' and 'fibrous'. The grilled sample was rated an average score of between 3 to 6 points for 'tenderness', whilst all assessors scored the goat meat low in terms of 'juiciness'.

5.7.2.4 Final lexicon terms, definitions, and anchors

Through several discussions and the process of elimination through consensus of the panel, the final lexicon terms, definitions, protocols for evaluation and anchors were agreed upon depicted in Table 5.2.

Table 5.2: Goat meat lexicon

Attribute	Term	Definition	Protocol	Anchors on 10cm line scale
Appearance	Pinkish-brown	Varying in colour ranging in hues of pink and brown	Visually look at the sample, turning it to reveal both sides. Take note of variegated colouring and surface appearance	Pink to brown
	Brownish-grey	Varying in colour ranging in hues of brown and grey		Brown to grey
	Caramelised	Dark brown exterior because of caramelisation		None to much
	Marbled	Fat distribution present in the piece of meat		None to much
Aroma	Meaty	Aroma characterised by smell of game animals	Open the glass jar with the sample, place close to your nose and take two short sniffs	None to much
	Boiled	Reminiscent of moist heat preparation typical of the boiling process		None to much
	Gamey	Aroma associated with meat		Nome to much
	Smoky	Distinct aroma associated with grilling using charcoal		None to much
	Earthy	Musky, fresh		None to much
	Bloody	Metallic aroma associated with undercooked meat due to the presence of blood		None to much

Attribute	Term	Definition	Protocol	Rating on a line scale
Flavour	Meaty	Characteristic of animal products	Place the sample in your mouth and chew starting the mastication process to release the flavour of the sample being evaluated. Take note of the initial flavour and whether the flavour intensifies or not as chewing progresses	None to much
	Charred	Associated with dry heat cooking methods such as grilling/braaing which results in the exterior browning		None to much
	Sweet	Natural sweetness of meat		None to much
	Irony	Associated with the presence of blood in meat and its metallic properties		None to much
	Umami	Savoury flavour naturally found in meat, highlighted through the grilling process		None to much
Texture	Tender	Not resistant to bite and minimal chewing required to breakdown the meat	Place the meat sample in your mouth and bite down using your front teeth - take note of the amount of force required to bite into the sample. Proceed to chew the sample, taking note of the number of times the sample needs to be chewed before breaking down. Take note of the residual feel in the mouth after swallowing/ expectorating the sample	Tender to tough
	Tough	Firm, with much resistance and effort required to breakdown meat		
	Chewy	Springy, with some effort required to breakdown the meat		Not at all to much
	Dry	Associated with shorter muscle fibres and a lack of liquid usually due to overcooking		Not at all to much
	Juicy	Associated with optimal cooking times and temperatures that retain natural juices present in the meat		Not at all to much
	Stringy/fibrous	Associated with meat from an older carcass that has lost its water retaining capacity		Not at all to much

Performance by panellists in the main test showed that the panel scored similarly in terms of the average ratings for the four goat meat samples that were evaluated. This shows that the

terms developed in the lexicon are representative of the characteristics of goat meat. However, different cooking methods will influence the sensory properties therefore the lexicon captures the full range of words that can be associated with goat meat.

The developed lexicon for goat meat covers a range of terms for the various sensory attributes. These terms were also identified in other lexicons, indicating that goat meat has similar properties to both beef and lamb/mutton (Hastie *et al.* 2022: 3; Adhikari *et al.* 2011: 417; Maughan *et al.* 2012: 118). The terms are also consumer orientated as is the QDA method which allows assessors to use a language that they prefer and hence, may not be technical, as in the case of the goat meat lexicon developed in this study (Kemp, Hort and Hollowood 2018: 690).

Goat is often referred to as mutton in countries around the world, and this is also indicative of the similarities of these meat species. Even though there are similarities with other meats, goat meat has its own uniqueness. The lexicon therefore serves to provide product developers with the associated terms that can be used to describe goat meat properties, the protocol used to evaluate the sensory attributes and the rating scale used for evaluation.

5.8 Conclusion

Sensory evaluation is an important part of the product development process. Chapter 5 expanded on the sensory training methods used in this study. The persons who completed the full duration of training and met the minimum requirements were trained as panellists who then participated in the descriptive sensory evaluation which was used to develop the goat meat lexicon. The goat meat lexicon serves as a tool to aid product developers in understanding the sensory attributes of goat meat to formulate consumer acceptable goat meat products.

CHAPTER SIX: CONSUMER ACCEPTANCE OF GOAT MEAT BURGER PATTIES AND SAUSAGES

6.1 Introduction

Sensory evaluation is an important aspect of the product development process. Consumer acceptance sensory evaluation involves acceptance tests. It is typically conducted with a large group of participants due to the varying nature of human perception (Gengler 2009: 7). Key to this method of testing is to ensure that the sensory panel comprises of individuals for whom the product is intended. This chapter documents the process involved in the administration of the consumer acceptance sensory tests, the results and the discussion, which is interlinked with the literature.

6.2 Methodology

6.2.1 Eligibility criteria

The eligibility criteria listed below were applied to all potential participants for recruitment.

- All students registered from all levels of study from the University of Zululand and Durban University of Technology during the 2021-2022 academic year.
- Students between the ages of 18 and 30 years.
- Students must be willing to taste different meats (beef, goat and mutton).
- Students without food-related allergies/ intolerances.

6.2.2. Recruitment of participants

Consumer acceptance sensory evaluation participants were recruited by means of a survey link which was shared with students in the Department of Consumer Sciences at both universities. The information and consent form were embedded in the survey and a series of questions including participants' suitability based on the eligibility criteria were included. Potential participants were required to indicate a convenient time slot during which they would be able to complete the evaluation (Consumer acceptance sensory evaluation Microsoft™ form link: https://forms.office.com/r/KD9ivyUa2q). All participants were sent an email indicating whether they met the requirements for the consumer acceptance sensory evaluation and those that qualified, were given details pertaining to the session.

The participants that met the eligibility criteria and suitability requirements outlined in the survey were informed that participating in the sensory evaluation was voluntary, and that they could withdraw from the study at any time.

6.2.3 Sample preparation of goat sausage and burger patty

The goat meat patties and sausages were cooked according to the detailed methods described under chapter 4, section 4.6.3.

The goat meat sausages and patties were shallow fried until an internal temperature of 72°C was reached and the interior of the patty/sausage was fully cooked. In terms of serving size, the goat meat patties were each cut into six equal wedges and the sausages cut into 3 cm pieces. Each sample was placed in a 200 ml glass jar with a metal lid that was placed in a Bain Marie water bath to maintain a warm serving temperature (Image 6.1). All participants were served the samples warm, at 40ºC (American Meat Science Association 2015: 24).

Image 6.1: Samples placed in Bain Marie water bath

6.2.4 Sensory evaluation environment and serving of samples

The setting for the sensory evaluation sessions were in accordance with ISO 8589:1988. A specific area, one of the lecture venues, which was in reasonable proximity to the preparation area, was selected to conduct the sessions. The room had warm white lighting, air-conditioning set at 21ºC for comfort, and two emergency exit points. Ablution facilities were also available and easily accessible from the room.

All participants involved in the evaluations were seated in comfortable, well-spaced chairs at a table with a privacy shield placed on each table to prevent undue influence among the evaluators. Each session comprised of 25 panellists to ensure the sample integrity was not

compromised and to allow sufficient spacing. A total of 100 panellists completed the sensory evaluation of both products.

Each panellist was given a tray with the samples served in 200 ml glass jars, coded with random 3-digit numbers, a scorecard, potable water and a plain unsalted cracker that served as a palate cleanser in-between tasting (Image 6.2). The instructions were verbally given to participants as well as being included on the score cards. The panellists completed their demographic information and then proceeded to complete a total of five score cards for the two goat meat products (two Check-all-that-apply (sausage and patty) tests, two food action rating scales (sausage and burger) and one paired preference test (Appendix K).

Image 6.2: Sensory evaluation tray for consumer acceptance testing

6.2.5 Consumer acceptance sensory evaluation tests

Consumer acceptance sensory evaluation is a vital part of the product development process. Various sensory evaluation tests can be administered to determine the consumers' attitude, their perception of a product's attributes, and their willingness to purchase. Three tests were used in this study to determine consumers attitude and intent to purchase: check-all-that-apply, a food action rating scale, and a paired preference test. These are discussed in detail below.

6.2.5.1 Check-All-That-Apply (CATA)

The check all that apply (CATA) score card was based on the terms established from the goat meat lexicon, which was developed by a trained sensory panel. The CATA served as a means

of verification that the terms generated for the lexicon were relevant for goat meat products and in this study, for the goat meat patty and sausage. Participants were required to select all the terms that they felt were relevant for the sample being assessed (da Conceição Jorge *et al.* 2015: 124 and Gere *et al.* 2021: 1).

6.2.5.2 Food action rating scale (FACT)

The purpose of using the food action rating scale, which is a category scale, was to determine the participants' intent to consume the goat meat burger patty and sausage in a real-life situation and their attitude towards consuming the product (Professional Development Service for Teachers 2004: 28). This would give direction as to whether the product had potential to be successfully marketed to the intended target population. The scale had seven options ranging from 'I would eat this at every opportunity that I had' to 'I would eat this only if forced to'.

6.2.5.3 Paired preference test

The paired preference test was used to determine which one of the two products were preferred. This may also be an indication of which product may have the better potential of success if commercialised and made available in the retail market.

6.2.6 Data analysis

Data was checked for correctness and completeness prior to statistical analysis. The Statistical Package for Social Sciences (SPSS®) version 28.0 was used for descriptive statistics including means and standard deviations, where applicable. Frequencies are presented 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 of the response options were selected significantly more/less often than the others. The binomial test was used to test whether a significant proportion of participants selected one of a possible two responses. Pearson's chi-square test was used to determine whether the selection of each variable differed significantly across university and age of the participants.

6.2.7 Results and discussion

Table 6.1 provides an overview of the demographic profile of the consumer acceptance participants.

Table 6.1: Demographic profile of the consumer acceptance participants (n=100)

Demographics		DUT (%)	UNIZULU (%)
Gender	Men	17	15
	Women	33	35
Race	African	100	100
	Indian	0	0
	White	0	0
	Coloured	0	0
Age (years)	17-20	22	20
	21-24	28	24
	25-28	0	5
	29>	0	1

The demographic profile depicts that all participants were of African ethnicity with the majority being females (68%) and within the age cohort 17-24 years old (94%).

6.2.7.1 Check-All-That-Apply (CATA)

This score card was based on the lexicon terms determined by the trained sensory panel. The panellists participating in the current study selected the terms that they felt were appropriate for the samples evaluated. The CATA method, which has grown in popularity recently, involves using a simple tick box questionnaire to gather data on customers' sensory assessment of a product (Mello, Almeida and Melo 2019: 599).

Table 6.2: CATA results for goat meat patty and sausage (n=100)

		Attribute	Overall Frequency	UNIZULU Rank	DUT Rank	Overall Rank
GOAT MEAT BURGERS	AROMA	Smoky	82	1	1	1.0
		Boiled	29	2.5	2	2.0
		Gamey	20	2.5	3	3.0
		Bloody	1	4	4	4.0
	APPEARANCE	Brownish-grey	68	1	1	1.0
		Pinkish-brown	25	2	3	2.0
		Caramelised	22	3	2	3.0
		Lean	14	4	4	4.0
		Marbled	3	5	5	5.0
	FLAVOUR	Meaty	92	1	1	1.0
		Charred	13	2	3	2.5
		Umami	13	4	2	2.5
		Sweet	8	3	4	4.0
		Iron	4	5	5	5.0
	TEXTURE	Tender	59	1	1	1.0
		Chewy	44	2	2	2.0
		Juicy	34	3	3	3.0
		Dry	14	4	4	4.0
		Fibrous	2	5	5	5.0
		Tough	0	6	6	6.0
GOAT MEAT SAUSAGE	AROMA	Smoky	55	2	1	1.0
		Boiled	42	1	2	2.0
		Gamey	24	3	3	3.0
		Bloody	2	4	4	4.0
	APPEARANCE	Brownish-grey	80	1	1	1.0
		Pinkish-brown	16	3	2	2.0
		Caramelised	11	4	3	3.0
		Lean	9	2	4	4.0
		Marbled	2	5	5	5.0
	FLAVOUR	Meaty	86	1	1	1.0
		Umami	17	3	2	2.0
		Sweet	12	2	4	3.0
		Charred	11	4	3	4.0
		Iron	2	5	2	5.0
	TEXTURE	Chewy	51	1	2	1.0
		Tender	45	3	1	2.0
		Dry	35	2	3.5	3.0
		Juicy	21	5	3.5	4.0
		Tough	12	4	5.5	5.0
		Fibrous	7	6	6	6.0

Ranking is based on the frequency that the terms were selected, i.e rank one refers to majority of the panellists selecting that term

Results for the CATA test revealed the most frequently selected attribute denoted by ranking as being 'smoky' for aroma (82%), 'brownish-grey' for appearance (68%), 'meaty' for flavour (92%), and 'tender' for texture (59%) (Table 6.2).

Figures 6.1 to 6.8 illustrate the ranking for the attributes through radar plots. Table 6.2 shows a summary for both universities and the radar plots show the differences between the universities.

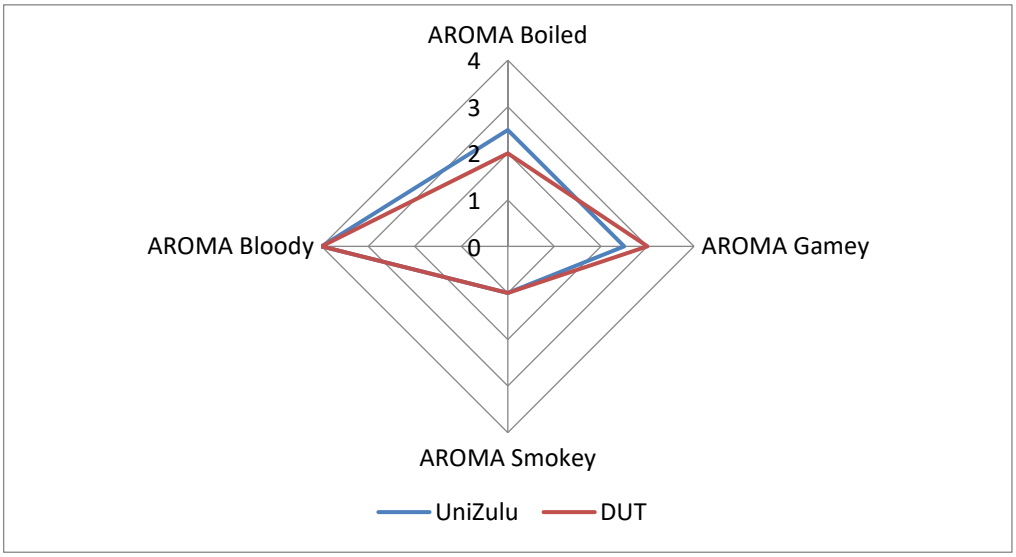


Figure 6.1: Radar plot for the goat meat burger CATA test depicting university and the aroma attribute

In order of ranking based on most frequently selected, the participants selected 'smoky', 'boiled', 'gamey' and 'bloody' as being representative of the aroma of the goat burger sample. More students from UNIZULU identified the aroma as being 'boiled', whilst more students from DUT associated the aroma as being 'smoky'.

The radar plot for words used to describe the appearance of the goat meat burger are shown in Figure 6.2

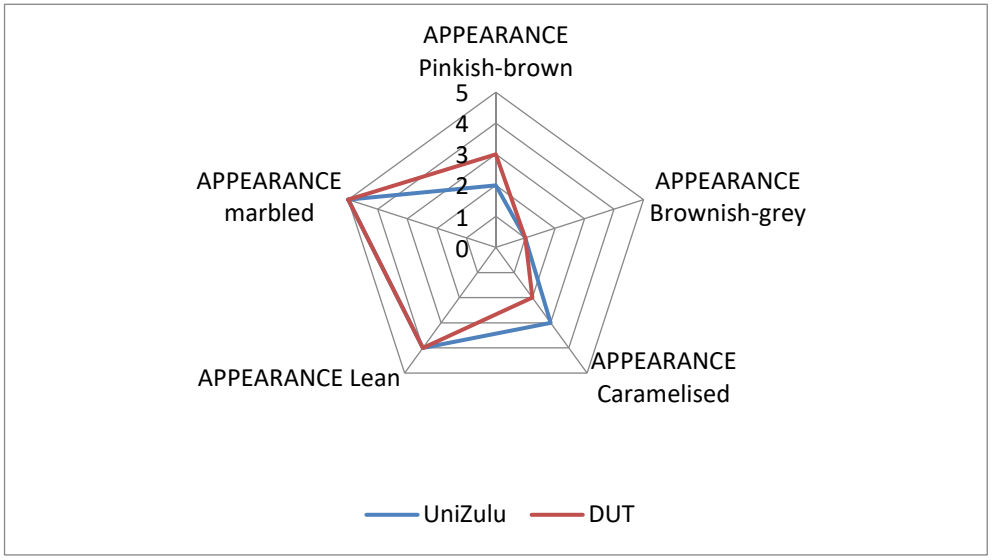


Figure 6.2: Radar plot for the CATA test for the goat meat burger depicting university and the appearance attribute

The appearance of the goat meat burger, as selected by the participants, was more 'brownish-grey' (68%), with very few participants selecting 'marbled' (3%), which was ranked fifth, to describe the appearance of the sample.

The terms that each university associated the flavour of the burger with are represented in Figure 6.3.

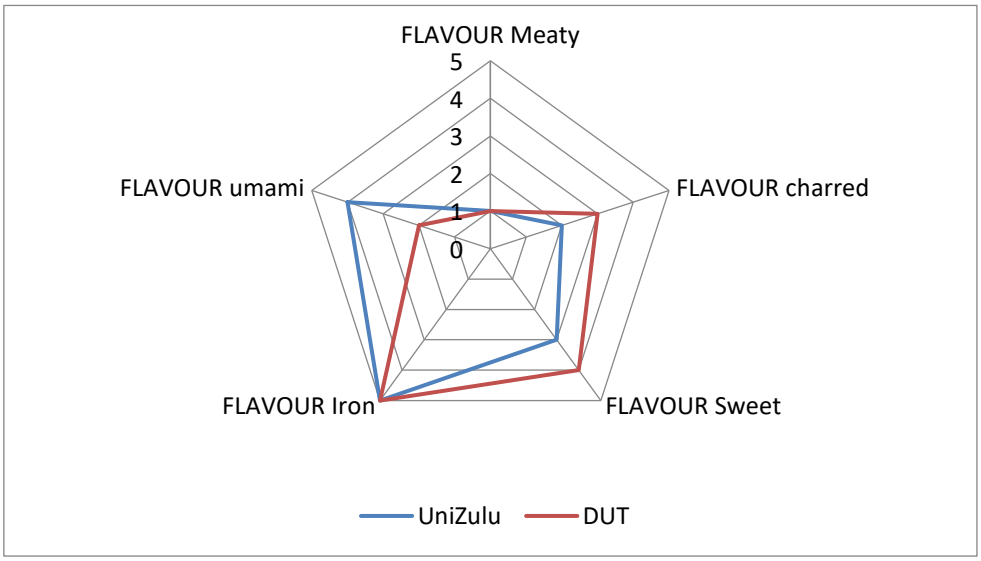


Figure 6.3: Radar plot for CATA test for the goat meat burger depicting university and the flavour attribute

Comparing across institutions, a significant number of students from DUT selected the word 'umami' for the flavour (p=.037) of the goat meat sausage. The flavour 'meaty' ranked first

in terms of the frequency of selection by both UNIZULU (n=48) and DUT (n=44) participants.

The texture attribute terms as selected by students from both universities are represented in Figure 6.4.

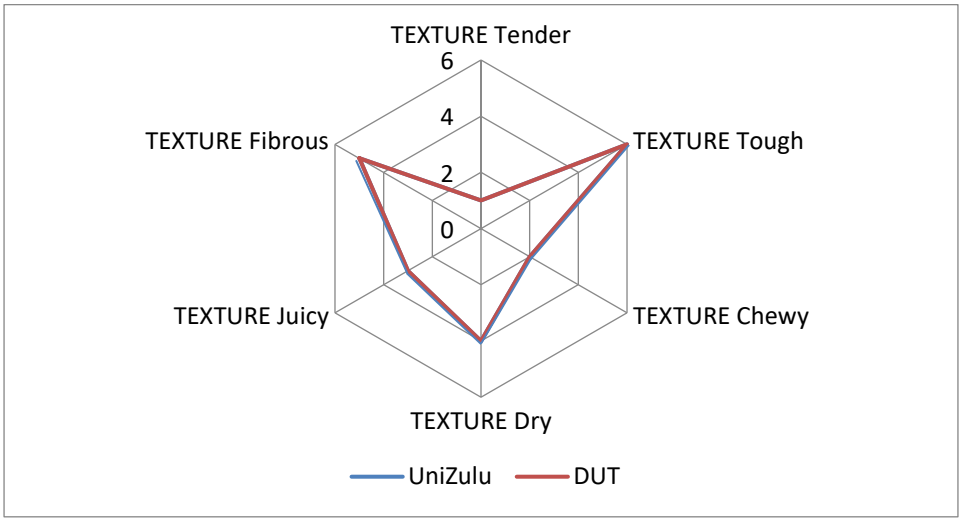


Figure 6.4: Radar plot for CATA test for the goat meat burger depicting university and the texture attribute

Results for the texture of the goat meat burger were the same across both universities. Students from both universities selected the word 'tender' to describe the texture attribute and 'chewy' was selected as the next most frequently chosen descriptor.

The words used to describe the aroma of the goat meat sausage are shown in Figure 6.5.

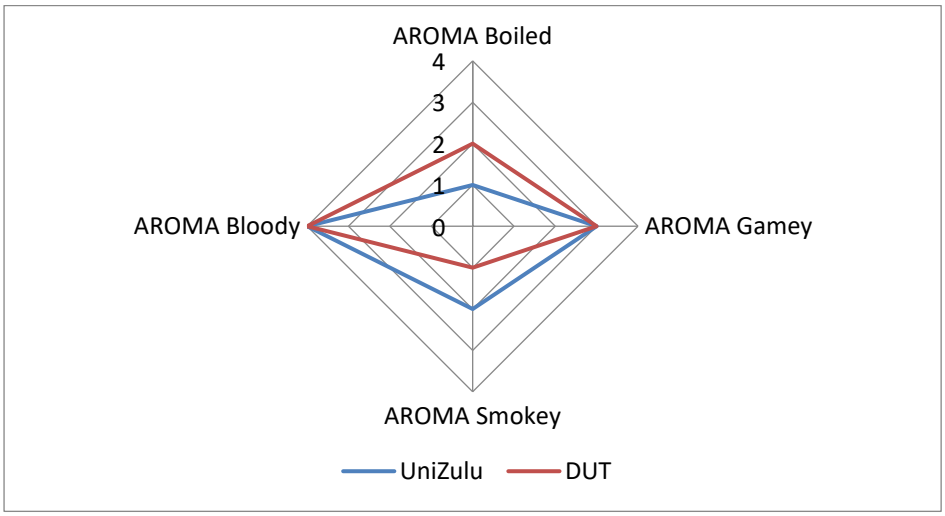


Figure 6.5: Radar plot for CATA test for the goat meat sausage depicting university and the aroma attribute

Comparing across institutions, a significant number of students from UNIZULU selected the word ‘boiled’ for the aroma of the goat meat sausages (p=.015) whilst a significant number of students from DUT selected ‘smoky’ for the aroma (p=.003). The words ‘boiled’ and ‘smoky’ were also the most frequently selected descriptors at DUT and UNIZULU respectively.

The terms associated with the appearance of the goat meat sausages as selected by students from both universities is shown in Figure 6.6.

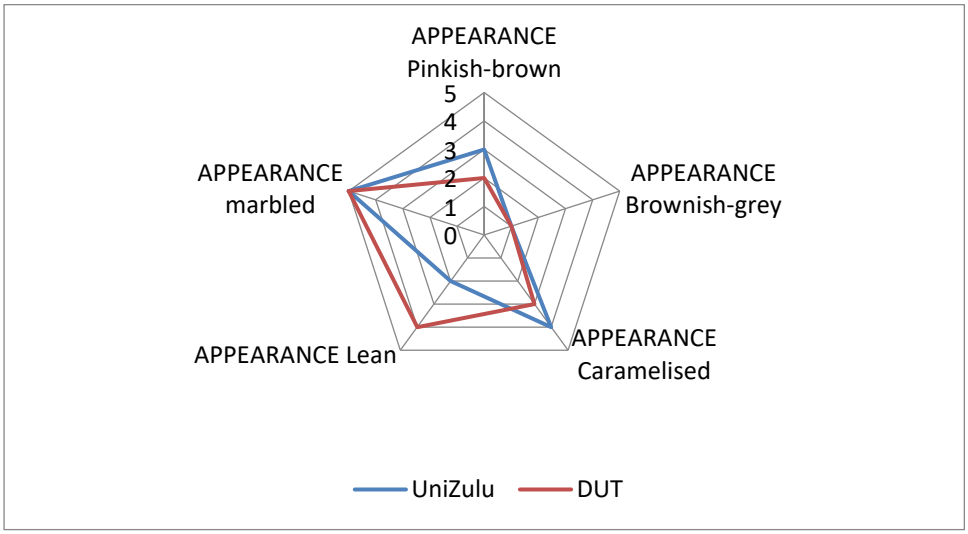


Figure 6.6: Radar plot for CATA test for the goat meat sausage depicting university and the appearance attribute

The majority of participants from both universities identified the appearance of the goat meat sausage as ‘brownish-grey’. Comparing across universities, a significant number from DUT selected the word ‘pinkish-brown’ (p=.029), whilst a significant number from UNIZULU selected ‘brownish-grey’ (p<.001).

Terms used to describe the flavour of the goat meat sausages by students from both universities are represented in figure 6.7.

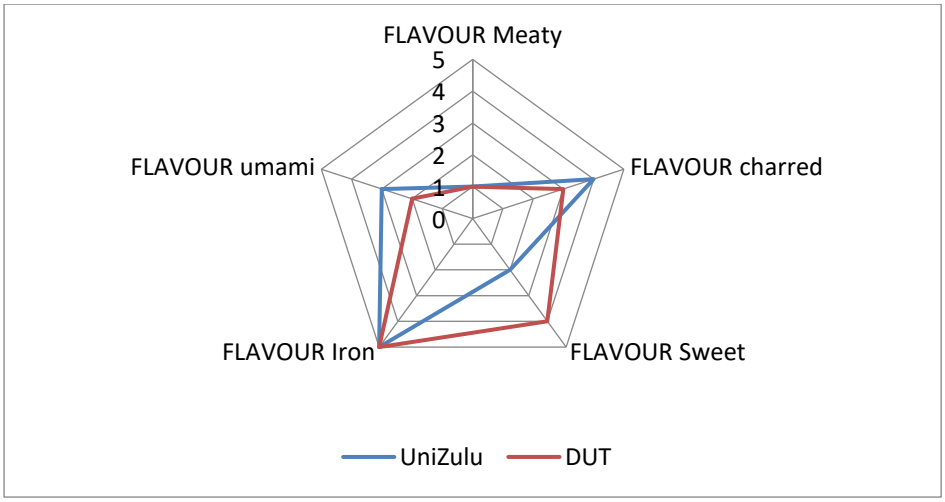


Figure 6.7: Radar plot for CATA test for the goat meat sausage depicting university and the flavour attribute

Most participants from both universities selected 'meaty' as the descriptive word for the flavour of the goat meat sausages, ranking this attribute in first place in terms of frequency (86%). However, a noticeable difference was identified for the flavour 'sweet', with more students from UNIZULU identifying the sample with some degree of sweetness as opposed to those from DUT.

Figure 6.8 shows the ranking of the terms used to describe the texture attribute for the goat meat sausage.

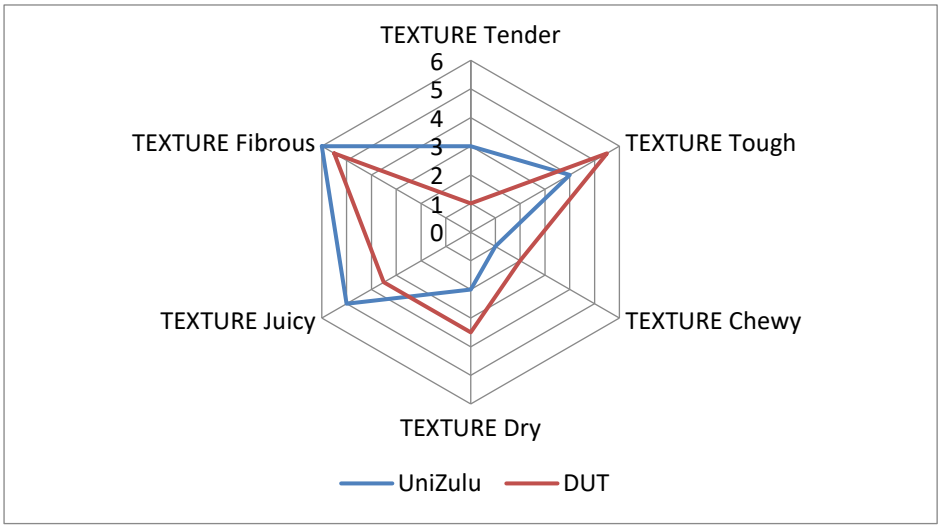


Figure 6.8: Radar plot for CATA test for the goat meat sausage depicting university and the texture attribute.

Comparing across universities, a significant number of participants from DUT selected the descriptors ‘tender’ (p=.009) and ‘juicy’ (p=.012). Most participants from DUT used the descriptor ‘tender’ to describe the texture of the goat meat sausage as opposed to participants from UNIZULU, where the majority chose ‘chewy’ to describe the texture.

Figures 6.9 to 6.12 shows a comparison of the two goat meat products for the specific attributes. Slight differences were noted for the aroma, with more participants selecting the word ‘smokey’ to describe the aroma of the patty (n=82), whilst the aroma of the sausage was described as ‘smokey’ (n=55), and ‘boiled’ (n=42).

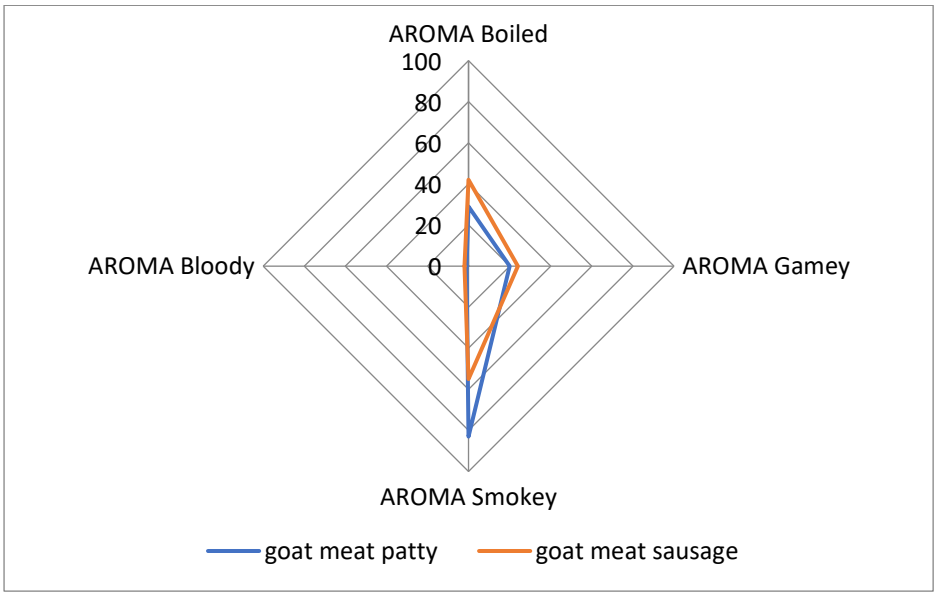


Figure 6.9: Radar plot for CATA test comparing the aroma attribute for goat meat patty and goat meat sausages.

Figure 6.10 shows the descriptors used for the appearance of the goat meat patty and sausage. The descriptor ‘brownish- grey’ was used to describe both the patty (n=68) and the sausage (n=80).

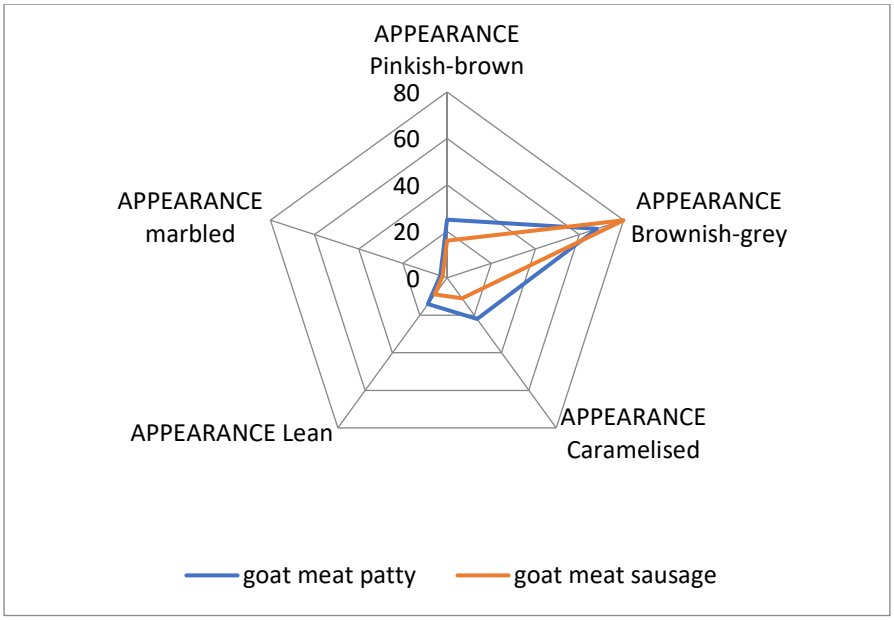


Figure 6.10: Radar plot for CATA test comparing the appearance attribute for goat meat patty and goat meat sausages.

The descriptor 'meaty' was used to describe both products for the flavour attribute depicted in figure 6.11 (n=92, and n=86 for the patty and sausage, respectively).

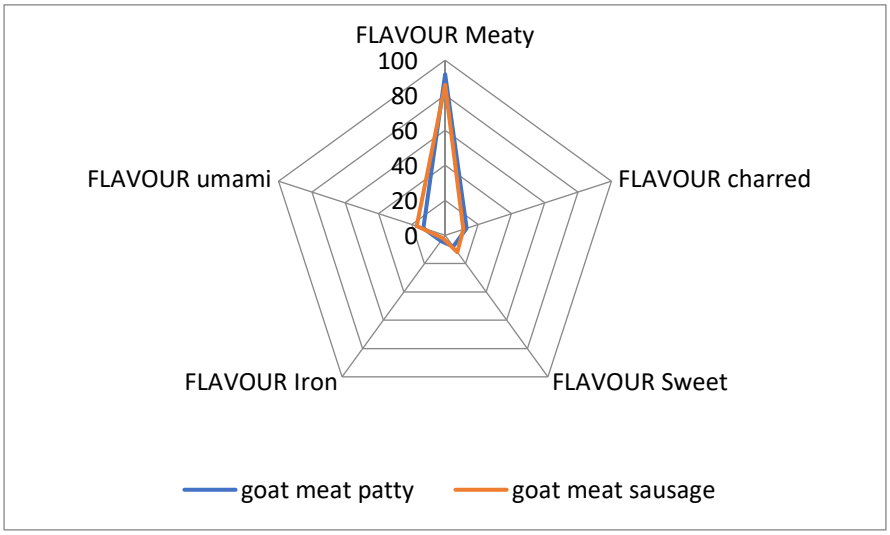


Figure 6.11: Radar plot for CATA test comparing the flavour attribute for goat meat patty and goat meat sausages.

The radar plot in figure 6.12 shows that the texture of the patty was regarded as 'tender' by most participants (n=59) followed by 'chewy' (n=44). Most participants selected the descriptor 'chewy' for the sausage (n=51), followed by 'tender', (n=45).

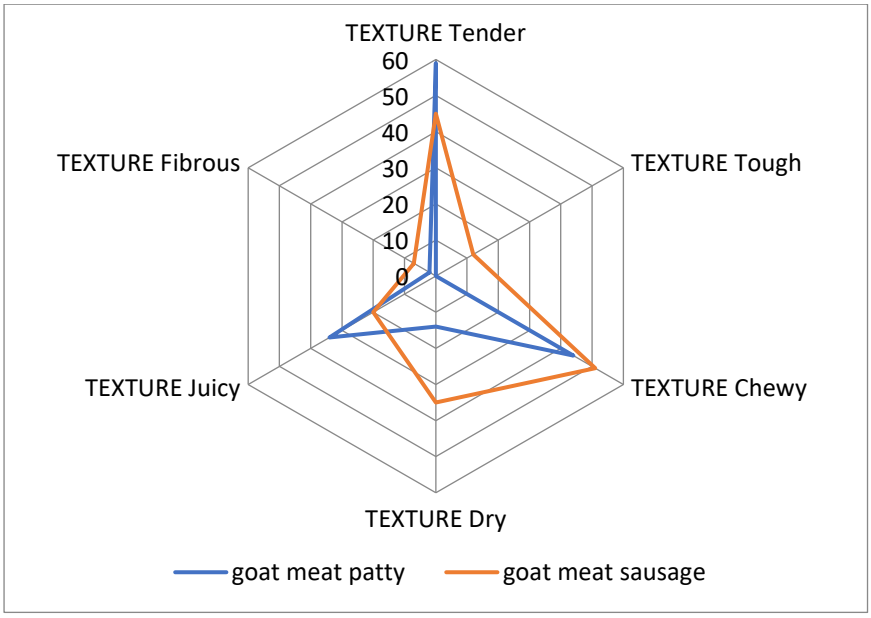


Figure 6.12: Radar plot for CATA test comparing the texture attribute for goat meat patty and goat meat sausages.

6.2.7.2 Food action rating scale

The food action rating scale is a category scale that was used to determine participants' willingness to eat the two developed goat meat products. The majority of the participants from both universities showed a positive attitude regarding whether they were willing to eat the goat meat burger (78%) and sausage (68%). Fewer participants from both universities were seemingly undecided in terms of their attitude to repeat consumption of the burger (18%) and sausage (20%), whilst a marginal percentage indicated a negative attitude towards the goat meat patty (4%) and sausage (12%).

Table 6.3: Food action rating scale responses stratified by university (n=100)

	Food action response	GOAT MEAT BURGER			GOAT MEAT SAUSAGE		
		UNIZULU %	DUT %	COMBINED %	UNIZULU %	DUT %	COMBINED %
Positive attitude	I would eat this at every opportunity that I had	28	20	24	28	20	24
	I would eat this very often	12	28	20	18	26	22
	I like this and would eat it now and then	40	28	34	16	28	22
	Total for positive attitude	80	68	78	62	74	68
Undecided	I would eat this if available but would not go out of my way to do so	16	20	18	20	20	20
	Total for undecided	16	20	18	20	20	20
Negative attitude	I don't like this but would eat it on occasion	2	2	2	12	2	7
	I would hardly ever eat this	2	2	2	6	2	4
	I would eat this only if forced to	0	0	0	0	2	1
	Total for negative attitude	4	4	4	18	5	12

Table 6.4: Chi-square goodness-of-fit test across universities and product for the food action rating scale (n=100)

Product	University	Responses as frequency (%)							X^2	df	p-value
		I would eat this at every opportunity that I had	I would eat this very often	I like this and would eat it now and then	I would eat this if available but would not go out of my way to do so	I don't like this but would eat it on occasion	I would hardly ever eat this	I would eat this only if forced to do so			
Goat meat burgers	UNIZULU	28	12	40	16	2	2	0	33.760	5	<.000
	DUT	20	28	28	20	2	2	0	21.280	5	.001
	COMBINED	24	20	34	18	2	2	0	47.840	5	.000
Goat meat sausages	UNIZULU	28	18	16	20	12	6	0	8.320	5	.139
	DUT	20	26	28	20	2	2	2	29.520	6	<.000
	COMBINED	24	22	22	20	7	4	1	40.700	6	.000

6.2.7.3 Paired preference

Upon completion of the CATA test and food action rating scale, students were then required to select the sample that they preferred. This was a forced choice, meaning they had to select one or the other. The paired preference test provides key information as to which product may have the potential of being successful if commercialised.

Table 6.5: Preferred goat meat product (n=100)

University	Frequency		%	p-value
	Goat meat burger n=50	**Goat meat sausages n=50**		
UNIZULU	43	7	100	.002
DUT	23	27	100	.001
Combined	66	34	100	.002

When exploring the relationship between choice of sample and institution, it was found that a significant number of participants from UNIZULU selected the goat meat burger (p=.002), while a significant number of respondents from DUT selected the goat meat sausage, p<.001.

6.2.8 Discussion

a) Sensory attributes of goat meat sausages and burgers as perceived by consumers

Whilst trained panels are necessary for product refinement, consumer panels are also important for informing product developers about their perceptions and preferences (Teixeira *et al.* 2020: 11). Overall, consumer feedback from the evaluation of the goat meat sausage and burger 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 an important role in sensory acceptability as it is one of the first attributes that a consumer encounters, even without the intention 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 important dimensions influencing food choice (Cunha *et al.* 2018: 32).

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 this cooking method 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 (Starowicz and Zieliński 2019: 708). This influence was evident in the goat meat sausage and burger, whereby consumers were able to associate the terms 'smoky' (aroma) and 'brownish-grey' (colour) with both products 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 both the sausage and burger. Grilling, or braaing/barbequeing 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 those previously mentioned.

Uncooked/raw meat is slightly flavoured, but the heat treatment of meat provides a non-species-specific 'meaty flavour', whilst heating up meat that contains fat develops a flavour more specific to the species it is sourced from (Ripoll *et al.* 2019: 1261). Meaty flavour is composed of thousands of volatile compounds; however, only a few contribute to the characteristic odour and flavour of meat (Shahidi 1998: 27).

The flavour terms that were frequently selected to describe the goat sausage and burger 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 (Proserpio *et al.* 2017: 36).

The formulation for both the burger and sausage contained rusk, with was used to improve the moisture retention and allow for a juicy sausage as the butchers' rusk (cereal flakes) absorbs the freely available moisture which remains in the product during cooking (Ranken 2000:137). Goat meat is generally associated with being tough or chewy (Mowa 2018: 19; Ngomane, Tsvakirai and Mlambo 2022: 4) but in this study, due to the mincing process, which is mechanically tenderising the meat, the texture of both the products was frequently selected as 'tender' with only some consumers selecting 'chewy' as being more descriptive of the texture (Shi *et al.* 2021: 12). 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 (Shi *et al.* 2021: 13). By mincing the meat to make the two products, the overall texture of the products was made more desirable to most of the consumers. In terms of the sausage texture, a significant number from DUT selected the word 'tender' for texture (p=.009) and 'juicy' (p=.012) to describe the texture.

b) Willingness to purchase the developed goat meat products

Whilst 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 (Ngomane, Tsvakirai and Mlambo 2022: 5). 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 either undecided (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 goat meat sausages were perceived by consumers to be harder, more fibrous, and less juicy than sheep meat sausages. Despite the different consumer perceptions, there was no preference for one sausage over the other, indicating goat meat sausages have market potential (Paulos *et al.* 2015: 1572).

This is also the case in the current study, whereby both products developed using goat meat show potential for acceptance in a retail setting. Even though more preference was given to goat meat burgers, the goat meat sausages were not entirely disliked, but rather, certain sensory characteristics were not found to be as favourable compared to the goat meat burgers. Whilst most of the participants from the rurally located university 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 largely 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 (Boesveldt *et al.* 2018: 82).

6.2.9 Conclusion

The check-all-that apply test, food action rating scale and paired preference test provided insight into which sensory descriptors participants perceived to be representative of each product, their intent/willingness to purchase the developed products, as well as the final selection of the product they preferred. Through this consumer sensory evaluation valuable information that could influence the product development cycle can be used to improve the success rate of the products if they were to be commercialised in the South African context.

CHAPTER SEVEN:
RECOMMENDATIONS AND CONCLUSION

7.1 Introduction

This chapter serves to provide the findings of the study, the significance and its limitations and strengths. In addition, recommendations for further research are suggested.

7.2 Summary of findings

a) *Objective one: To determine the meat consumption pattern and preferences of young adults*

The meat consumption and preferences of university adults was determined through an online survey. Key findings showed that chicken was the most popular and frequently consumed meat choice. Participants selected sausage, burger patties and polony as their preferred processed meat products. In terms of goat meat consumption, it was reported that the main reason for consuming goat meat was due to cultural and religious practices and not due to the several health and sustainability benefits that goat meat offers. Chapter 3 highlights that there is potential for goat meat product development and acceptance by young adults.

b) *Objective two: To develop two processed goat meat products*

Objective one prompted the development of a goat meat sausage and burger patty which met the requirements of objective two. In the development process various trials were conducted to develop suitable formulations for both products. After each trial, internal sensory evaluation was conducted, the results of which indicated the changes that needed to be made. Both the goat meat sausage and burger patty formulations were acceptable. The final formulations are documented in chapter 4.

a) *Objective three: Analyse the microbial and nutrient content and conduct shelf-life testing on the goat meat products*

In keeping with food safety regulations, both products were subjected to microbial testing. Nutrient testing and organoleptic shelf-life testing was also conducted. The goat meat patty and sausage were reported to have acceptable microbial results and nutrient testing showed that both products were high in protein and low in fat and cholesterol. The analysis for all testing conducted is reported in chapter 4.

b) Objective four: To create a lexicon for goat meat

Sensory evaluation training through a series of training sessions was completed by university students. The students that met the requirements for the trained panel then proceeded to the phase on lexicon development for goat meat. The goat meat lexicon was developed through a series of discussions and the process of elimination of terms. Once developed, the terms identified in the lexicon were verified in a CATA questionnaire.

c) Objective five: To determine the consumer acceptability of the developed chevon meat products

The developed products were then subjected to consumer testing by students from DUT and UNIZULU. Participants evaluated the products using a food action rating scale, CATA questionnaire (based on the developed lexicon) and a paired preference test to determine the preferred product. Overall, both products received favourable results. However, the goat meat burger was the product preferred by students from both universities, indicating the potential of this product to be successful in the retail market.

7.3 Limitations

The target audience selected was young adults due to this age cohort being more willing to be experimental, or adventurous with food options. It is perceived that young adults are also keen on driving the sustainability agenda which is pivotal to meeting the sustainable development goals set by the United Nations. Although the study was conducted in a specific province in South Africa, the demographic profile and food environment is not representative of the rest of the country. However, the demographic profile is typical of the emerging consumer. Results from the study cannot be generalised to the rest of South Africa as consumption and preferences may differ, however it can be used as a point of reference for future studies.

The development process was also a challenge, as the sourcing of goat meat due to limited suppliers posed delays in conducting product development trials. A goat meat lexicon had to be developed as there were no processed goat meat products to benchmark against the products that were developed in this study. The goat meat lexicon was developed using one breed of goat and factors such as age and sex were not components of the lexicon. The sensory evaluation training and especially the odour tests required specific chemicals which are not easily available in South Africa and had to be ordered from other countries.

7.4 Strengths

- A comprehensive sensory training manual specifically developed for this study but which can be used by other researchers interested in training a sensory panel was developed.
- The study chose a target population (young adults) consisting of emerging consumers that are of interest to marketers and product developers alike.
- Burger patties and sausages are readily available in retail stores. By selecting products that are familiar to the intended target population it was anticipated that acceptance of the goat meat versions of these products would be more likely.

7.5 Recommendations

- Further studies on the awareness of goat meat and value-added products as a sustainable food source needs to be done.
- The accessibility and availability of goat meat in the retail environment needs to be promoted to improve consumption and gain consumer interest.
- Studies exploring the different breeds of goat and their distinct sensory attributes need to be investigated to further understand the nature of goat meat and how to improve its properties through product development.
- It is recommended that for upscaling and commercialisation, further batches of the developed products be manufactured at different process times using random sampling methods of each batch produced.
- It is recommended that the developed products undergo further analysis to better explore the chemical and textural composition. This was not included in the scope of this study as the focus was more food and nutrition based as opposed to food sciences.
- The minimum sample size for consumer acceptance is 60 people and the sample size for this study was 100 people; however, consumer acceptance sensory evaluation can be conducted with a larger sample to increase validity.
- Even though the recommended training time for the QDA method was applied for this study, training of the assessors can be conducted over a longer period to increase power of discrimination.

- Further research to test the appropriateness of the developed lexicon among different population groups from various ethnic backgrounds and countries would provide further insight.
- The products have the potential for commercialisation; however, market analysis and feasibility studies would need to be conducted prior to large-scale production.

7.6 Conclusion

Sustainable food sources such as goat meat are overshadowed by more popular meat choices in South Africa. The importance of this study is therefore highlighted in its uniqueness to make goat meat more acceptable by using a lexicon as a tool to direct and inform product development in particular, for the emerging South African consumer. Goat meat can play a role in addressing the food security crisis whilst also being a nutritious food source. A multidimensional approach involving stakeholders in the agricultural sector, researchers, retailers, and marketers is needed to increase goat meat awareness, availability and acceptance.

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Appendix A1: Gatekeeper letter UNIZULU

Dear Chairperson of the University of Zululand Research Ethics Committee – (UZREC),

Re: Gatekeeper permission

Study title: Product development, lexicon creation and sensory acceptability of goat meat products for the emerging consumer.

We kindly request Gatekeeper permission to share an online survey among University of Zululand students as well as conduct consumer acceptance sensory evaluation tasting sessions.

The data collection forms part of a PhD qualification by Mrs K Palmer, who is a registered student at Durban University of Technology, Department of Food and Nutrition Consumers. Consent is therefore requested to conduct research to determine the meat consumption and preferences (online survey) and the consumer acceptability of products developed using goat meat (consumer acceptance testing).

We have attached supporting documentation; proposal, copies of the data collection tool, letter of information and consent forms to be used in the research process and a copy of the approval letter from the DUT Institutional Research Ethics Committee.

If you require any further information, please do not hesitate to contact the Principal Investigator: Karina Palmer 074 645 7004 (PalmerK@unizulu.ac.za). Thank you for your time and consideration in this matter.

Yours sincerely,

Mrs K Palmer, Dr A Naicker (DUT), Prof U Kolanisi (UNIZULU)

Appendix A2: Gatekeeper letter DUT

Dear Chairperson of the Durban University of Technology Research Ethics Committee,

Re: Gatekeeper permission

Study title: Product development, lexicon creation and sensory acceptability of goat meat products for the emerging consumer.

We kindly request Gatekeeper permission to share an online survey among Durban University of Technology students as well as conduct consumer acceptance sensory evaluation tasting sessions.

The data collection forms part of a PhD qualification by Mrs K Palmer, who is a registered student at Durban University of Technology, Department of Food and Nutrition Consumers. Consent is therefore requested to conduct research to determine the meat consumption and preferences (online survey) and the consumer acceptability of products developed using goat meat (consumer acceptance testing).

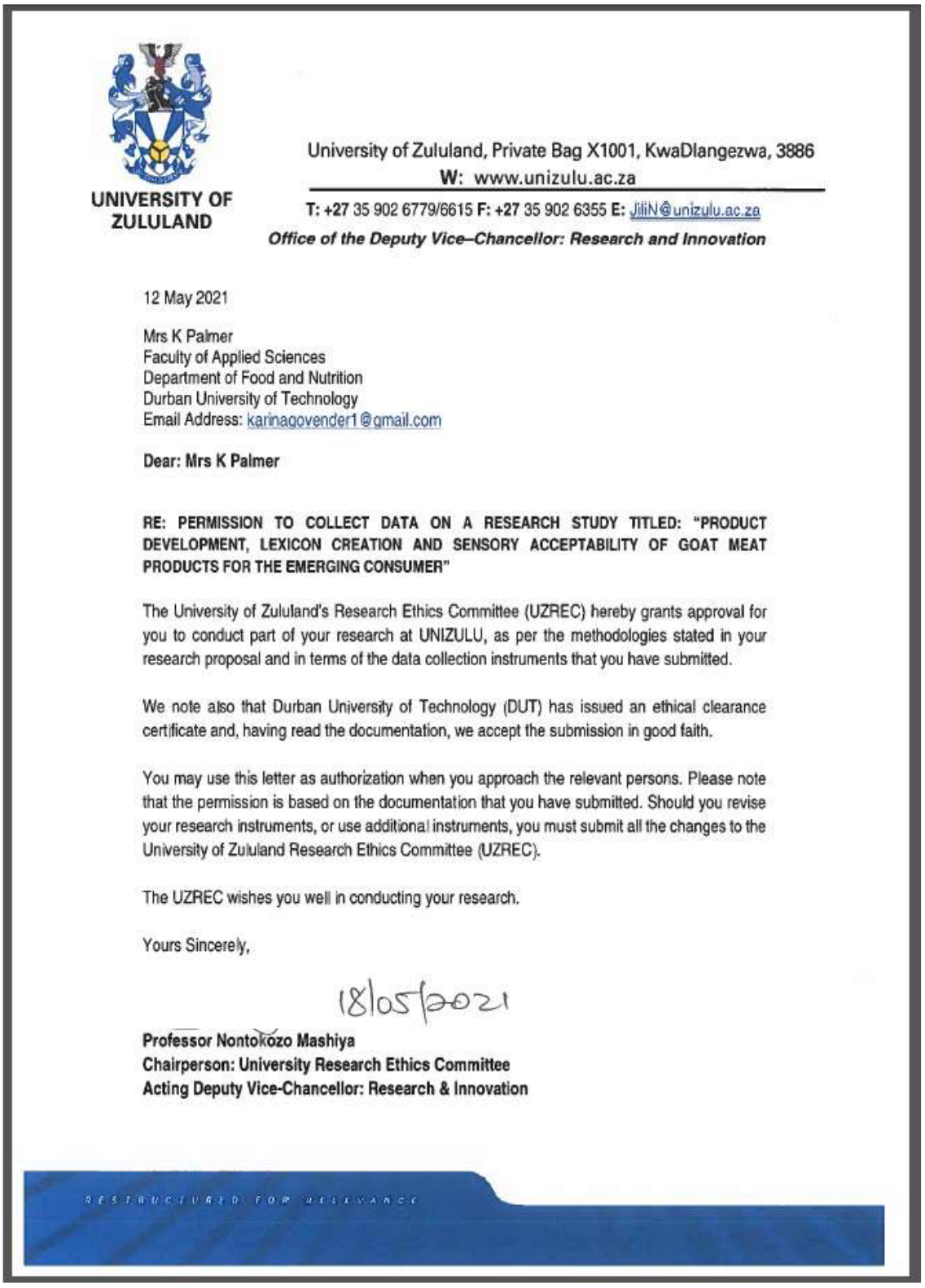
We have attached supporting documentation; proposal, copies of the data collection tool, letter of information and consent forms to be used in the research process and a copy of the approval letter from the DUT Institutional Research Ethics Committee _____

If you require any further information, please do not hesitate to contact the Principal Investigator: Karina Palmer 074 645 7004 (PalmerK@unizulu.ac.za). Thank you for your time and consideration in this matter.

Yours sincerely,

Mrs K Palmer, Dr A Naicker (DUT), Prof U Kolanisi (UNIZULU)

Appendix B1: Permission letter UNIZULU



UNIVERSITY OF ZULULAND

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W: www.unizulu.ac.za
T: +27 35 902 6779/6615 F: +27 35 902 6355 E: JiliN@unizulu.ac.za
Office of the Deputy Vice-Chancellor: Research and Innovation

12 May 2021

Mrs K Palmer
Faculty of Applied Sciences
Department of Food and Nutrition
Durban University of Technology
Email Address: karinagovender1@gmail.com

Dear: Mrs K Palmer

RE: PERMISSION TO COLLECT DATA ON A RESEARCH STUDY TITLED: "PRODUCT DEVELOPMENT, LEXICON CREATION AND SENSORY ACCEPTABILITY OF GOAT MEAT PRODUCTS FOR THE EMERGING CONSUMER"

The University of Zululand's Research Ethics Committee (UZREC) hereby grants approval for you to conduct part of your research at UNIZULU, as per the methodologies stated in your research proposal and in terms of the data collection instruments that you have submitted.

We note also that Durban University of Technology (DUT) has issued an ethical clearance certificate and, having read the documentation, we accept the submission in good faith.

You may use this letter as authorization when you approach the relevant persons. Please note that the permission is based on the documentation that you have submitted. Should you revise your research instruments, or use additional instruments, you must submit all the changes to the University of Zululand Research Ethics Committee (UZREC).

The UZREC wishes you well in conducting your research.

Yours Sincerely,

18/05/2021

Professor Nontokozo Mashiya
Chairperson: University Research Ethics Committee
Acting Deputy Vice-Chancellor: Research & Innovation

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Appendix B2: Permission letter DUT

Directorate for Research and Postgraduate Support
Durban University of Technology
Tromso Annexe, Steve Biko Campus
P.O. Box 1334, Durban 4000
Tel.: 031-3732576/7
Fax: 031-3732946

12th May 2021
Mrs Karina Palmer
c/o Department of Food and Nutrition
Faculty of Applied Sciences
Durban University of Technology

Dear Mrs Palmer

PERMISSION TO CONDUCT RESEARCH AT THE DUT

Your email correspondence in respect of the above refers. I am pleased to inform you that the Institutional Research and Innovation Committee (IRIC) has granted **Gatekeeper Permission** for you to conduct your research "Product development, lexicon creation and sensory acceptability of goat meat products for the emerging consumer" at the Durban University of Technology. **Kindly note that this letter must be issued to the IREC for approval before you commence data collection.**

The DUT may impose any other condition it deems appropriate in the circumstances having regard to nature and extent of access to and use of information requested.

We would be grateful if a summary of your key research findings would be submitted to the IRIC on completion of your studies.

Kindest regards.
Yours sincerely

DR LINDA ZIKHONA LINGANISO
DIRECTOR: RESEARCH AND POSTGRADUATE SUPPORT DIRECTORATE

Appendix C: Information letter and consent form

LETTER OF INFORMATION

Title of the Research Study: Product development, lexicon creation and sensory acceptability of goat meat products for the emerging consumer.

Principal Investigator/s/researcher: K Palmer (Masters Consumer Science: Food and Nutrition),

Co-Investigator/s/supervisor/s: Dr Ashika Naicker (PhD: Nutrition) and Prof U Kolanisi (PhD: Food Security)

Brief Introduction and Purpose of the Study:

Good day. I, Karina Palmer am a PhD student registered at the Durban University of Technology and Department of Consumer Sciences.

I am conducting a research study to investigate meat consumption and preferences of young adults in order to develop sensory acceptable goat meat products to encourage consumption of goat meat as a sustainable and nutritious food source. In this context, I invite you to take part in this online survey.

Outline of the Procedures:
This study aims to investigate the meat consumption and preferences of young university adults in order to develop sensory acceptable goat meat products to ultimately encourage consumption of goat meat. You will be required to complete an online survey that will take you approximately 15 minutes of your time. If you decide to participate in this research survey, you may withdraw at any time and can choose not to answer specific questions. This letter of information will be hyperlinked to the online questionnaire. Your consent will be attained through a checkbox at the start of the survey.

Risks or Discomforts to the Participant:
There will be no risks to you for your participation in this survey.

Explain to the participant the reasons he/she may be withdraw from the study:
Should you wish to withdraw from the survey, there will be no adverse consequences.

Benefits:
This study will benefit the advancement of knowledge of goat meat perceptions and consumption by young adults as a means to develop sensory acceptable chevon products that will increase the consumption of goat meat.

Remuneration:
You will not receive any remuneration for completing the survey.

Costs of the Study:
There will be no cost incurred to you, if you participate in this study.

Confidentiality:
The survey has no identifying values that can link the information to you such as; your name, email address or IP address. All data will be stored in a password protected electronic format and used only for research purposes.

Results: The results of the survey will be published in a PhD thesis, accredited journals and through a webinar.

Research-related Injury:
There is no expected research related injury from your participation in this survey.

Storage of all electronic and hard copies including tape recordings
Data will be stored in the Durban University of Technology: Department of Consumer Sciences: Food and Nutrition server. This information will only be available to the research team for a retention period of 5 years.

Persons to contact in the Event of Any Problems or Queries:(Mrs K Palmer) Please contact the researcher (074 645 7004) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

CONSENT

Full Title of the Study: Product development, lexicon creation and sensory acceptability of goat meat products for the emerging consumer.

Names of Researcher/s: Karina Palmer, Ashika Naicker, Unathi Kolanisi

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Karina Palmer, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
Full Name of Participant	**Date**	**Time**	**Signature / Right Thumbprint**

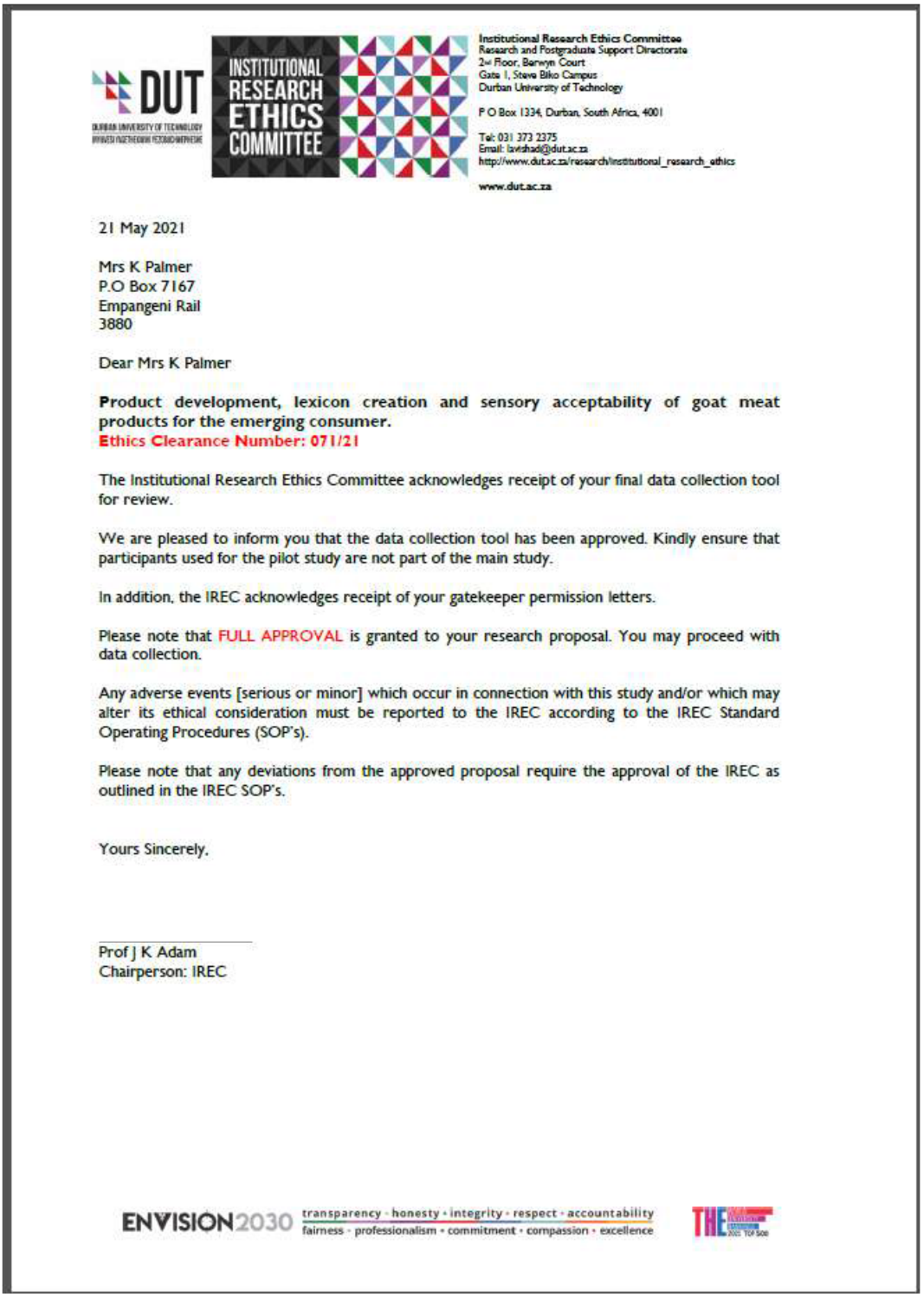
I, _____ (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____	_____	_____
Full Name of Researcher	**Date**	**Signature**

_____	_____	_____
Full Name of Witness (If applicable)	**Date**	**Signature**

_____	_____	_____
Full Name of Legal Guardian (If applicable)	**Date**	**Signature**

Appendix D: Ethical clearance



Institutional Research Ethics Committee
Research and Postgraduate Support Directorate
2nd Floor, Berwyn Court
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Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

21 May 2021

Mrs K Palmer
P.O Box 7167
Empangeni Rail
3880

Dear Mrs K Palmer

Product development, lexicon creation and sensory acceptability of goat meat products for the emerging consumer.
Ethics Clearance Number: 071/21

The Institutional Research Ethics Committee acknowledges receipt of your final data collection tool for review.

We are pleased to inform you that the data collection tool has been approved. Kindly ensure that participants used for the pilot study are not part of the main study.

In addition, the IREC acknowledges receipt of your gatekeeper permission letters.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC Standard Operating Procedures (SOP's).

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely,

Prof J K Adam
Chairperson: IREC

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fairness · professionalism · commitment · compassion · excellence

Appendix E: Meat consumption and preference survey

Good day,

This study aims to investigate the meat consumption and preferences of young adults and to develop sensory acceptable goat meat products to ultimately encourage consumption of goat meat. You will be required to complete an online survey that will take you approximately 15 minutes of your time. If you decide to participate in this research survey, you may withdraw at any time and can choose not to answer specific questions. This letter of information will be hyperlinked to the online questionnaire. Your consent will be attained through a checkbox at the start of the survey.

Please take a few minutes to complete the following questionnaire.

Section A: Demographics

1. At which university do you attend lectures on?

- ☐ University of Zululand
- ☐ Durban University of Technology

2. Ethnic group

- ☐ African
- ☐ Indian
- ☐ White
- ☐ Coloured

3. Sex

- ☐ Male
- ☐ Female

4. Age group

- ☐ 17-20 years
- ☐ 21-24 years
- ☐ 25-28 years
- ☐ 29 years or >

5. Level of study

- ☐ First year
- ☐ Second year
- ☐ Third year
- ☐ Fourth year>

Section B: Meat consumption

1. How often do you eat chicken?

☐ Not at all
☐ 1-2 times a month
☐ 3-4 times a month
☐ More than 4 times a month

2. How often do you eat beef?

☐ Not at all
☐ 1-2 times a month
☐ 3-4 times a month
☐ More than 4 times a month

3. How often do you eat pork?

☐ Not at all
☐ 1-2 times a month
☐ 3-4 times a month
☐ More than 4 times a month

4. What processed meat products do you usually eat? (you may select more than one)

☐ Burger patties
☐ Sausage/wors
☐ Meat balls/ kebabs
☐ Polony
☐ Biltong

5. Have you eaten goat meat before? if you answered no, go to question 5.d

☐ Yes
☐ No

a. If you answered 'yes', how often do you eat goat meat

☐ Not at all
☐ 1-2 times a month
☐ 3-4 times a month
☐ More than 4 times a month

b. When was the last time you ate goat meat? _____

c. What was the reason for eating goat meat (mark one)

☐ Religious
☐ Cultural

☐ Health
☐ Convenience
☐ Availability

Other, please specify

_____

d. If you answered 'no', please indicate the main reason why you do not eat goat meat (tick all that apply).

☐ Appearance
☐ Taste
☐ Texture
☐ Aroma/smell
☐ Availability

Other, please specify

_____

Section C: Goat meat and milk consumption

1. Have you ever consumed goat milk before?

☐ Yes
☐ No

2. Have you ever consumed processed goat milk products like cheese/yoghurt before?

☐ Yes
☐ No

3. Would you be interested in tasting goat meat in a processed form such as burger patties or sausages etc.?

☐ Yes
☐ No

4. Would you be interested in tasting goat milk?

☐ Yes
☐ No

5. Would you be interested in tasting processed products like cheese and yoghurt made from goat milk?

☐ Yes
☐ No

Section D: Purchasing of goat meat

1. If goat meat products were available at your local shop, at a price similar to your favourite protein would you purchase it?

☐ Yes
☐ No

2. If goat meat products were available as a menu item at a restaurant, at a price similar to your favourite protein would you purchase it?

☐ Yes
☐ No

THANK YOU FOR YOUR TIME

Appendix F: Pilot meat consumption and preference survey

Good day,

This study aims to investigate the meat consumption and preferences of young adults and to develop sensory acceptable goat meat products to ultimately encourage consumption of goat meat. You will be required to complete an online survey that will take you approximately 15 minutes of your time. If you decide to participate in this research survey, you may withdraw at any time and can choose not to answer specific questions. This letter of information will be hyperlinked to the online questionnaire. Your consent will be attained through a checkbox at the start of the survey.

Please take a few minutes to complete the following questionnaire.

Section A: Demographics

1. At which university do you attend lectures on?

- ☐ University of Zululand
- ☐ Durban University of Technology

2. Ethnic group

- ☐ African
- ☐ Indian
- ☐ White
- ☐ Coloured

3. Sex

- ☐ Male
- ☐ Female

4. Age group

- ☐ 17-20 years
- ☐ 21-24 years
- ☐ 25-28 years
- ☐ 29 years or >

5. Level of study

- ☐ First year
- ☐ Second year
- ☐ Third year
- ☐ Fourth year>

Section B: Meat consumption

1. How often do you eat chicken?

☐ Not at all
☐ 1-2 times a month
☐ 3-4 times a month
☐ More than 4 times a month

2. How often do you eat beef?

☐ Not at all
☐ 1-2 times a month
☐ 3-4 times a month
☐ More than 4 times a month

3. How often do you eat pork?

☐ Not at all
☐ 1-2 times a month
☐ 3-4 times a month
☐ More than 4 times a month

4. What processed meat products do you usually eat? (you may select more than one)

☐ Burger patties
☐ Sausage/wors
☐ Meat balls/ kebabs
☐ Polony
☐ Biltong

5. Have you eaten goat meat before? if you answered no, go to question 5.4

☐ Yes
☐ No

a. If you answered 'yes', how often do you eat goat meat

☐ Not at all
☐ 1-2 times a month
☐ 3-4 times a month
☐ More than 4 times a month

b. When was the last time you ate goat meat? _____

c. What was the reason for eating goat meat (mark one)

☐ Religious
☐ Cultural

☐ Health
☐ Convenience
☐ Availability

Other, please specify

_____

d. If you answered 'no', please indicate the main reason why you do not eat goat meat

☐ Appearance
☐ Taste
☐ Texture
☐ Aroma/smell
☐ Availability

Other, please specify

_____

Section C: Goat meat and milk consumption

1. Have you ever consumed goat milk before?

☐ Yes
☐ No

2. Have you ever consumed processed goat milk products like cheese/yoghurt before?

☐ Yes
☐ No

3. Would you be interested in tasting goat meat in a processed form such as burger patties or sausages etc.?

☐ Yes
☐ No

4. Would you be interested in tasting goat milk?

☐ Yes
☐ No

5. Would you be interested in tasting processed products like cheese and yoghurt made from goat milk?

☐ Yes
☐ No

Section D: Purchasing of goat meat

1. If goat products were available at your local shop, at a price similar to your favourite protein would you purchase it?

☐ Yes
☐ No

2. If goat products were available as a menu item at a restaurant, at a price similar to your favourite protein would you purchase it?

☐ Yes
☐ No

THANK YOU FOR YOUR TIME

Pilot questions:

1. Could you easily understand the questions?

☐ Yes

☐ No, please specify in the table below:

Question no	Explanation

2. Was the flow of questions correct and easy to understand?

☐ Yes

☐ No, please specify in the table below:

Question no	Explanation

3. Please add any further comments/suggestions you have regarding the survey questionnaire.

Appendix G: 9-point hedonic rating scale and paired preference test

Good day,

Thank you for participating in the sensory evaluation of processed goat meat products. Kindly complete the information below by placing a tick (✓) in the relevant boxes.

‘

Scorecard
9-point hedonic rating scale & paired preference test

Tray number …… Participant number: ……

1. Gender

☐ Male
☐ Female

2. Ethnic group

☐ African
☐ Indian
☐ White
☐ coloured

3. Age

☐ 17-20 years
☐ 21-24 years
☐ 25-28 years
☐ 29 years or >

You are presented with a sample, **sample code 318**. Please taste the sample and tick ✓ the box that best describes how you feel about it.

1. How do feel about the appearance of the sample?
    - ☐ Like Extremely
    - ☐ Like Very Much
    - ☐ Like Moderately
    - ☐ Like Slightly
    - ☐ Neither Like nor Dislike
    - ☐ Dislike Slightly
    - ☐ Dislike Moderately
    - ☐ Dislike Very Much
    - ☐ Dislike Extremely

2. How do you feel about the aroma of the sample?
    - ☐ Like Extremely
    - ☐ Like Very Much
    - ☐ Like Moderately
    - ☐ Like Slightly
    - ☐ Neither Like nor Dislike
    - ☐ Dislike Slightly
    - ☐ Dislike Moderately
    - ☐ Dislike Very Much
    - ☐ Dislike Extremely

3. How do you feel about the taste of the sample?
    - ☐ Like Extremely
    - ☐ Like Very Much
    - ☐ Like Moderately
    - ☐ Like Slightly
    - ☐ Neither Like nor Dislike
    - ☐ Dislike Slightly
    - ☐ Dislike Moderately
    - ☐ Dislike Very Much
    - ☐ Dislike Extremely

4. How do you feel about the consistency (texture and juiciness) of the sample?
    - ☐ Like Extremely
    - ☐ Like Very Much
    - ☐ Like Moderately
    - ☐ Like Slightly
    - ☐ Neither Like nor Dislike
    - ☐ Dislike Slightly
    - ☐ Dislike Moderately
    - ☐ Dislike Very Much
    - ☐ Dislike Extremely

You are presented with a second sample, **sample code 701**. Please taste the sample and tick ✓ the box that best describes how you feel about it.

5. How do feel about the appearance of the sample?
    - ☐ Like Extremely
    - ☐ Like Very Much
    - ☐ Like Moderately
    - ☐ Like Slightly
    - ☐ Neither Like nor Dislike
    - ☐ Dislike Slightly
    - ☐ Dislike Moderately
    - ☐ Dislike Very Much
    - ☐ Dislike Extremely

6. How do you feel about the aroma of the sample?
    - ☐ Like Extremely
    - ☐ Like Very Much
    - ☐ Like Moderately
    - ☐ Like Slightly
    - ☐ Neither Like nor Dislike
    - ☐ Dislike Slightly
    - ☐ Dislike Moderately
    - ☐ Dislike Very Much
    - ☐ Dislike Extremely

7. How do you feel about the taste of the sample?
    - ☐ Like Extremely
    - ☐ Like Very Much
    - ☐ Like Moderately
    - ☐ Like Slightly
    - ☐ Neither Like nor Dislike
    - ☐ Dislike Slightly
    - ☐ Dislike Moderately
    - ☐ Dislike Very Much
    - ☐ Dislike Extremely

8. How do you feel about the consistency (texture and juiciness) of the sample?
    - ☐ Like Extremely
    - ☐ Like Very Much
    - ☐ Like Moderately
    - ☐ Like Slightly
    - ☐ Neither Like nor Dislike
    - ☐ Dislike Slightly
    - ☐ Dislike Moderately
    - ☐ Dislike Very Much
    - ☐ Dislike Extremely

Paired preference score card

After tasting the two samples that were presented to you, circle the number of the sample you prefer

318 701

Appendix H: Pre-screening survey for sensory panel

Pre-screening for participation in a trained sensory panel

The survey will take approximately 4 minutes to complete.
This survey is to determine students suitability to participate in pre screening tests and potentially be a trained sensory evaluation assessor for the study: Product development, lexicon creation and sensory acceptability of goat meat products for the emerging consumer.

Required

1. Please indicate if you provide consent to complete this online survey

- ◯ Yes I provide consent
- ◯ No, I do not provide consent- Thank you, please close this tab and do not proceed

2. Race (This data will be collected to describe the sample)

- ◯ African
- ◯ Coloured
- ◯ Indian
- ◯ White

3. Gender *

- ◯ Male
- ◯ Female

4. Age group

- ◯ 18 20 years
- ◯ 21-24 years
- ◯ 25 27 years
- ◯ 28 30 years
- ◯ 30 years>

5. Level of study

- ◯ Masters
- ◯ PG d ploma
- ◯ Advanced diploma
- ◯ Final year undergraduate
- ◯ Other

6. Please select the following options that applies to you (you may select more than one)

- ☐ Diabetic
- ☐ Hypertensive
- ☐ Hypoglycemic (low blood sugar)
- ☐ Take any medication that affects your taste or ability to smell
- ☐ Have lost all or part of your sense of taste or smell
- ☐ Food allergies or intolerances
- ☐ Dietary restrictions
- ☐ None of the above statements apply to me

7. Are you willing and available to participate in pre-screening tests to determine your sensory abilities?

- ○ Yes
- ○ No

8. Do you have an interest in learning more about sensory science?

- ○ Yes
- ○ No

9. If you are selected to participate in the pre-screening tests, are you willing to evaluate a variety of food samples? *

- ◯ Yes
- ◯ No

10. Do you have any particular food/ingredient that you strongly dislike? if yes indicate the food *

11. How would you rate your ability to distinguish aroma, taste and texture? *

- ◯ Better than average
- ◯ Average
- ◯ Worse than average

12. How would you rate your ability to describe aroma, taste and texture? *

- ◯ Better than average
- ◯ Average
- ◯ Worse than average

13. Think about your dinner last night. Please describe the meal, including how the food tasted and what you liked or disliked about it. Please use as much detail as possible (NB this is to determine your ability to describe and not based on what you eat)

14. What are some foods that taste like yoghurt?

15. How would you describe the difference between flavour and aroma?

16. How would you describe the difference between flavour and texture?

17. Select all the statements that you agree to:

- [ ] I am willing to taste meat samples cooked from medium (pink) to well done
- [ ] I am willing to taste goat meat and beef products
- [ ] I am willing to eat samples prepared using gelatine
- [ ] I am willing and able to contribute to group discussions about food products
- [ ] I am willing to voice my opinion but also be mindful and consideration of the opinions of others in a group
- [ ] I do not agree to any of the statements

5/6

18. Please include your name, surname and email address below so you can contacted about your suitability

Appendix I: Sensory training manual

Sensory training manual for the development of a goat meat lexicon using the Tragon Quantitative Descriptive Analysis (QDA) method

Developed for the study;

Product development, lexicon creation and sensory acceptability of goat meat products for the emerging consumer

Table of Contents

i. Aim and purpose of the manual

This guide has been developed for the dissertation titled; *Product development, lexicon creation and sensory acceptability of goat meat products for the emerging consumer*, to ensure uniform methods, standards and procedures are followed hence contributing to the validity of the study.

As such, this guide does not serve as an alternative to the ISO standards mentioned, but rather as a complementary document that can be used in conjunction with the various standards to assist other students and researchers alike in following the recommended procedures using a systematic approach.

ii. Steps followed in recruiting and training of the panel

The information outlined in this manual has been adapted from the ISO 8586 document Sensory analysis - General guidelines for the selection, training and monitoring of selected assessors and expert sensory assessors and various other accredited sources which are included in the text.

iii. Pre-recruitment and selection process

The number of panel members to be selected for the Tragon QDA method is between 8-12; however, for pre-recruitment and screening purposes three times the number of people are invited to compensate for drop-outs and unsuitable candidates (Kemp, Hort and Hollowood 2018) and ISO 8586.

A summary of the criteria that ISO 8586 recommends should be included is represented in Table 1, along with potential questions that can be asked.

Table i: Criteria and suitable questions for pre-recruitment of sensory panel members (ISO 8586).

Criteria	**Questions**
Demographics	Age group, sex, nationality, educational background, current occupation
Attitudes to foods	Are you willing to try different foods you have not eaten before? Do you strongly dislike any specific foods? Does your culture/ religion restrict you from eating any food/s?
Ability to communicate	Determined through screening tests
Ability to describe	Determined through screening tests
Health criteria	Do you have any allergies (food or non-food related)? Do you suffer from any disabilities that impair your colour vision, taste, ability to chew or smell?
Interest and motivation	Are you interested in food product development and its properties?
Sense of responsibility and power of concentration	Are you able to concentrate and stay focused on a task for at least 15 minutes? Are you punctual and willing to commit to attending ____ sessions ___ a week for the next ____ weeks
Ability to judge	Are you decisive and able to make a decision when faced with a choice? Are you self-critical and able to reflect and make decisions?
Willingness to co-operate	Are you willing to learn something new? Are you willing to contribute and share during group discussions?

1. Pre-screening workshop: Introductory & pre-screening sensory tests

Attendee requirements:

1. Please carry a laptop with charger for the online colour blindness test
2. Please ensure you do not use any strong-smelling perfume/deodorant
3. Please do not smoke or eat any strong-smelling foods

Table 1.1: Programme for the pre-screening workshop

Programme	
Time	**Activity**
08:30-09:00	Tea with refreshments
09:00-09:40	Introduction to the study and sensory evaluation techniques
09:40-09:50	Practical activity – Retronasal-olfaction demonstration
09:50-10:00	Stretch break
10:15-10:45	Ishihara colour test Munsell colour hue test
10:45-11:00	Odour matching test
11:00-11:15	Break
11:15-12:00	Taste matching test
12:00-12:30	Lunch and end of day

1.1 Introduction to the study and sensory evaluation techniques

- Overview of the role and importance of sensory evaluation
- Different sensory methods
- Basic evaluation protocol
- The expectations and role of panel members

1.2 Practical Activity: Retronasal-olfaction demonstration

It is important to use a short exercise to show the panellists the distinction between smell, flavour and aroma and to clearly define them, and to explain what happens during the olfaction process and tasting.

This retronasal-olfaction test demonstrates that the perception of a flavour in the mouth is a multimodal sensation. It consists of a set of taste, olfactory and trigeminal sensations (all the thermal, tactile and pain sensations). The steps outlined are as per the methods followed by Maraval, Forestier-Chiron and Bugaud (2018: 7).

It is important to underline and explain how air moves via the retro nasal passage (by the channels between the mouth and the nose, called choanae). The aromatic molecules are transported in this passage to the olfactory mucosa.

This test must be carried out using a reasonably aromatic product (e.g. Strawberry flavour marshmallow or other sweets with a high aromatic intensity).

Procedure: Give a sweet to everyone and explain the test process:

- Block the nose
- Place the product in the mouth and close the mouth
- Chew the product without opening the mouth
- Release the nostrils and take a breath of air through the mouth to assess the difference in perception

Discussion: Did you notice a change or any difference in the taste or aroma of the sweet?

1.3 Pre-screening session 1: Colour blindness test

Instruction: Click on the link that was emailed to you and complete the Ishihara colour test (https://www.colorblindnesstest.org/ishihara-test/). Once you have completed the test raise your hand and someone will assist you. You will be sent another link via email, proceed with the Munsell test (https://www.colorblindnesstest.org/farnsworth-munsell-100-hue-test/) and raise your hand once completed.

Assistant: Results for the colour test must be recorded in Table 1.2.

Table 1.2: Example of table to capture results for colour tests

Participant no.	**Ishihara colour test result**	**Farnsworth Munsell hue test result**

1.4 Pre-screening session 2: Matching test for odour

Objective: To determine sensory impairment of taste (anosmia).

Each chemical was first diluted in alcohol (stock solution); the stock solution was then diluted in water which was used for the participants to evaluate.

Table 1.3: Sample preparation for recognition of loss of odour (ISO 8586 2012:9)

Substance	1% solution in ethanol (100ml)	0.1% solution in water (200ml)	Amount added to cotton wool for odour test (ml)
Citral (C10H16O)	1g	20ml ethanol dilution + 180ml water (180ml water)	2ml water dilution
Vanillin (C8H8O3)	1g	20ml ethanol dilution + 180ml water	2ml water dilution
*Thymol (C10H14O)	1g	10ml ethanol dilution + 190ml water	2ml water dilution
Benzyl azetate (C9H10O2)	1g	20ml ethanol dilution + 180ml water	2ml water dilution

*Thymol is a 0.05% dilution in water

Stock solutions are prepared with ethanol, but the final dilution is made with water and shall not contain more than 2 % volume fraction of alcohol

NB. Check intensity of odour prior to administering test

Protocol

- Substances are absorbed in odourless cotton wool which is placed in an amber coloured odourless bottle with a cap and labelled with the sample codes (Table 1.4).
- Some of the odour will evaporate so it is necessary to check the intensity of the sample prior to the candidates' evaluation.

- Present the samples to the candidates (Table 1.5 - original set with name of item) to allow them an opportunity to become familiar with each sample before the test.
- Candidates are given a set of the same substances labelled with different random numbers (table 6). They are asked to match the samples to the original set and describe the sensation they experience.

Table 1.4: Serving order of samples to determine anosmia (original set)

Sample	302	143	546	762
Response	Thyme	Vanilla	Lime	Floral

Table 1.5: Serving order of samples to determine anosmia (test set)

Sample	583	435	634	832	745	202	932	473
Response	Lime	Vanilla	Thyme	Floral	Vanilla	Lime	Thyme	Floral

Odour matching test

Score card and instructions

In front of you are four samples on tray 1. Remove the cap and take a short sniff to smell each sample. You will then be presented with a tray of 14 samples on tray 2.

Match the samples in tray 2 that you think are representative of each of the samples on tray 1. Fill in the sample codes in the table below

Tray 1 samples	Corresponding sample (s) from tray 2
302	
143	
546	
762	

Figure 1.1: Odour matching score card

Assistant: Refer to the answer sheet (Table 1.6) and record the results in the 'participants' results' Table 1.7.

Table 1.6: Answers for odour matching test

Answer sheet for odour matching test	
Tray 1 samples	Corresponding sample (s) from tray 2
302	634√ 932√
143	435√ 745√
546	583√ 202√
762	832√ 473√

Table 1.7: Example of table to record participants' results for odour matching test

Participants results for odour matching test	
Participant no.	No. of correctly identified samples (total of 8)

Qualifying criteria for assessors

Participants who make fewer than 80% correct matches should not be chosen as selected assessors (ISO 8586 2012:9).

1.5 Pre-screening session 2: Matching test for taste

Objective: To determine sensory impairment of taste (ageusia).

Table 1.8: Sample preparation for recognition of loss of taste (ISO 8586 2012: 9)

Material	Taste	Concentration in water at room temperature g/l
Caffeine	Bitter	0,3g/l
Citric acid	Sour	0,3g/l
Sodium chloride	Salty	2g/l
Sucrose	Sweet	10g/l
Monosodium glutamate	Umami	0,6g/l
Potassium aluminium sulphate dodecahydrate	Astringent*	0,5g/l
Iron (II) sulphate heptahydrate	Metallic*	0,01g/l

*Tactile sensations

Protocol

- Prepare the samples according to the dilutions in Table 1.8.
- Present the samples to the candidates (Table 1.9- original set with names) to allow them an opportunity to be familiar with each sample before the test.
- Participants are given a set of the same materials labelled with different random numbers (Table 1.11). The instruction is to match the samples to the original set and describe the sensation they experience.

Table 1.9: Serving order of samples to determine ageusia (original set)

Sample Code	328	452	745	982	363	932	230
Correct response	bitter	sweet	astringent	Sour	Salty	metallic	umami

Table 1.10: Serving order of samples to determine ageusia (test set)

Sample	825	349	541	309	768	901	326	257
Correct response	bitter	water	sweet	umami	astringent	sour	Metallic	bitter

Table 1.11: Serving order of samples to determine ageusia (test set) continued

Sample	871	210	921	129	743	107	257
Correct response	water	sour	salty	astringent	umami	sweet	bitter

Taste matching test

Score card and instructions

In front of you are eight flavour/sensation samples on tray 1 (bitter, sour, salty, sweet, umami, astringent and metallic) Taste each sample.

You will then be presented with a tray of 14 samples (two samples are water) on tray 2.

Match the samples in tray 2 that you think are representative of each of the samples on tray 1. Fill in the sample codes in the table below

Tray 1 samples	Corresponding sample (s) from tray 2
328	
452	
745	
982	
363	
932	
230	
Water	

Figure 1.2: Taste matching score card

Assistant: Refer to the answer sheet (Table 1.12) and record the results in the 'participants' results' table.

Table 1.12: Answer sheet for taste matching test

Answer sheet for taste matching test	
Tray 1 samples	**Corresponding sample (s) from tray 2**
328	825√ 257√
452	541√ 107√
745	768√ 129√
982	901√ 210 √
363	921√
932	326√
230	309√ 743√
Water	349√ 871√

Table 1.13: Example of table to record participants' results for taste matching test

Participants' results for taste matching test	
Participant no.	Correctly matched sample (s) (total 14)

2. Training workshop 1: Detection & discrimination of intensities of a stimulus

Attendee requirements:

- Please ensure you do not use any strong-smelling perfume/deodorant
- Please do not smoke or eat any strong-smelling foods

Table 2.1 Programme for training workshop 1

Programme	
Time	**Activity**
09:00-09:10	Tea with refreshments
09:10-10:30	Test for detection of a stimulus (7 trays)
10:30-10:45	Stretch break
10:45-11:45	Intensity ranking test – colour
10:15-10:45	Intensity ranking test – odour
10:45-11:00	Intensity ranking test – taste
11:00-11:15	Intensity ranking test – texture
11:15-12:00	Lunch and end of day 2

2.1 Test for detection of a stimulus

Protocol: A triangle test is used whereby one substance at a time is tested (one tray presented at a time). Two samples of water and one sample of the test substance is presented to each person (Table 2.2).

Table 2.2: Serving order of samples for the taste detection test

Tray no.	Sample 1	Sample 2	Sample 3
1	water (326)	water (534)	caffeine (735)
2	water (729)	citric acid (984)	water (382)
3	sodium chloride (358)	water (529)	water (203)
4	water (639)	water (284)	sucrose (901)
5	water (833)	monosodium glutamate (437)	water (582)
6	iron (II) sulfate heptahydrate (897)	water (391)	water (221)
7	water (763)	water (637)	(z)-hex-3-en-1-ol (836)

Table 2.3: Dilution ratios of detection of a stimulus test

Material	**CAS no.**	**Taste**	**Quantity fraction diluted in water**
Caffeine	58-08-2	Bitter	0,2 g/l
Citric acid	77-92-9	Sour	0,2 g/l
Sodium chloride	7647-14-5	Salty	1,3 g/l
Sucrose	57-50-1	Sweet	6 g/l
Monosodium glutamate	142-47-2	Umami	0,3 g/l
Iron (II) sulphate heptahydrate	7782-63-0	Metallic	0,005 g/l
(Z)-Hex-3-en-1-ol	928-96-1	Grassy, green, unripe	0,4 ml/l

Scorecard
Triangle Test: Taste detection

Tray number …… Participant no. ……

In front of you are three coded samples; two are the same and one is different.
Starting from the left, taste the samples and circle the one that is different from the other two. You may re-taste the samples. You must make a choice.

_____ _____ _____

Figure 2.1: Score card for taste detection test

Assistant: Refer to the answer sheet below and record the results in the 'participants' results' Table 2.4.

Table 2.4: Answer sheet for test detection test

Answer sheet for taste detection test	
Tray	**Correctly identified sample**
Tray 1	735√
Tray 2	984√
Tray 3	358√
Tray 4	901√
Tray 5	437√
Tray 6	897√
Tray 7	836√

Table 2.5: Example of table to capture participants' results for the taste detection test

Participants results for taste detection test	
Participant no.	**No. of correctly identified samples (total of 7)**
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

2.2 Tests procedure for discrimination between levels of intensity of a stimulus

Tests for discrimination between levels of intensity of a stimulus use the ranking test procedure according to ISO 8587. The tests are carried out using stimuli for taste, odour (use very small amounts), texture (mouth and hand), and colour.

Protocol: Four samples having different intensities of the substance are presented in a random order to the candidates, who are required to put them in order of increasing intensity (Figure 2.2 and 2.3).

Scorecard
Intensity Ranking Test for Odour

Tray number …… Participant no. …….

You are provided with the following samples for odour evaluation labelled as:

918	732	589	641

Please take a sniff of each sample initially in this order and then smell and re-smell them in any order until you can place them in front of you from left to right in order of increasing intensity.

When you have done this, write the sample codes in the boxes below in order of increasing intensity:

Lowest	→		Highest

Figure 2.2: Intensity ranking score card for odour (PDST 2017: 58)

Scorecard
Intensity Ranking Test for Colour

Tray number …… Participant no. …….

You are provided with the following samples for colour evaluation labelled as:

342	482	194	309

Please look at each sample initially in this order you wish until you can place them in front of you from left to right in order of increasing intensity.

When you have done this, write the sample codes in the boxes below in order of increasing intensity:

Lowest	→		Highest

Figure 2.3: Intensity ranking score card for colour (PDST 2017:58)

Table 2.6: Serving order to determine discriminating ability (odour)

Tray 2: Intensity ranking test for odour (fruity - ethanol dilution) Isoamyl acetate				
Sample order	(918) 10mg/l	(732) 5mg/l	(589) 40mg/l	(641) 20mg/l

Table 2.7: Correct order of samples (odour)

Correct order intensity ranking test for odour				
Answer	732√	918√	641√	589√

Table 2.8: Serving order to determine discriminating ability (colour)

Tray 1: Intensity ranking test for colour (scales/paint swatches)				
Sample order	342	482	194	309

Table 2.9: Correct order of samples (colour)

Correct order intensity ranking test for colour (scales/paint swatches)				
Answer	482√	309 √	342√	194√

Scorecard
Intensity Ranking Test for Taste

Tray number …… Participant no. ……

You are provided with the following samples for taste evaluation labelled as:

148	537	872	793

Please taste them initially in this order and then taste and re-taste them in any order you wish until you can place them in front of you from left to right in order of increasing intensity.

Between each tasting, please cleanse your palate by taking a sip of the water provided. When you have done this, write the sample codes in the boxes below in order of increasing intensity, from least to most sour:

Lowest	→		Highest

Figure 2.4: Intensity ranking score card for taste (Professional Development Service for Teachers 2004:58)

Samples prepared for the discriminating ability for taste are shown in Table 2.10. The correct order (answers) are depicted in Table 2.11.

Table 2.10: Serving order to determine discriminating ability (taste)

Tray 3: Intensity ranking test for taste (citric acid- sour)				
Sample order	148 0,3g/l	537 0,5g/l	872 0,2g/l	793 0,1g/l

Table 2.11: Correct order of samples (taste)

Correct order intensity ranking test for odour				
Answer	793√	872√	148√	537√

Scorecard
Intensity Ranking Test for Texture

Tray number …… Participant no. …….

You are provided with the following samples for texture evaluation labelled as:

873	742	249	592

Please taste them initially in this order and then taste and re-taste them in any order as you wish until you can place them in front of you from left to right in order of increasing intensity.

Between each tasting, please cleanse your palate by taking a sip of the water provided. When you have done this, write the sample codes in the boxes below in order of increasing intensity, from least creamy to creamiest:

Lowest Least creamy	→		Highest Creamiest

Figure 2.5: Intensity ranking score card for taste (Professional Development Service for Teachers 2004: 58)

The order in which samples for the discriminating ability (texture) should be served is shown in Table 2.12.

Table 2.12: Serving order to determine discriminating ability (texture)

Tray 3: Intensity ranking test for texture (creaminess)				
Sample order	873 Low fat yoghurt	742 Fat free yoghurt	249 Double cream	592 Medium fat

Table 2.13: Correct order of samples (texture)

Correct order intensity ranking test for texture				
Answer	742√	873√	592√	249√

3. Training workshop 2: Tests for descriptive ability

Attendee requirements:

- Please ensure you do not use any strong - smelling perfume/deodorant
- Please do not smoke or eat any strong - smelling foods

Table 3.1: Programme for the pre-screening workshop

Programme	
Time	**Activity**
08:30-09:00	Tea and refreshments
09:00-09:20	Odour description test tray 1
09:30-10:00	Odour description test tray 2
10:00-10:30	Tea break
10:30-11:15	Texture description test tray 1
11:25:11:55	Texture description test tray 2
11:55-12:30	Lunch and end of day 3

3.1 Tests for descriptive ability

The purpose of descriptive tests is to determine a candidate's ability to describe sensory perceptions. Two tests are usually used, one covering odour stimuli and the other textural stimuli.

3.1.2 Odour description test

Protocol: Each person is given between five and 10 olfactory stimuli. The set includes samples which are easy to recognise and others which are not as common. The method for preparing the samples is described below and Table 3.2 and 3.3 shows the serving order.

a) Sample stimuli are immersed in odourless cotton wool which is placed in an odourless amber coloured glass bottle which does not permit visual recognition of the colour and can be tightly sealed to avoid dispersion of the odour.
b) Some of the odour will be allowed to evaporate into the headspace of the bottle; however, the intensity of the sample must be checked before presentation of the bottles to candidates.

Table 3.2: Serving order for odour description test (tray 1)

Sample	215	150	409	318	889
Response	Bitter almonds	Fresh grass	Cinnamon	Butter	Garlic

Table 3.3: Serving order for odour description test (tray 2)

Sample	948	986	435	609	387
Response	Camphor	Peppermint	Clove	Aniseed	Vinegar

Table 3.4: Olfactory materials for odour description test (choose between 5-10) (ISO 8586 2012)

Sample code	Material	CAS no.	Name most associated with odour
215	Benzaldehyde	100-52-7	Bitter almonds, cherry
150	(Z)-Hex-3-en-1-ol	928-96-1	Fresh grass
409	Cinnamaldehyde	431-03-8	Butter
318	Diacetyl	104-55-2	Cinnamon
889	Diallyl sulphide	2179-57-9	Garlic
948	Camphor	76-22-2	Camphor, medicine
986	Menthol	1490-04-6	Peppermint
435	Eugenol	97-53-0	Clove
609	Anethol	104-46-1	Aniseed
387	Acetic acid	64-19-7	Vinegar

The ethanol dilutions are stated in ISO 8586, the less concentrated (water solutions) used for the olfactory materials are shown in Table 3.5. The odour identification and description test score card is depicted in Figure 3.1.

Table 3.5: Olfactory materials dilution

Material	1% solution in ethanol	0.1% solution in water	Quantity for odour test
Benzaldehyde	1g/100ml	20ml ethanol dilution + 180ml water	2ml
(Z)-Hex-3-en-1-ol	1g/100ml		2ml
Cinnamaldehyde*	-	-	1 stick
Diacetyl	1g/100ml		2ml
Diallyl sulphide*	-	-	0.5 ml crushed garlic
Camphor	1g/100ml	20ml ethanol dilution + 180ml water	2ml
Menthol	1g/100ml	20ml ethanol dilution + 180ml water	2ml
Eugenol	1g/100ml	20ml ethanol dilution + 180ml water	2ml
Anethol	1g/100ml	20ml ethanol dilution + 180ml water	2ml
Acetic acid	-	2.5ml acetic acid + 197.5ml water	2ml

*Cinnamon sticks were broken into 2cm pieces and covered with cotton pads.

Odour identification and description test

Place an x in the appropriate column and complete the following questions

Sample no.	Do you perceive an odour?		Do you know this odour?		Name of smell, description or association	Comment
	Yes	*No*	*Yes*	*No*		

Figure 3.1: Odour identification and description test score card

Considerations: The intensity of the samples must be well above the recognition threshold, but not greatly above the levels that might be noticed in the products ultimately of interest.

Assessors' suitability: Candidates are graded according to performance on a scale such as the following (ISO 8586 2012: 12).

a) 3 points for correctly identifying or describing the most common association with the sample;
b) 2 points for describing the sample in general terms;
c) 1 point for identifying or describing an appropriate association following discussion;
d) 0 points for no response or a totally incorrect response.

Table 3.6: Example of table to capture participants results for odour description test

Participants results for odour description test			
Participant no.	No. of correctly **identified** and **described** samples (total 10)	No. of samples able to describe **in general** terms (total 10)	Total score
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

3.2 Texture description test

***Protocol*:** Candidates are provided with a series of six products at a time presented in random order and are asked to describe their textural characteristics.

Texture description test **Write the word/s that you think best describe the texture of each of the samples presented**						
Sample no.						
Word that describes the texture of the sample						

Figure 3.2: Texture description test score card

***Considerations*:** Solid sample products should be presented as uniformly sized blocks and liquid sample products should be presented in vessels hiding any possible differences.

Assessor suitability: Candidates are graded according to performance on the scale below (ISO 8586 2012: 12).

a) 3 points for correctly identifying or describing the most common association with the sample;
b) 2 points for describing the sample in general terms;
c) 1 point for identifying or describing an appropriate association following discussion
d) 0 points for no response or a totally incorrect response.

Table 3.7: Products for texture description test and the associated texture

Sample code	**Product**	**Texture most associated with product**
354	Oranges	Juicy, cellular particles
373	Cornflakes	Crispy, crunchy
799	Pears (Passe Crassane)	Gritty, juicy
413	Granulated sugar	Crystalline, coarse
543	Marshmallow topping	Sticky, malleable
061	Chestnut puree/ macadamia nut paste	Pasty
823	Semolina	Grainy
296	Double cream	Unctuous, creamy
861	Edible gelatine	Gummy
169	Crumbly puthu (cooked mealie meal)	Crumbly
503	Champion toffee	Tacky
572	Calamari	Elastic, springy, rubbery
130	Celery	Fibrous
910	Raw carrots	Crunchy, hard

The results for the texture description test can be captured in Table 3.8.

Table 3.8: Example of table to capture participants results for texture description test

Participants results for texture description test			
Participant no.	No. of correctly **identified** and **described** samples (total 10)	No. of samples able to describe **in general** terms (total 10)	Total score
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Table 3.9: Serving order for texture description test (tray 1)

Sample	354	373	799	413	543	061	823
Response	orange	cornflakes	pear	granulated sugar	marshmallow topping	chestnut puree	semolina

Table 3.10: Serving order for texture description test (tray 2)

Sample	296	861	169	503	572	130	910
Response	double cream	gelatine	crumbly phutu	champion toffee	calamari	celery	raw carrots

4. Training workshop 3: Recognition of differences in texture & scales

Attendee requirements:

- Please ensure you do not use any strong - smelling perfume/deodorant
- Please do not smoke or eat any strong - smelling foods

Table 4.1: Programme for workshop 3

Programme	
Time	**Activity**
09:00-09:10	Tea and refreshments
09:10-09:20	Recognition of differences in texture
09:30-09:35	How to use a line scale example
09:35-09:40	Line scale rating tray 1
09:50-10:15	Stretch break
10:15-10:30	Line scale rating tray 2
10:40:10:55	Line scale rating tray 3
11:05-11:30	Line scale rating tray 4
11:30-12:00	Results discussion
12:00-12:30	Lunch and end of workshop

4.1 Recognition of differences in texture

***Protocol*:** Ranking test according to ISO 8587. Test samples are gelatine at different firmness levels. Gelatine Type A, 240 bloom, particle size 0,5mm; saccharose; demineralised water; red food colour, mass concentration 5g/500 ml).

Preparation of samples: Prepare the day before the test. Weigh all ingredients and place in a pot, to achieve the desired mass which then should be recorded and heat the mixture to 60°C. Add water to return to the mass recorded before heating. Pour the solution into an ice cube tray. Keep at room temperature for 4 hours and in refrigerator for 24 hours to harden the gelatine.

Table 4.2: Composition of gelatine samples

Sample code	Correct order (least to most firm)	Demineralised water (ml)	Sacchrose (g)	Food colour (g)	Gelatine (g)
542	1	500	60	1,20	20,5
507	2	500	60	1,25	25,0
170	3	500	60	1,30	27,5
808	4	500	60	1,40	32,5
974	5	500	60	1,45	42,5
166	6	500	60	1,55	57,5
470	7	500	60	1,60	67,5
787	8	500	60	1,70	82,5
310	9	500	60	1,75	95,5
629	10	500	60	1,85	100

Protocol for presenting to assessors: Each assessor gets all samples in a randomised order and tests each encoded sample by touching and reorders the samples by firmness.

The serving order for samples for the texture ranking test are shown in Table 4.3.

Table 4.3: Serving order of samples for ranking test (texture)

Sample order	808	507	170	542	166	787	974	629	470	310

Intensity Ranking Test (texture)

Tray number …… Participant no. …….

You are provided with the following 10 samples of gelatine labelled as:

Please touch each sample and then rearrange in order of firmness.
When you have done this, write the sample codes in the boxes below:

very soft sample → very firm sample									

Figure 4.1: Score card for ranking test (texture)

Assessor suitability: At least 80 % of the samples must be arranged in the correct order.

Result for the intensity ranking test can be captured in Table 4.4.

Table 4.4: Participants results for intensity ranking test

Participants' results for intensity ranking test	
Participant no.	**No. of correctly ranked samples (total of 10)**
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

4.2 Training in the use of line scales

Line scales are used to train panels and for QDA data collection. The line scale is 15cm in length. The scale direction goes from left to right with increasing intensities (for example, ranging from weak to strong). During data collection, candidates measure sensory intensities independently at individual booths. The candidates are allowed to use different parts of the scale to determine the sensory intensities on their own. As a result, the difference among products produced by QDA® will be recorded as a relative measurement. Assessors' reliability is evaluated by their ability to repeat measurements on product attributes.

Table 4.5: Intensity ranking test sample dilution

Taste/texture	**Sample code**	**Sample serving/dilution**
Tray 1 Sucrose (sweetness)	342	10g/1L
	864	20g/1L
	925	50g/1L
	674	100g/1L

Serving order

Code	342	925	674	864
Sample				

Tray 2 Citric acid (sourness)	308	0.25g/1L
	153	0.50g/1L
	621	1.0g/1L
	871	1.5g/1L

Serving order

Code	153	871	308	621
Sample				

Tray 3 Sodium chloride (saltiness)	359	1.0g/1L
	214	2.0g/1L
	602	5.0g/1L
	477	10g/1L

Serving order

Code	359	602	477	214
Sample				

Tray 4 Texture (hardness)	872	Cream cheese
	632	Mature cheddar cheese (0.5cm-thick slice)
	435	Peanuts
	943	Carrot slices (0.5cm-thick slice)

Serving order

Code	632	872	943	435
Sample				

Serving order

Tray 5 Juiciness	512	Rump medium
	236	Rump medium to well
	382	Rump well done

Serving order

Code	236	382	512
Sample			

Tray 5 Tenderness	632	Fillet steak
	872	Picanah steak
	943	Hanger steak

Serving order

Code	943	632	872
Sample			

Scorecard
Intensity Rating Test (taste)

Tray number ..... Participant no. .....

Taste the samples in front of you and place a mark on the line to indicate how you would rate the sweetness of each sample.

Sample code: _____

Not sweet very sweet

Sample code: _____

Not sweet very sweet

Sample code: _____

Not sweet very sweet

Sample code: _____

Not sweet very sweet

Figure 4.2: Score card for intensity rating test- sweetness (Marval, Forestier-Chiron and Bugaud 2018: 16)

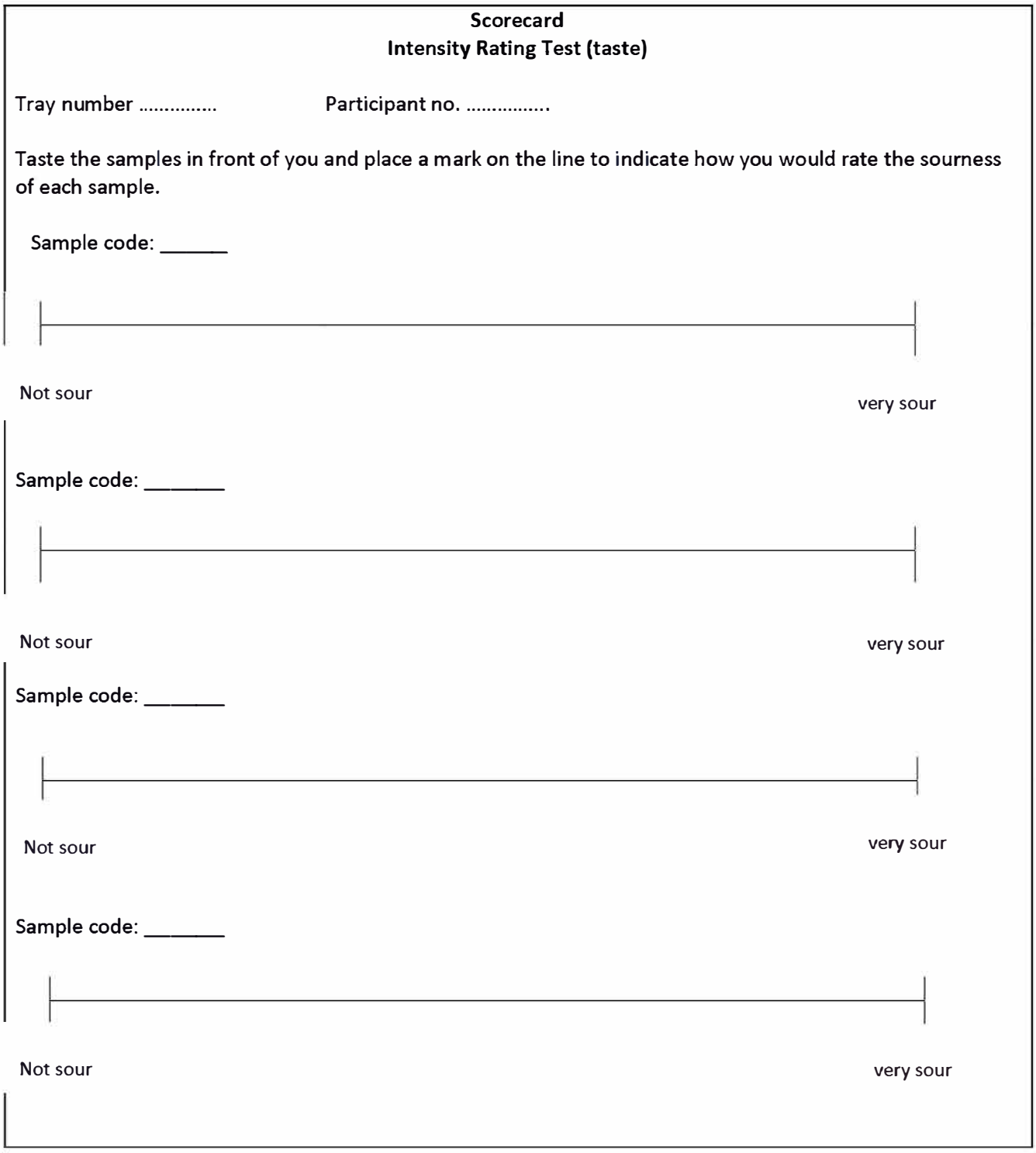


Figure 4.3: Score card for intensity rating test - sourness (Marval, Forestier-Chiron and Bugaud 2018:16)

Scorecard
Intensity Ranking Test (taste)

Tray number ..... Participant no. .....

Taste the samples in front of you and place a mark on the line to indicate how you would rate the saltiness of each sample.

Sample code: _____

Not salty very salty

Sample code: _____

Not salty very salty

Not salty very salty

Sample code: _____

Not salty very salty

Sample code: _____

Figure 4.4: Score card for intensity ranking test - saltiness (Marval, Forestier-Chiron and Bugaud 2018: 16).

Scorecard
Intensity Ranking Test (texture)

Tray number …… Participant no. …….

Taste the samples in front of you and place a mark on the line to indicate how you would rate the tenderness of each sample.

Sample code: _____

Not tender very tender

Sample code: _____

Not tender very tender

Sample code: _____

Not tender very tender

Sample code: _____

Not tender very tender

Figure 4.5: Score card for intensity ranking test - tenderness (Marval, Forestier-Chiron and Bugaud 2018: 16).

5. Lexicon development

Guidelines provided by Kemp, Hollowood and Hort (2011) as well as a descriptive sensory evaluation book by Kemp, Hort and Hollowood (2018).

Attendee requirements:

- Please ensure you do not use any strong - smelling perfume/deodorant
- Please do not smoke or eat any strong - smelling foods

Table 5.1: Programme for lexicon development

Lexicon development part one and two	
Time	**Activity**
09:30-10:00	Tea and refreshments
10:00-10:10	Part 1: Panel orientation
10:10-11:30	Part 2: Generation of attributes
11:30-11:45	Stretch break
11:45-12:45	Part 2: Generation of attributes cont.
12:45	Lunch
End of day one	
Lexicon development parts 3-5	
09:30-10:00	Tea and refreshments
10:00-11:30	Part 3: Scaling of attributes and assessment protocol
11:30-11:45	Tea break
11:45-12:45	Part 4: Pre-test and panel calibration
12:45-13:30	Lunch
13:30-14:30	Part 5: Main test using lexicon
End of day two	

5.1 Part one: Panel orientation and purpose of the lexicon

Panel members are introduced to the general concepts of language development, describing their sensations and perceptions of the product category.

5.1.1 Facilitator's role

During the orientation, the panel leader facilitates introductions and introduces the general concepts of language development, describing their sensations and perceptions of the product category.

5.1.2 Training in the development and use of language descriptors

The Quantitative Descriptive Analysis technique was used to develop a lexicon for goat meat. A spectrum of samples was included in the evaluation to capture the variations in the sensory attributes of goat meat under different preparation conditions (Table 5.2). The factors included:

a) Quality based on location on the carcass (neck, shoulder, loin, leg).
b) Quality based on preparation methods (braising, boiling, grilling [outdoor charcoal grill/ braai], roasting and air-frying).

Storage: Meat samples were stored in vacuum sealed bags in the freezer at -18°C until the samples were ready to be cooked and evaluated. The samples were removed from the freezer 10 hours before cooking and left to thaw in the refrigerator (4°C) (Foodstuffs, Cosmetics and Disinfectants Act no.54 1972, Regulation 638: 6).

Table 5.2: Cooking methods and procedure

Cooking method	**Procedure**	**Cuts of meat**
Braising	An aluminium pan was placed on the stove over medium heat, 15ml of sunflower oil was added to the pan. The meat was placed in the pan after the oil was hot enough and seared for 2 minutes on each side. After browning, the sample was removed from the pan and placed in a vessel with 500ml de-ionized water, which was then set over high heat. The heat was kept high until the water began to boil (5 minutes), then it was reduced to medium, and the sample simmered for 30 minutes with the lid on.	Neck, shoulder Cubed 25mm x 25mm
Boiling	The meat cuts were placed in a cast iron pot with 500ml of water and allowed to boil until cooked.	Shank, leg Cubed 25mm x 25mm for stew
Air- fried	Pre heat the air fryer to 200°C for 3 minutes. Spray the meat with vegetable oil and place in the air fryer basket. Reduce the temperature to 180°C and cook for 5 minutes, turn and cook for a further 5 minutes.	Loin and leg chop 25mm thick
Roasting	The oven was set on "bake" with both top and bottom elements on and allowed to preheat to 180°C. The sample was placed in a roasting pan on a wire aluminium rack (fat side up if there was a fat side). The roasting pan (with the rack) was placed in the oven and cooked to different degrees of doneness e.g. medium (60°C), medium to well (65°C) and well done (71°C).	Leg, shoulder Shoulder shank Leg 500g, 50mm thick
Warmed over flavour – microwave	Once the samples were cooked to the varying degrees of doneness, they were wrapped in aluminium foil and refrigerated for 24 hours. After that time, the samples were reheated in a microwave oven (2 min on high power). The sample was heated until an internal temperature of 60°C was reached.	Leg (roasted), rib chop (braai) neck (braised)
Grilling-outdoor (braai)	A disposable mini braai (Ignite Disposable Picnic Barbeque) was used, and the coal was allowed to burn for approximately 10 mins. The meat sample was then placed on the grill and was turned every 4 mins until the internal temperature (68°C) was reached.	Loin chop and leg chop 25mm thick

5.2 Part two: Generation of attributes

5.2.1 Sample preparation

- Samples were prepared as per Table 5.2.
- One cooking method was used per sample set (two cuts of meat), i.e. roasting of the shoulder and leg.
- The tendon, cartilage, and excess fat on the edge of the meat piece were removed prior to cubing the samples.

5.2.2 Serving and evaluation procedure

- Immediately after the internal temperature was reached, the goat meat sample was removed from the cooking vessel and allowed to rest for 5 minutes. The sample was then cut into approximately 3cm cubes (to allow for the grill marks to be visible) and three pieces of meat were given to each panellist.
- Each sample plate was coded with a random three-digit number and placed on a warming tray 15 minutes before serving (temperature for warming tray approximately 70°C).
- Glass jars with screw-on lids (approximately 120ml) were used to serve meat samples to the panellists.
- Samples were served in the same order to all the panellists.
- One sample set was served at a time with 20 minutes per session. A 10minute break was allowed in-between evaluation of samples. A limited number of samples were presented per session to avoid sensory fatigue.

5.2.3 Compiling attribute list

- Each panel member is asked to divide his/her perceptions into categories/modalities such as ‘before usage’ (appearance, aroma, etc.), ‘during usage’ (flavour, mouthfeel etc.) and ‘after usage’ (after taste).

- Once each panel member has written down his/her individual perceptions, the panel leader will call on each assessor to describe what they have written, tracking each response on the board.
- This process is repeated for three or four products that best represent the range of products in the research, when typically, 90% of the words needed to describe the product category will have been generated.
- Each panellist must independently and qualitatively generate a list of descriptors for all the products presented. Once each panel member has written down his/her individual perceptions, the panel leader will call on each assessor to describe what they have written, tracking each response on the board.
- Panellists are asked to use their own words to describe the product that is presented to them.
- Each panel member must give the descriptors that come to mind for the different attributes (appearance, aroma, flavour, texture, and aftertaste) and write them on the attribute form (Figure 5.1).
- The group will then work by consensus to select the most relevant and most commonly stated descriptors; to group together synonyms and antonyms; and to eliminate hedonic, irrelevant or quantitative terms.
- The terms selected are the descriptors which, after the sorting-out process described above, have been validated by over 70% of the panel.

Generation of attributes **Write the word/s that you think best describe each of the samples presented to you**						
Attribute	Appearance	Aroma	Taste	Texture	After taste	Other
Words that describe the sample						

Figure 5.1: Attribute generation form for panel members

5.3 Part three: Scaling attributes and assessment protocol

- An evaluation form including the definitions, assessment protocol and 10-point rating scale for **four of the products** previously contrasted was created (Table 5.2).
- Each descriptor was defined according to a precise method of characterisation. A table was drawn up with the selected panel that included the definition and assessment protocol for each attribute as well as the limits for a scale that had been chosen previously.
- The sample assessment protocol was clearly defined (smell, first bite, chew, swallow, aftertaste). Panel members understand and agree on the use of the scale and the anchors for attributes.
- Individual panel members must be able to repeat the assessment.

Table 5.2: Detailed evaluation form for lexicon

Attribute	**Term**	**Definition**	**Assessment protocol**
Appearance			
Aroma			
Taste			
Texture			
After taste			

5.4 Part four: Pre-test and panel performance

- Serve what are expected to be the two most different samples (boiled and roast) in the project.
- Assess the words that were selected in the brain storming session on a continuous line scale.
- Make sure all the assessors agree and verify where the two samples in the pre-test are on an unstructured 10cm scale for all attributes assessed.
- Adjust the list of attributes, remove redundant attributes, add ones that differentiate the samples better.
- Use two-way ANOVA testing, bi-plot chart, and spider plot to analyse results.

5.5 Part five: Main test using lexicon

- The list of attributes and assessment protocol is set, and the assessors agree on what the attributes describe in the product.
- Each assessor was served two samples, which were evaluated twice to be able to control that they can reproduce their assessment.
- All attributes are assessed for each product in the test on a continuous scale from 1 to 10.

The lexicon that was developed for the main test including the attributes, terms, definitions and protocols is shown in Table 5.2.

Table 5.3: Lexicon generated to be used in main test

Attribute	Term	Definition	Protocol
Appearance	Pinkish-brown	Varying in colour ranging in hues of pink and brown	Visually look at the sample, turning it to reveal both sides. Take note of variegated colouring and surface appearance.
	Brownish-grey	Varying in colour ranging in hues of brown and grey	
	Caramelized	Dark brown exterior as a result of caramelization due to cooking	
	Poorly marbled	Lack of fat distribution in the specific piece of meat	
	Marbled	Fat distribution present in the piece of meat	
Aroma	Meaty	Aroma characterised by animal products	Open the glass jar with the sample, place close to your nose and take two short sniffs.
	Boiled	Reminiscent of moist heat preparation typical of the boiling process	
	Gamey	Aroma associated with undomesticated animals	
	Smoky	Distinct aroma associated with grilling using charcoal	
	Earthy	Reminiscent of a natural, unadulterated aroma, clean and free of chemicals	
	Bloody	Metallic aroma associated with undercooked meat due to the presence of blood	
Attribute	**Term**	**Definition**	**Protocol**
	Meaty	Characteristic of animal products	Place the sample in your mouth and chew starting the
	Charred	Associated with dry cooking methods such as grilling/braaiing which results in seared meat	

Flavour			mastication process to release the flavour of the sample being evaluated. Take note of the initial flavour and whether the flavour intensifies or not as chewing progresses.
	Sweet	Natural sweetness of meat highlighted when caramelized	
	Irony	Associated with the presence of blood in meat and its metallic properties	
	Umami	Savoury flavour naturally found in meat, highlighted through the grilling process	
Texture	Tender	Not resistant to bite and minimal chewing required to break down the meat	Place the meat sample in your mouth and bite down using your front teeth- take note of the amount of force required to bite into the sample. Proceed to chew the sample, taking note of the number of times the sample needs to be chewed before breaking down. Take note of the residual feel in the mouth after swallowing/ expectorating the sample.
	Tough	Firm, with little resistance, effort required to break down the meat	
	Chewy	Springy, with effort required to break down the meat	
	Dry	Associated with shorter muscle fibres and a lack of liquid usually due to overcooking	
	Moist	Associated with optimal cooking times and temperatures that retain natural juices present in the meat	
	Mouth coating	Residue remaining after chewing meat that coats the palate	
	Stringy/fibrous	Associated with meat from an older carcass that has lost its water retaining capacity	

The score cards used for the pre-test and main test are depicted on the next four pages (Figure 5.2 to 5.6).

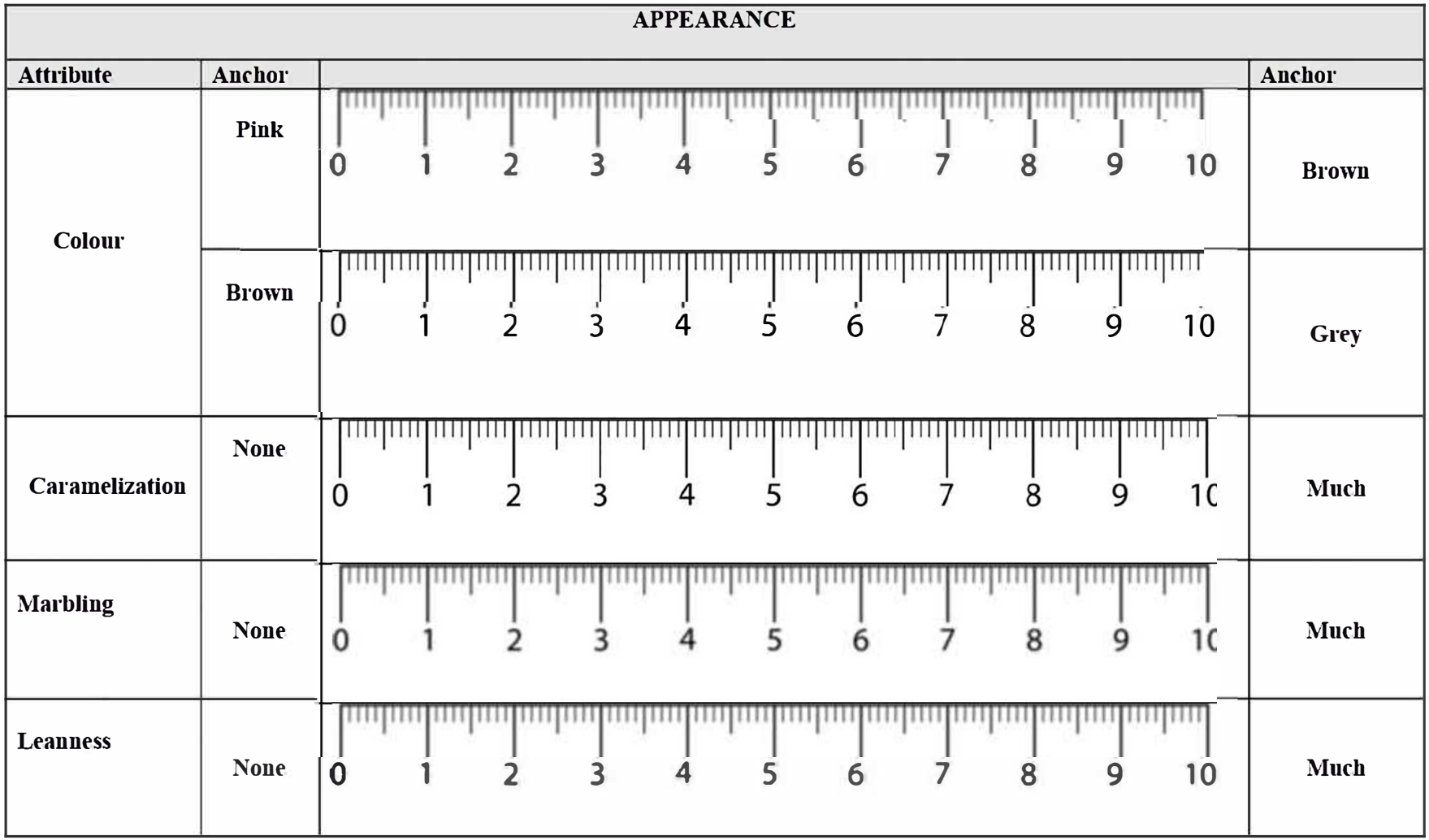


Figure 5.2: Lexicon score card for appearance

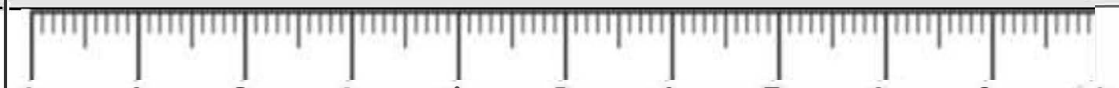
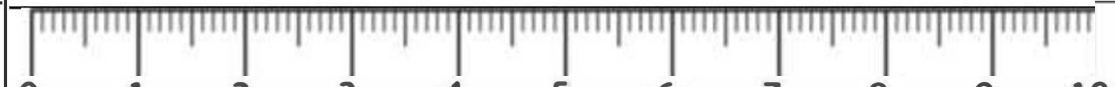
AROMA			
Attribute	**Anchor**		**Anchor**
Boiled aroma	**None**		**Much**
Gamey	**None**		**Much**
Smoky	**None**		**Much**
Bloody	**None**		**Much**

Figure 5.3: Lexicon score card for aroma

FLAVOUR			
Attribute	**Anchor**		**Anchor**
Meaty	**None**		**Much**
Charred	**None**		**Much**
Sweetness	**None**		**Much**
Irony	**None**		**Much**
Umami	**None**		**Much**

Figure 5.4: Lexicon score card for flavour

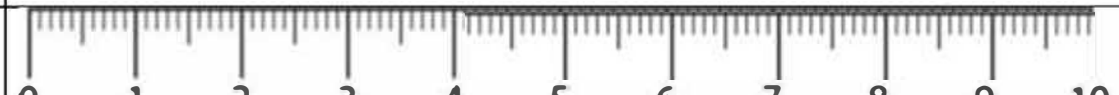
TEXTURE			
Attribute	**Anchor**		**Anchor**
Tenderness	**Tender**		**Tough**
Chewiness	**Not at all**		**Much**
Juiciness	**Dry**		**Juicy**
Fibrous	**Not at all**		**Much**

Figure 5.6: Lexicon score card for texture

6. References

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O'sullivan, M. 2016. *A handbook for sensory and consumer-driven new product development: innovative technologies for the food and beverage industry*. Woodhead Publishing.

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Appendix J: Attribute generation form

Generating attributes

Evaluate the sample in front of you and answer the following questions

Required

1. Write down your name and surname

Move to sample 327

2. Sample 327 - write down all the words that best describe the **appearance** of this sample

3. Sample 327 - write down all the words that best describe the **aroma** of this sample

4. Sample 327 - write down all the words that best describe the **flavour** of this sample

5. Sample 327 write down all the words that best describe the **texture** of this sample

6. Sample 327 write down all the words that best describe the **after taste** of this sample

Move on to sample 431

7. Sample 431- write down all the words that best describe the **appearance** of this sample

8. Sample 431- write down all the words that best describe the **aroma** of this sample

9. Sample 431 write down all the words that best describe the **flavour** of this sample

10. Sample 431- write down all the words that best describe the **texture** of this sample

11. Sample 431- write down all the words that best describe the **after taste** of this sample

Move on to sample 967

12. Sample 967- write down all the words that best describe the **appearance** of this sample

13. Sample 967- write down all the words that best describe the **aroma** of this sample

14. Sample 967- write down all the words that best describe the **flavour** of this sample

15. Sample 967- write down all the words that best describe the **texture** of this sample

16. Sample 967- write down all the words that best describe the **after taste** of this sample

4/7

Move on to sample 680

17. Sample 680- write down all the words that best describe the **appearance** of this sample

18. Sample 680- write down all the words that best describe the **aroma** of this sample

19. Sample 680 write down all the words that best describe the **flavour** of this sample

20. Sample 680- write down all the words that best describe the **texture** of this sample

21. Sample 680- write down all the words that best describe the **after taste** of this sample

Move to sample 522

22. Sample 522- write down all the words that best describe the **appearance** of this sample

23. Sample 522- write down all the words that best describe the **aroma** of this sample

24. Sample 522- write down all the words that best describe the **flavour** of this sample

25. Sample 522- write down all the words that best describe the **texture** of this sample

26. Sample 522- write down all the words that best describe the **after taste** of this sample

6/7

Move to sample 834

27. Sample 834- write down all the words that best describe the after **appearance** of this sample

28. Sample 834- write down all the words that best describe the after **aroma** of this sample

29. Sample 834 write down all the words that best describe the after **flavour** of this sample

30. Sample 834- write down all the words that best describe the after **texture** of this sample

31. Sample 834- write down all the words that best describe the after **after taste** of this sample

Appendix K: Consumer sensory evaluation

LETTER OF INFORMATION

Title of the Research Study: Product development, lexicon creation and sensory acceptability of goat meat products for the emerging consumer.

Principal researcher: K Palmer (Masters Consumer Sciences: Food and Nutrition),

Co-Investigator/s/supervisor/s: Dr Ashika Naicker (PhD: Nutrition) and Prof U Kolanisi (PhD: Food Security)

Brief Introduction and Purpose of the Study:

Good day. I, Karina Palmer am a PhD student registered at the Durban University of Technology in the Department of Consumer Sciences.

I am conducting a research study to determine the sensory acceptability of goat meat products to encourage consumption of goat meat by young adults as a sustainable and nutritious food source. In this context, we invite you to participate in the consumer acceptance sensory evaluation.

Outline of the Procedures:

Two processed goat meat products have been developed in a lab setting and have undergone microbiological and nutrient testing prior to the sensory evaluation. There will be a series of sensory evaluation sessions, these sessions will be conducted at your university in the Department of Consumer Sciences. The duration of the consumer acceptance sensory evaluation will take no more than 30 minutes to complete.

Risks or Discomforts to the Participant:

There will be no risks to you for your participation in this sensory evaluation session.

Explain to the participant the reasons he/she may be withdraw from the study:

Should you wish to withdraw from the sensory evaluation, there will be no adverse consequences.

Benefits:

This study will benefit the advancement of knowledge of the acceptability of products developed from goat meat to increase the consumption of goat meat by young adults.

Remuneration:

You will not receive any remuneration for completing the sensory evaluation.

Costs of the Study:

There will be no cost incurred to you if you participate in this study.

Confidentiality:

The sensory evaluation forms have no identifying values that can link the information to you such as; your name or identity number. All data will be stored in a password protected electronic format All data collected will only be used for research purposes.

Results: The results of the sensory evaluation will be published in a PhD thesis, an accredited journal and through a webinar.

Research-related Injury:

There is no expected research related injury from your participation in this survey.

Storage of all electronic and hard copies including tape recordings

Data will be stored in the Durban University of Technology: Department of Consumer Sciences: Food and Nutrition server. This information will only be available to the research team for a retention period of 5 years.

Persons to contact in the Event of Any Problems or Queries:(Mrs K Palmer) Please contact the researcher (074 645 7004) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za.

CONSENT

Full Title of the Study: Product development, lexicon creation and sensory acceptability of goat meat products for the emerging consumer.

Names of Researcher/s: Karina Palmer, Ashika Naicker, Unathi Kolanisi

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Karina Palmer,

about the nature, conduct, benefits, and risks of this study - Research Ethics Clearance Number: 071/21,

- I have also received, read, and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

Full Name of Participant	Date	Time	Signature

I, Karina Palmer, herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Full Name of Researcher	Date	Signature
Karina Palmer	20 October 2022	

Sensory evaluation score card

Participant number: ……

Please place a tick (✓) to indicate your response.

1. University

☐ University of Zululand
☐ Durban University of Technology

2. Gender

☐ Male
☐ Female

3. Ethnic group

☐ African
☐ Indian
☐ White
☐ Coloured

4. Age

☐ 17-20 years
☐ 21-24 years
☐ 25-28 years
☐ 29 years or >

Score card 1: Check All That Apply

Sample 326

Please tick ✓ the words that you think best describes the sample you have tasted. You can select as many as you like. There are no right or wrong answers.

Aroma/odour		Appearance		Flavour		Texture	
	Boiled		Pinkish-brown		Meaty		Tender
	Gamey		Brownish-grey		Charred		Tough
	Smokey		Caramelised		Sweet		Chewy
	Bloody		Lean		Iron (metallic)		Dry
			Marbled		Umami (savoury)		Juicy
							Fibrous

Score card 2: Food action rating scale

Sample 326

You are presented with a food sample. Please taste the sample and tick ✓ **ONE** box that best describes how you feel about it.

- ☐ I would eat this every opportunity that I had
- ☐ I would eat this very often
- ☐ I like this and would eat it now and then
- ☐ I would eat this if available but would not go out of my way
- ☐ I don't like this but would eat it on occasion
- ☐ I would hardly ever eat this
- ☐ I would eat this only if forced to

Score card 3: Check all that apply

Sample 871

Please tick ✓ the words that you think best describes the sample you have tasted. You can select as many as you like. There are no right or wrong answers.

	Aroma/odour		Appearance		Flavour		Texture
	Boiled		Pinkish-brown		Meaty		Tender
	Gamey		Brownish-grey		Charred		Tough
	Smokey		Caramelised		Sweet		Chewy
	Bloody		Lean		Iron (metallic)		Dry
			Marbled		Umami (savoury)		Juicy
							Fibrous

Score card 4: Food action rating scale

Sample 871

You are presented with a food sample. Please taste the sample and tick ✓ **ONE** box that best describes how you feel about it.

- ☐ I would eat this every opportunity that I had
- ☐ I would eat this very often
- ☐ I like this and would eat it now and then
- ☐ I would eat this if available but would not go out of my way
- ☐ I don't like this but would eat it on occasion
- ☐ I would hardly ever eat this
- ☐ I would eat this only if forced to

Score card 5: Paired preference

Based on the two samples that you have tasted, circle the sample that you prefer.

326 **871**

To Whom It May Concern

Re: Editing of Doctoral Dissertation entitled:

Product development, lexicon creation and sensory acceptability of goat meat products for the emerging consumer Student: Karina Palmer

This is to certify that I have recently edited this paper in terms of language usage and grammatical correctness.

I am an experienced editor and proof reader and have edited several academic dissertations/theses and various academic papers.

My academic qualifications are as follows:

Bachelor of Arts (English and Afrikaans) (UN Durban)

University Education Diploma (UED) (UN Durban)

Diploma in Translation (Afrikaans/English) (Unisa)

Prior to my retirement I was for several years initially a senior editor and subsequently a senior publisher with Via Afrika Publishers in Cape Town, which is the educational publishing arm of the Naspers/Media 24 company.

I was subsequently employed as a publisher on a one-year contract basis at Oxford University Publishers in Cape Town.

Michael Vermeer
Editor Proofreader Translator

07 December 2022