



Effect of Different Processing Treatments on the Chemical and Sensory Characteristics of Camel Meat Sausage

Yagoub Magboul Yagoub

Faculty of Agricultural Technology and Fish Sciences, Al-Neelain University

Khartoum, Sudan. P. O. Box: 12702 Fax: 0024911-776338.

E-mail: d.yagoub @ hotmail.com.

Abstract

INFORMATION:

Submission:

Accepted:

Publication:

This study was conducted to evaluate the effect of different processing treatments on the chemical composition and sensory characteristics of camel meat sausage. Three sausage treatments were prepared: control sausage (A), vinegar-treated sausage (B), and finely blended sausage (C). Camel meat samples were processed using standard sausage manufacturing procedures with natural sheep casings and different additives, including spices, fat, filler materials, and binding agents.

Chemical analyses were carried out to determine moisture, protein, fat, ash content, and pH values according to AOAC (1984) methods. Sensory evaluation was also performed to assess color, tenderness, juiciness, and flavor of the sausage samples. The results showed significant differences ($P < 0.01$) among treatments in moisture, protein, ash, and pH values, whereas no significant differences were observed in fat content. The vinegar treatment increased sample acidity, while fine blending reduced moisture and protein contents. Sensory evaluation revealed no significant differences among the three treatments in color, tenderness, juiciness, or flavor. The study concluded that processing treatments had noticeable effects on the chemical composition of camel meat sausage, whereas sensory properties remained generally acceptable among all treatments.

KEYWORDS

Camel meat, sausage, vinegar treatment, sensory evaluation, chemical composition, meat processing

Introduction

Camel meat has long been recognized as an important source of animal protein in many arid and semi-arid regions, particularly in the Middle East and Africa. For centuries, camels have played a vital role in the livelihood of pastoral and rural communities due to their exceptional ability to survive and produce under harsh environmental conditions characterized by drought, feed scarcity, and high temperatures. In many Arab societies, camel meat is traditionally regarded as a premium meat product commonly served during social and ceremonial occasions.

In recent years, growing attention has been directed toward camel meat because of its nutritional and economic importance. Camel meat is characterized by relatively low fat and cholesterol contents, high-quality protein, and valuable mineral composition compared with meat from other livestock species (Kadim et al., 2019). Furthermore, camels possess superior adaptability to marginal environments; making them an increasingly important livestock species for sustainable meat production in regions affected by climate change and limited natural resources.

According to the Food and Agriculture Organization (FAO, 2021), camel production contributes significantly to food security in several developing countries, particularly in Sudan, Somalia, Mauritania, and other African and Arab countries where camel meat represents an important component of animal protein supply. Sudan is considered one of the major camel-producing countries in the Arab world, with substantial potential for camel meat processing and commercialization.

Despite the increasing importance of camel meat, its utilization in processed meat products remains limited compared with beef and mutton. One of the major challenges facing camel meat processing is the relatively limited scientific information regarding the effect of processing techniques on the quality characteristics of camel meat products.

Previous studies have shown that processing treatments such as acidification, fine grinding, and emulsification may influence the physicochemical and sensory properties of processed meat products by affecting protein functionality, moisture retention, texture, and flavor development (Mohammed et al., 2020).

Sausage is one of the most popular processed meat products worldwide and is generally manufactured from minced meat mixed with fat, salt, spices, fillers, binders, and other additives, then stuffed into natural or synthetic casings. The quality of sausage products is largely influenced by raw materials and processing methods, which affect both chemical composition and sensory acceptability (Aberle et al., 2018).

Although several studies have investigated beef and poultry sausages, limited information is available concerning camel meat sausage, especially regarding the impact of vinegar treatment and fine blending on product quality. Therefore, further research is required to improve camel meat utilization and develop acceptable processed camel meat products suitable for local consumers and commercial production.

The objective of this study was to evaluate the effect of vinegar treatment and fineblending on the chemical composition and sensory characteristics of camel meat sausage.

Particular emphasis was placed on moisture, protein, fat, ash content, pH, color, tenderness, juiciness, and flavor in order to determine the suitability of camel meat for sausage production.

Materials and Methods

Study Area and Experimental Period: This study was conducted at the Faculty of Agricultural Technology and Fish Sciences, Elneelain University at Jabel Awlia town. The experiment aimed to evaluate the effect of different processing treatments on the quality characteristics of camel meat sausage.

Experimental Design: Three different sausage treatments were prepared and evaluated as follows:

- **Treatment A:** Control sausage (untreated camel meat).
- **Treatment B:** Camel meat sausage treated with vinegar.
- **Treatment C:** Camel meat sausage processed by fine blending.

The experiment was conducted using a Completely Randomized Design (CRD).

Raw Materials and Ingredients: Fresh camel meat was used as the main raw material for sausage preparation. The ingredients used in the sausage formulation included:

- Minced camel meat.
- Sheep fat.
- Natural sheep casings.
- Wheat flour as filler material.
- Skimmed milk powder as binding agent.
- Spices (black pepper, cinnamon, nutmeg, garlic, and salt).
- Chilled water.
- Vinegar solution (7%).

The spice formulation consisted of approximately:

- 2.75 g cinnamon.
- 1 g black pepper.
- 3 g sugar.
- 1.5–2 g nutmeg.
- 15–16 g salt.

The formulation was prepared according to standard sausage processing methods described by Frank (1945), Al-Zaeem Al-Azhari University (2005), and Kadro Meat Research Institute (2004).

Preparation of Natural Casings: Natural casings were obtained from sheep intestines. The intestines were thoroughly washed with hot water to remove mucosal tissues and impurities, cleaned carefully, and preserved in salt until use.

Preparation of Sausage Emulsion: Camel meat was deboned and trimmed to remove connective tissues and cartilage. The meat was then minced using a meat grinder. Fat, filler materials, binding agents, spices, and chilled water were weighed and mixed thoroughly with the minced meat until a homogeneous emulsion was obtained.

The prepared emulsion was subsequently stuffed into natural sheep casings using a sausage stuffing machine.

Processing Treatments

Vinegar Treatment: For treatment B, camel meat was immersed in 7% vinegar solution for 15 minutes before mincing. The treated meat was then mixed thoroughly with the other ingredients and stuffed into casings.

Fine Blending Treatment: For treatment C, approximately 70% of the minced meat was further homogenized using a blender to obtain a finer texture. Fat, filler materials, binding agents, chilled water, and spices were added and mixed thoroughly before stuffing into the casings.

Chemical Analysis: Fresh sausage samples from each treatment were analyzed for:

- Moisture content.
- Crude protein.
- Fat content.
- Ash content.
- pH value.

Proximate chemical analyses were carried out according to the standard methods of the Association of Official Analytical Chemists (AOAC, 1984).

Sensory Evaluation: Sensory evaluation was conducted to assess the effects of the different treatments on sausage quality attributes, including:

- Color.
- Tenderness.
- Juiciness.
- Flavor.

Sausage samples from each treatment were cooked and randomly presented to panelists for evaluation. Each panelist received an evaluation form and assessed the samples independently to minimize bias.

Statistical Analysis: The obtained data were statistically analyzed using analysis of variance (ANOVA) under a Completely Randomized Design (CRD) according to the procedures described by Cochran (1980). Differences among treatment means were considered significant at $P < 0.05$.

Limitations of the Study: Several difficulties were encountered during the study, including:

1. Limited availability of camel meat in local and central markets.
2. Insufficient published information and previous studies related to camel meat processing.
3. Camels are generally slaughtered for meat only when affected by disease, advanced age, or reduced productivity, limiting access to high-quality meat samples.

Results and Discussion

Chemical Composition of Camel Meat Sausage

Moisture Content: The results presented in Table (1) showed significant differences ($P < 0.01$) among the three sausage treatments in moisture content. The control treatment (A) recorded a moisture value of 63.76%, while the vinegar-treated sample (B) showed the highest moisture content (65.21%). In contrast, the fine blending treatment (C) recorded the lowest moisture content (63.00%).

The observed variation in moisture content may be attributed to differences in processing methods. The increase in moisture retention in the vinegar-treated sample may be associated with the effect of acidification on water-holding capacity of meat proteins.

Conversely, intensive mincing and fine blending may have disrupted muscle structure and reduced the ability of the meat matrix to retain water.

Table 1. Chemical Composition and pH Values of Camel Meat Sausage Treatments

Parameter	A(Control)	B (Vinegar)	C(Fine Blending)	Significance	Standard Error
Moisture (%)	63.76	65.21	63.00	**	0.28
Fat (%)	03.57	03.67	03.52	N.S	0.28
Protein (%)	19.17	18.37	18.10	***	0.09
Ash (%)	02.43	02.40	02.20	**	0.05
pH	06.38	06.23	05.40	***	0.03

N.S = No significant difference

** = Significant at $P < 0.01$

*** = highly significant at $P < 0.001$

These findings are consistent with previous reports indicating that processing methods and acid treatments significantly influence moisture retention and emulsion stability in processed meat products (Kadim et al., 2019; Mohammed et al., 2020).

Fat Content: No significant differences ($P > 0.05$) were observed among treatments in fat content, as shown in Table 1. Fat values ranged from 3.52% to 3.67%, which may be attributed to the equal proportions of added fat used during sausage preparation.

The absence of significant variation suggests that the applied treatments had minimal influence on lipid composition. Similar findings were reported by Abdelhadi et al. (2022), who observed that formulation treatments had limited effects on fat percentage in processed camel meat products.

Protein Content: Highly significant differences ($P < 0.001$) were observed among treatments in protein content. The control sample (A) exhibited the highest protein percentage (19.17%), followed by treatment B (18.37%) and treatment C (18.10%).

The reduction in protein content in vinegar-treated and finely blended samples may be related to protein denaturation and proteolytic activity induced by acidification and mechanical processing. Fine blending may have accelerated enzymatic protein breakdown due to increased surface area exposure.

These results agree with findings reported by Ibrahim and Babiker (2021), who noted that processing intensity and acidic treatments could reduce measurable protein content in processed camel meat products.

Ash Content: Significant differences ($P < 0.01$) were detected among treatments in ash content. Treatment A showed the highest ash value (2.43%), whereas treatment C recorded the lowest value (2.20%).

The reduction in ash content observed in vinegar-treated and finely blended samples may be attributed to partial degradation of structural components and dilution effects during processing. Acidic conditions may also influence mineral solubility and retention within the meat matrix. Similar observations were reported by FAO (2021), which indicated that processing conditions may affect mineral retention and ash composition in meat products.

pH Value: The pH values differed significantly ($P < 0.001$) among the treatments.

Treatment A recorded the highest pH value (6.38), while treatment C showed the lowest value (5.40).

The lower pH observed in vinegar-treated sausage is directly related to the acidic nature of vinegar. In treatment C, fine blending may have promoted biochemical reactions and lactic acid formation, resulting in further reduction in pH. The reduction in pH is considered important for improving microbial stability and shelf life of processed meat products. Similar findings were reported by Mohammed et al. (2020), who demonstrated that acidification treatments reduced pH and improved preservation characteristics of camel meat products.

Sensory Evaluation: The sensory evaluation results revealed no significant differences ($P > 0.05$) among treatments in color, tenderness, juiciness, and flavor (Table 2). The panelists generally accepted all sausage samples regardless of processing treatment.

The absence of significant sensory differences suggests that vinegar treatment and fine blending did not negatively affect consumer acceptability of camel meat sausage. These

findings indicate that camel meat can be successfully utilized in sausage production without adverse effects on sensory quality.

Table 2. Sensory Evaluation of Camel Meat Sausage Treatments

Attribute	A	B	C	Significance	Standard Error
Color	03.00	02.50	02.40	N.S	0.24
Tenderness	02.00	01.93	01.79	N.S	0.26
Juiciness	02.34	02.29	02.36	N.S	0.36
Flavor	02.34	02.50	02.57	N.S	0.50

N.S = No significant difference

Previous studies have similarly reported acceptable sensory characteristics for processed camel meat products, particularly when appropriate formulations and spices are used to enhance flavor and texture (Kadim et al., 2019; Abdelhadi et al., 2022).

Conclusion and Recommendations

Conclusion:

The present study demonstrated that camel meat can be successfully utilized in the production of sausage with acceptable chemical and sensory quality characteristics. The applied processing treatments, namely vinegar treatment and fine blending, significantly affected some chemical properties of the sausage, including moisture content, protein content, ash content, and pH values, while fat content remained unaffected.

The vinegar treatment increased acidity and contributed to changes in moisture retention and protein composition, whereas fine blending reduced moisture and protein contents due to increased mechanical disruption and possible enhancement of proteolytic activity. Despite these chemical variations, sensory evaluation results indicated no significant differences among treatments in color, tenderness, juiciness, and flavor, suggesting that all sausage samples were generally acceptable to panelists.

The findings of this study support the potential use of camel meat as an alternative raw material for processed meat products. Camel meat possesses favorable nutritional and technological characteristics that make it suitable for sausage production, particularly in regions where camels represent an important livestock resource.

Recommendations:

Based on the findings of this study, the following recommendations are proposed:

1. Greater attention should be directed toward the development and commercialization of camel meat products in Sudan and other camel-producing countries.
2. Further studies should be conducted to evaluate the microbiological quality, shelf life, and storage stability of camel meat sausage under different preservation conditions.
3. Additional research is needed to optimize processing techniques and formulation ingredients in order to improve texture, flavor, and consumer acceptability of camel meat products.

4. Modern meat processing technologies should be introduced to enhance the utilization and economic value of camel meat in the food industry.
5. Public awareness programs are recommended to promote the nutritional value and health benefits of camel meat and to correct common misconceptions regarding its consumption.
6. Future studies should investigate the effect of different additives, packaging systems, and preservation methods on the quality characteristics of camel meat sausage.
7. Governmental and research institutions should support camel meat research programs due to the important role of camels in food security and sustainable livestock production in arid and semi-arid regions.

References:

- Aberle, E. D., Forrest, J. C., Gerrard, D. E., & Mills, E. W.** (2018). *Principles of meat science* (6th ed.). Kendall Hunt Publishing.
- Abdelhadi, O. M. A., Babiker, S. A., & Picard, B.** (2022). Camel meat quality and processing characteristics: A review. *Journal of Camel Practice and Research*, 29(1), 1–10.
- Al-Zaeem Al-Azhari University**, Department of Food Science. (2005). *Sausage processing formulations and meat product technology* [Unpublished teaching materials]. Sudan.
- Association of Official Analytical Chemists (AOAC).** (1984). *Official methods of analysis* (14th ed.). AOAC International.
- Cochran, W. G.** (1980). *Experimental designs* (2nd Ed.). John Wiley & Sons.
- FAO.** (2021). *Camel production systems and meat utilization in arid regions*. Food and Agriculture Organization of the United Nations.
- Frank, A.** (1945). *Meat processing and sausage manufacture*. Meat Industry Publications.
- Ibrahim, H. M., & Babiker, S. A.** (2021). Effect of processing methods on physicochemical properties of camel meat products. *Sudan Journal of Food Science and Technology*, 13(2), 45–53.
- Kadim, I. T., Mahgoub, O., & Purchas, R. W.** (2019). Camel meat and meat products: Composition, nutritional value, and processing technologies. *Food Reviews International*, 35(2), 123–145. <https://doi.org/10.1080/87559129.2018.1426907>
- Kadro Meat Research Institute.** (2004). *Meat processing techniques and sausage preparation methods* [Technical report]. Sudan.
- Mohammed, H. O., Ahmed, M. E., & Hassan, A. A.** (2020). Effect of processing methods on quality attributes of camel meat products. *Meat Science*, 162, 108025. <https://doi.org/10.1016/j.meatsci.2019.108025>
- Zarafi, M. A.** (2003). *Processed meat products and sausage technology*. Arab Publishing House.