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A Comparative Study on the Effects of Feedlot and Grazing System on Nutritional Profile of Indigenous Beef: A Case Study of Chipata District Eastern Zambia

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Abstract
Beef production systems greatly affect the nutritional quality and consumer acceptability of meat. In Zambia, indigenous breeds like Angoni cattle are very important in rural livelihoods and food security; however, there is limited information on how feeding strategies influence their nutritional profile. The current study compared feedlot and grazing systems on the nutritional composition and quality of indigenous beef in Chipata District. Using a quasi-experimental design, ten meat samples were collected-five from cattle reared under feedlot conditions and five from grazing systems. Laboratory analyses on protein, fat, moisture, and fatty acid composition were done using mass spectrometry and gas chromatography, while sensory attributes such as tenderness, flavor, and color were evaluated. There were marked differences between the two systems. Feedlot beef had higher levels of omega-6 fatty acids and saturated fats, while the protein content ranged up to 69.92%. On the contrary, the grazing beef showed a superior level of monounsaturated fatty acids, higher levels of omega-3 fatty acids, and protein value reaching 68.87%. The grazing system similarly produced leaner meat with favorable fatty acid ratios, which may imply some health benefits like reduced incidence of cardiovascular diseases. On the other hand, feedlot systems enhanced rapid growth and marbling at the expense of nutritional balance. These findings highlight some trade-offs between productivity and nutritional integrity. Grazing systems offered better fatty acid profiles and aligned well with sustainable livestock practice, although feedlots provide efficiency.

Keywords: Rotational Grazing System, Feedlot System, Nutritional Content, Comparative Study, Crude Protein and Monounsaturated Fat

Introduction

Background Consumer awareness of nutrition and food quality has continued to drive the demand for high-quality beef throughout the world. In Zambia, indigenous breeds like Angoni cattle are central to the production, raised under grazing and feedlot systems that influence beef's nutritional profile. Grazing systems where cattle feed on natural pasture are associated with healthier meat, while feedlots ensure faster growth and efficiency. However, in the case of indigenous Angoni beef, there is no clear understanding of how these systems influence the product. Indigenous breeds, such as the Barotse, Angoni, and Tonga, are adapted to the local conditions and are resistant to diseases and heat stress, hence playing a pivotal role in the livelihood of rural people, despite them normally showing slower growth and lower carcass yields compared to the exotic breeds. This is according to Musonda *et al*. (2020) [11] and Simukoko *et al*. (2021) [17].

Quality beef largely relies on cattle diet, which influences the fatty acid composition and tenderness of the beef. Pasture-fed cattle are usually leaner, with a higher content of conjugated linoleic acids, which is considered healthy for human beings. However, seasonal feed shortages result in inconsistent quality, hence requiring supplementation using protein-rich forages and mineral licks. Minerals such as iron and zinc may be crucial to alleviate micronutrient deficiencies, while pasture-fed systems improve the nutritional value of meat products. Optimization of cattle nutrition through proper rations and forage management increases productivity levels and maintains food security.

Beef production has become polarized between grazing and feedlot systems on a worldwide scale, each with significant impacts on nutrition and sustainability. Grazing emphasizes ecological balance and leaner beef, while feedlots maximize efficiency but risk metabolic disorders. Grass-fed beef contains more omega-3s and CLA, while grain-fed beef has more saturated fats. Domestication of cattle dates back to 8000 BCE, according to Smith (2006) [18], while in the present day, beef production is dominated by countries such as the U.S., Brazil, and China. The pastoralist tradition continues to thrive in Africa, although feedlots raise acute environmental sustainability concerns. Anaerobic digesters and novel integrated systems that marry regenerative grazing with precision feedlots are among new innovations that offer mitigations to the environmental costs while maintaining a high level of productivity with ecological resilience.

Problem Statement

The nutritional composition of beef varies significantly between feedlot and grazing production system, yet there is limited research that has been done on how these different production systems affect the nutritional profile of indigenous beef. Studies by Odubole (2022) [14] indicated that feedlot systems typically produce beef with higher fat content due to grain-based diets, while grazing systems yield leaner meat enriched with health-promoting fatty acids like monounsaturated fats. Cheng *et al*. (2025) [2] added that grass-fed beef may contain higher levels of antioxidants and other micronutrients, such as vitamins and iron, compared to grain-fed counterparts.

While Siebecker *et al*. (2024) [16] on Nguni and Tuli cattle breeds, further highlighted that, those grazing systems enhance meat quality through diverse forage intake, despite having trade-offs in productivity. The core problem addressed in this study was the lack of comparative data on how feedlot and grazing systems influence the nutritional profile of indigenous beef, which is critical for regions like Zambia where cattle rearing is both economically and culturally vital. Specifically, this research compares key nutritional metrics such as protein and fats and moisture content between the two systems, and evaluates the health implications for consumers while emphasizing the unique attributes of indigenous breeds. By addressing these gaps, the study provides essential guidance for farmers and policymakers in adopting feeding strategies that enhance productivity without compromising nutritional integrity or environmental health.

Research Objective

To compare the effects of grazing and feedlot systems on nutritional profile of indigenous Angoni beef in Kaphinde Camp Chipata District.

Specific Objectives

In order to address the research problem outlined above, this study pursued the following objectives.

1. To compare the protein, the fats and moistures content between grazing and feedlot beef.
2. To analyze the influence of the protein, fat and moisture content on the quality of beef feedlot and grazing systems.
3. To suggest beef production practices that can improve nutritional quality of meat.

Hypothesis

H01: There is no significant difference in the nutritional composition (protein, fat and moisture content) of indigenous beef between grazing and feedlot systems.

HA1: There is a significant difference in the nutritional composition (protein, fat and moisture content) of indigenous beef between feedlot and grazing systems.

H02: There is no significance difference in the influence of protein, fat, and moisture content on beef quality from feedlot versus grazing systems.

HA2: There is a notable difference in the influence of protein, fat, and moisture content on the quality of beef from feedlot and grazing systems.

H03: There is no significance differences in the practices as in regard to their influence on beef quality.

HA3: There is a significance differences in the practices as in regard to their influence on beef quality.

Significance of Study

The purpose of this study was to address the gap of knowledge on nutritional profile of the indigenous beef and provide guidance for better quality of beef production. Beef production in Zambia plays a vital role in the country's agriculture economy and food security. Specifically, the common production systems used were feedlot and grazing systems, both of which have significant implications for the nutritional content of beef, overall meat quality, and promote health beef for consumers. Lubungu and Sitko (2015) had documented a lack of localized research on similarities and differences in livestock production systems in Zambia's indigenous beef cattle industry, with special reference to Chipata District of Eastern Province. Even with rising demand for quality beef and concerns related to health benefits, conventional agriculture still dominates. However, farmers, policymakers, and consumers have no definite idea and evidence based on information of between these systems, and therefore it becomes challenging to support practices that have economic feasibility along with environmental sustainability. This information will help the stakeholders to make the informed decisions regarding to which production system optimally balances nutritional value and meat quality. By doing so the study seeks to inform best practices for beef production in Eastern Zambia and contribute to policy development, sustainable livestock management, and improved consumer health outcomes.

Literature Review

The nutritional profile of beef, mainly regarding its contents of protein, fat, and moisture, strongly depends on the type of production system employed during cattle growth. Literature is consistent that grazing systems tend to produce leaner beef with a high moisture content with slightly higher protein content, whereas feedlot production systems increase intramuscular fat deposition with grain-based, energy-dense diets (Nuernberg *et al*., 2005; Chisha *et al*., 2017) [13, 4]. These differences have major implications for sensory quality, nutritional health, and consumer preferences. Generally, moisture retention is higher in pasture-fed beef, owing to the lower fat infiltration that allows more water to occupy muscle spaces, enhancing juiciness and cooking yield (Bautista-Martínez *et al*., 2020; Chingala *et al*., 2018) [1, 3]. On the other hand, feedlot beef has been consistently associated with higher intramuscular fat and marbling, which improve tenderness and flavor yet increase the caloric density of meat (Pethick *et al*., 2011; Tembo *et al*., 2019) [15, 19].

Early comparative studies established that leaner muscle is developed under grazing, largely attributed to increased animal activity and lowered dietary energy intake. These findings by Nuernberg *et al*. (2005) [13] and Chisha *et al*. (2017) [4] align with the objective of the present study, aimed at assessing protein variability and support the expectation that higher protein levels may be observed in cattle from Zambia's grazing systems. In the same way, evidence that grain-fed feedlot systems enhance fat deposition, as reported by Pethick *et al*. (2011) [15] and Odubole (2022) [14], thus informs a theoretical expectation of elevated fat content in feedlot beef.

Although less frequently investigated in regional studies, moisture content is widely recognized as being inversely related to intramuscular fat. Experimental evidence has been able to establish that with increases in fat, there is a reduction in muscle water content, as shown by Bautista-Martínez *et al*. (2020) [1] and Chingala *et al*. (2018) [3]. Such findings justify the trends of moisture observed in the present study and further validate the use of moisture content as one of the key indicators of beef quality.

Various African studies further demonstrated that indigenous and pasture-raised cattle in Southern Africa tend to present lean carcasses with higher moisture contents (Muchenje *et al*., 2010; Esterhuizen *et al*., 2008; Mawona, 2010) [10, 6, 9]. Since this study is also dealing with indigenous cattle of similar adaptive traits, these findings directly support the assumption that ecological conditions and genetic adaptability largely affect nutrient composition in beef.

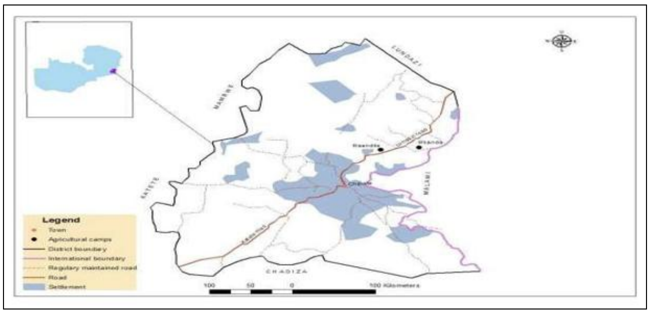
Recent Zambian research has also increasingly examined nutritional differences arising from varied production systems; however, most studies highlight methodological shortcomings, such as limited sample control and inconsistent analytic methods. Examples of such studies include Tembo *et al*. (2019) [19] and Mwale *et al*. (2023) [12]. These shortcomings highlight the importance of the methodological precision applied in the present study, where standardized laboratory techniques like Kjeldahl, gravimetric analysis, and gas chromatography were employed to obtain reliable results.

Furthermore, the extensive studies on fatty acid composition have demonstrated that grass-fed cattle tend to yield beef with a better profile of lipids, having higher concentrations of beneficial fatty acids. These benefits have been noted in literature by Daley *et al*., 2010 [5]; Hocquette *et al*., 2010 [8]; Van Vliet, 2021 [20]; and Hall & Schönfeldt, 2015–2016 [7]. This enhances the nutritional and public-health interest in focusing on fat content within beef sourced from different production environments. In sum, the literature supports the conceptual basis for this study: production systems wield a large influence on nutritional composition, and these variations in nutrition contribute to divergences in the overall quality of the meat. This should justify the importance and relevance of the research to enable informed livestock management and improved consumer health in Zambia.

Materials and Methodologies

This chapter gives a detailed overview of the research framework. It describes the experimental site, including its geographical location, climate, and relevance to the study goals. It outlines the experimental design, detailing the layout, treatments, and replication methods to ensure reliability and validity. The section also covers the experimental materials and procedures, including the selection of subjects, equipment, and the protocols followed during the study. Finally, it explains the data collection techniques and statistical analysis methods used to interpret the results and draw meaningful conclusions.

Site and Location



Source: https://www.Chipata, Zambia district 2022.

Experimental Design

The research design is the overall plan, framework, or blueprint that provides the logical structure for a study. Research design is defined as framework methods and techniques chosen by a researcher to combined various components of research in a reasonably logical manner so that the research problem is efficiently handled according to Seliz. C. (2023). The research used a cross-section study design, where samples from various cattle ages and different animal sex was collected. This research design allows data collection from a diverse group of cattle at a single point and time and data collection occurs at one point making it relatively quick and cost effective. The study used an observational field-based method that systematically sampling beef cattle from farms that practice tradition grazing and those that operate feedlot systems. This is so because the design allows for direct comparisons of nutritional outcomes, such as protein content, fat composition, moisture content and fatty acids.

Description of Experimental Materials

Experimental materials refer to the tangible or intangible items, such as biological samples, chemical reagents, engineered components, or digital stimuli, used in a study to support the manipulation of independent variables and the measurement of dependent variables in a controlled environment Kumar *et al*., (2023). In this study ten beef samples weighing 100g per sample were taken from two different farms which these production systems are done respectively, from grazing and feedlot. Later, the samples of beef were taken to laboratory for data analysis. Thereafter, the raw data was use to conduct statistical test such as ANOVA and multiple comparisons using SPSS 20 software at 0.05 significance level.

Data Collection

The study used stratified random sampling technique, in which samples were taken from 10 beef sample of 10 cattle from two different farms where five of them from feedlot and another five from grazing farm. The cattle were clinically healthy of the ages 18 to 24 months, were chosen for data collection. They were equally represented from feedlot and grazing systems. Study Procedures Muscle samples were taken from the Longissimus dorsi of slaughtered cattle. This muscle is one of the most used in studies of meat quality because it is uniform and relates well to consumer preference. The procedure for samplings was standardized in order to minimize animal-to-animal variability that could arise from differences in muscle type or anatomical location. Each sample was labeled, kept under controlled conditions, and promptly transported to authorized laboratories to maintain its integrity and prevent biochemical changes that might alter the results.

Laboratory Procedures Once in the laboratory, the samples were analyzed using conventional methods established by the Association of Official Analytical Chemists (AOAC). These procedures have been internationally recognized for their reliability and accuracy regarding food composition analysis. The following nutrients were measured by nutritional proximate analysis were all the samples analyses Lamp A2, Mutton C2 and Mutton for Protein, fats moisture content Ash and energy of the samples from grazing and feedlot systems. Every test was done under strict quality control protocols in order to achieve reproducibility and meet laboratory standards. Integration of Results The data that was generated from these analyses provided a comprehensive nutritional profile of the beef samples. Comparing protein, fat, and moisture levels across different cattle management.

Method of Data Collection

To provide a controlled comparison between the two feeding systems, a quasi-experimental approach was used. Ten cattle from feedlots and pasture systems, all certified healthy and between the ages of 18 and 24 months, were chosen by stratified random sampling. Following slaughter, muscle samples were gathered and examined in approved labs utilizing GC-MS for fatty acid profiling and AOAC (2016) methods for proximate composition. Supplementary data were acquired by semi-structured interviews and direct observation of feeding behaviors, pasture conditions, and management procedures.

Analysis of Statistical Data

Descriptive statistics were used to assess quantitative data and summarize the amounts of protein, fat, and moisture in both systems. To identify significant variations in nutritional composition and meat quality indices, inferential techniques such as independent t-tests and one-way ANOVA were used. Fixed effects models and rigorous tests of equality of means. To guarantee dependability and scientific rigor, all statistical tests were carried out at a 95% confidence level.

Identifying the Statistical Software

IBM SPSS Statistics version 26 was the statistical program utilized for data analysis in this investigation. This software made it easier to do descriptive statistics, t-tests, and ANOVA, guaranteeing precise interpretation of dietary and quality variations. Because SPSS is compatible with laboratory-generated datasets and is robust when handling biological data, it was selected. In order to depict the main findings, SPSS was also used to create graphical outputs including pie charts and marginal means plots.

Significance Level

All statistical tests were conducted with a significance level of $p < 0.05$. This cutoff point was used to assess the statistical significance of reported variations in meat quality and nutritional content between feedlot and pasture systems. P-values less than 0.05 were regarded as significant, meaning that it was unlikely that the differences were the result of chance. This standard is in line with accepted methods in nutritional and agricultural research.

Findings/ Results

For objective one, Multiple Comparison of Protein, Fats and Moisture content of indigenous beef from Grazing and Feedlot System.

		Grazing	Grazing	Grazing	Feedlot	Feedlot	Feedlot
Nutritional analysis	unit	Fresh	Dry	Boiled	Fresh	Dry	Boiled
Moisture	g	66.2	73.8	60.2	65.5	63.4	60.0
Protein (N* 6.25)	g	23.2	17.09	18.9	20.3	16.07	18.07
Fat	g	10.1	9.8	17.06	13.1	10.2	9.07
Ash	g	2.6	1.15	0.9	3.01	1.21	1.9
Energy	kJ	678	802	915	699	789	978
SAMPLE 2							
Moisture	g	65.1	72.9	70.1	63.5	63.9	62.9
Protein (N*6.25)	g	22.5	20.9	18.9	21.2	18.7	17.9
Fat	g	10.7	9.17	7.89	12.5	11.9	10.5
Ash	g	2.90	2.07	1.97	1.89	0.67	1.57
Energy	kJ	695	899	976	690	789	987

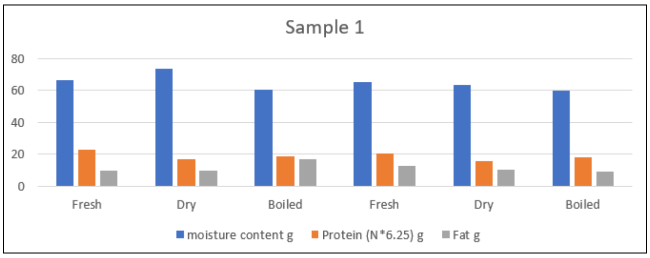


Chart 4.3.4 Shows the trends in nutritional variations and between grazing and feedlot system. Sample 1: clearly show the decreases from fresh to dry to boiled in both production systems. Fat content slightly variations and the protein content appear relatively stable across all conditions. While in sample 3: moisture content is higher in grazing which 60% to relatively 80% than in feedlot system which below 60%. Protein is similar between two systems and finally, Fat is higher is slightly higher in feedlot system compared to the grazing system.

Figure 4.3.4: Estimated Marginal means of protein Content

The diagram below shows the mean plot of estimated marginal means of protein content and the results were got after ANOVA using 5% level of significance. the results clearly indicate that that grazing system has a high protein content compared to the feedlot one.

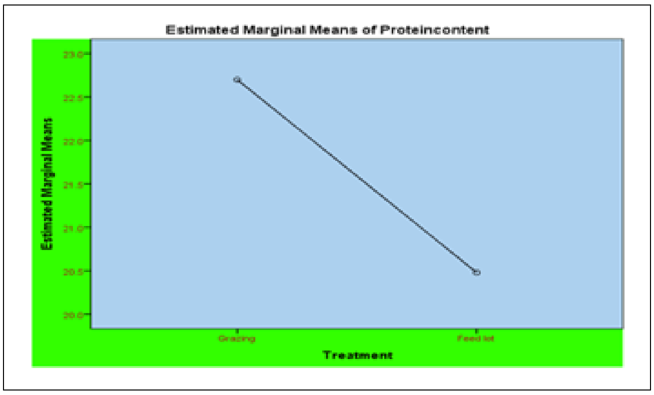


Figure 4.2 highlights the comparison between the grazing system and the feedlot system regarding protein content. According to the estimated marginal means of protein content derived from the ANOVA results, the grazing system exhibits a higher protein content. This difference is statistically significant at the 5% level of significance. These findings demonstrate that production environment plays a meaningful role in influencing the nutritional quality of indigenous beef, with grazing conditions promoting superior protein retention compared to intensive feedlot feeding.

ANOVA and Robust Tests of Equality of Means of Fat Content

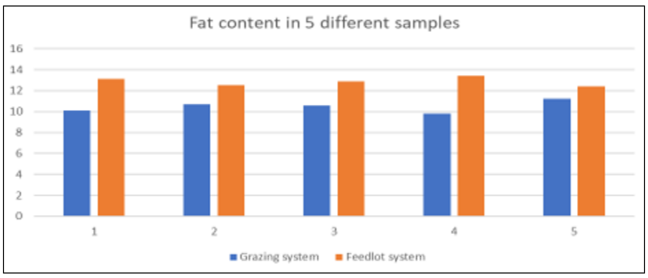
Highlights the ANOVA and Robust test of equality of fat content and testing the hypothesis of whether there is there is the significance difference between the feedlot and grazing system.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	14.161	1	14.161	60.260	.000
Within Groups	1.880	8	.235		
Total	16.041	9			

The ANOVA analysis shows a significant difference in fat content between the groups tested. This is because the p-value (.000) is less than 0.05, indicating a statistically significant result. With an F-value of 60.260, we can reject the null hypothesis that the group means are equal.

Multiple Samples of Fats from two different beef production systems

Shows multiple samples of fats from two different beef production systems. The chart compares the fat content in samples from these two systems, with blue bars representing grazing system and orange bars representing the other. The fat content in both systems appears to be relatively consistent across the sample shown.



Source: Generated from excel (2025)

Omnibus Test and Parameter Estimates of Moisture Content

This diagram below represents the omnibus test and parameter estimates of moisture content between feedlot system and grazing system.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
19.720	1	.000

Dependent Variable: Moisturecontent
Model: (Intercept), Treatment

a. Compares the fitted model against the intercept-only model.

Parameter Estimates

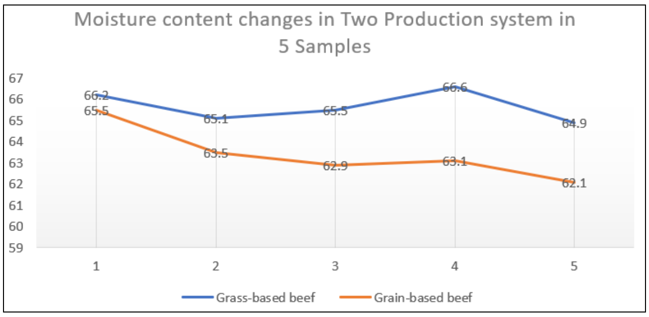
Parameter	B	Std. Error	95% Wald Confidence Interval Lower	Upper	Hypothesis Test Wald Chi-Square	df	Sig.
(Intercept)	62.820	.2553	62.320	63.320	60526.877	1	.000
[Treatment=1]	2.840	.3611	2.132	3.548	61.853	1	.000
[Treatment=2]	0	.	.	.	.	.	.
(Scale)	.326	.1458	.136	.783			

Source: SPSS software (2025)

The omnibus test checks if there's a statistically significant difference in moisture content between beef from grazing and feedlot systems. With a likelihood ratio chi-square of 19.720 and a p-value of .00, the test indicates a significant difference between the systems. The parameter estimates show the average difference in moisture content between the two systems, suggesting that the production method (grazing against feedlot) impacts beef moisture levels.

Shows the Moisture content in the five samples

Shows multiple samples of moisture content from two different beef production systems. The chart compares the fat content in samples from these two systems, with blue bars representing grazing system and orange bars representing the other. The moisture content in both systems appears to be relatively consistent across the sample shown.



Compares the moisture content changes in grass-based beef and grain-based beef across five samples. Grazing produced beef consistently shows higher moisture content than feedlot counterpart. Though both types of production systems experiences fluctuations in moisture content across the collected samples, but grass-based beef remains above grain-based beef. The moisture content in grass-based beef ranges from approximately 64.9 to 66.6 while feedlot production beef it ranges from about 62.1 to 63.6.

Second Objective: Presentation of Findings on Influence of Production System Nutrients Profile on Quality of Beef

Presents the findings influence of production system nutrients on indigenous beef quality. Analyzing protein, fat and moisture content in indigenous beef from feedlot and grazing systems helps to understand how production methods impact beef quality factors like tenderness, flavor and nutritional value. This understanding can inform producers on optimal production choices to meet consumer preferences and market demands for indigenous beef in Zambia.

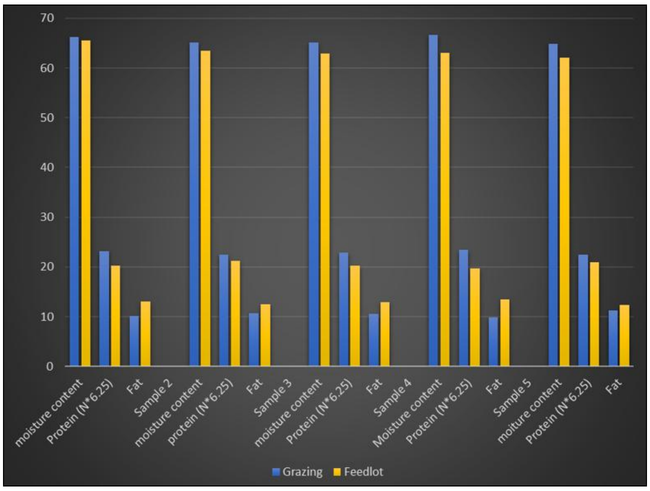


Fig 4.3: The Influence the of Two different Production system on Quality of Indigenous Beef

The figure compares the Moisture content, Protein and Fats of beef from five samples under two different systems that is grazing and feedlot. In all five samples, the grazing system results in higher moisture content compared to the feedlot system, while the feedlot system leads to higher protein content. This suggests that the grazing system produce beef that's more tender and juicier due to higher moisture, whereas the feedlot system could result in beef with potentially more concentrated protein.

Discussion

The findings of this study show clear nutritional differences between beef produced under grazing and feedlot systems, supporting earlier literature on the influence of production systems on meat quality. Moisture content was consistently higher in grazing beef samples (64.9–66.6 g) compared to feedlot beef (62.1–65.5 g). This aligns with claims by Bautista-Martínez *et al*. (2020) [1] and Chingala *et al*. (2018) [3] that lower fat infiltration in grazing animals allows muscle spaces to retain more water. Higher moisture often contributes to improved juiciness and tenderness characteristic relevant to indigenous consumer preferences.

Protein levels were relatively close between the two systems, with grazing samples ranging between 22.4–23.5 g and feedlot samples between 19.7–21.2 g. However, the ANOVA results indicated a statistically significant difference favoring the grazing system. These results support earlier assertions by Nuernberg *et al*. (2005) [13] and Chisha *et al*. (2017) [4], who found that grazing systems promote leaner muscle development due to higher animal activity and lower dietary energy density. The higher protein concentration in grazing beef found in this study reinforces these conclusions and suggests that natural pasture diets favor protein retention.

Fat content showed the most notable divergence between systems, with feedlot beef recording consistently higher fat values (12.4–13.4 g) than grazing beef (9.8–11.2 g). This is consistent with Odubole (2022) [14] and Pethick *et al*. (2011) [15], who report that grain-based, energy-dense diets enhance intramuscular fat deposition. Fat differences observed also align with observations by Daley *et al*. (2010) [5] and Van Vliet (2021) [20] that feedlot beef accumulates more saturated fats, while grazing animals accumulate healthier monounsaturated and omega-3 fats.

The conspicuous difference in protein content and trends in fat-moisture trade-off signifies that the production environment makes a difference in the nutritional profile of indigenous Angoni beef. This finding agrees with Siebecker *et al*. (2024) [16] that pasture diversity enhances the quality of meat among African breeds like Nguni and Tuli. The present study presents supporting evidence for indigenous Angoni cattle, whose response is similar to that from feeding systems.

Furthermore, the results highlight the nutritional advantages of the grazing system, particularly for health-conscious consumers. Grass-fed beef is known for better fatty-acid profiles, as supported by literature (Hall and Schönfeldt, 2015–2016; Hocquette *et al*., 2010) [7, 8]. Although this study did not include full fatty-acid profiling, the lower fat values in grazing beef suggest potential benefits aligned with documented literature on omega-3 content in pasture-raised beef (Cheng *et al*., 2025) [2].

Overall, the results show a nutritional trade-off: feedlots enhance fat and marbling, while grazing promotes moisture and protein retention. This therefore reflects global debates that Smith (2006) [18] and Musonda *et al*. (2020) [11] have highlighted in their work of how one needs to balance productivity with nutritional integrity within these livestock systems.

Conclusion

This study showed that the nutritional composition of indigenous Angoni beef was significantly influenced by production systems. The grazing systems resulted in beef with higher moisture and significantly higher protein content, indicating leaner and presumably healthier meat. Feedlot beef had higher levels of fat, which are consistent with energy-dense grain diets promoting marbling. These differences emphasize important nutritional trade-offs: grazing supports nutritional quality and potential health benefits, while feedlot systems focus on rapid growth and fat deposition. Findings were consistent with the broader literature comparing grass-fed versus grain-fed beef and provided evidence-based insights that are of value to farmers, nutritionists, and policy analysts. Overall, grazing systems seem nutritionally superior for indigenous beef, though feedlots may remain essential for commercial efficiency.

Recommendations

1. Increase healthy nutritional quality with grazing systems with their higher protein and lower fat levels, grazing should be encouraged, at least for those consumers desiring healthier meat.
2. Introduce integrated feeding systems: Integrating short-term feedlot finishing with grazing might balance

marbling, growth efficiency, and nutritional integrity.
3. Expand future research Include larger sample sizes, multi-district studies, and seasonal comparisons to enhance generalizability.
4. Complete fatty-acid profiling Critical to understand differences in omega-3s, CLA, and saturated fats between systems.
5. Assess micronutrient composition: Iron, zinc, and vitamin profiles may provide more detail about the quality of indigenous beef.
6. Include in the ongoing work sensory analysis Consumer-based evaluations can complement chemical-nutritional results.
7. Farmer training Educate farmers about the nutritional benefits of proper grazing management, rotational systems, and supplementation.

Acknolwedgement
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