Turkish Journal of Agriculture - Food Science and Technology, 10(sp2): 2913-2919, 2022
DOI: https://doi.org/10.24925/turjaf.v10isp2.2913-2919.5617

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X | www.agrifoodscience.com | Turkish Science and Technology Publishing (TURSTEP)

Nutritional Composition, Sensory Quality and Consumer Acceptability of Beef Sausage Fortified With Edible Meat Waste[#]

Babatunde Oluwasegun Alao[1,a], Andrew Bamidele Falowo[1,b,*]

[1]*Department of Livestock and Pasture Science, Faculty of Science and Agriculture, University of Fort Hare, P. Bag X1314, Alice 5700, Eastern Cape Province, South Africa*
[*]*Corresponding author*

A R T I C L E I N F O

[#]*This study was presented at the 6th International Anatolian Agriculture, Food, Environment and Biology Congress (Kütahya, TARGID 2022)*

Research Article

Received : 17/10/2022
Accepted : 27/11/2022

Keywords:
Edible meat waste
Fat replacer
Meat sausage
Nutritional content
Sensory quality

A B S T R A C T

This study assessed the proximate composition, sensory quality and consumer acceptability of beef sausage fortified with edible meat waste. Lean beef and edible meat waste (EMW) samples were obtained from commercial abattoir and combined in ratio 50:50 and 70:30 and designated as T1 and T2 respectively, while CT contained 90% lean meat and 10% fat. The fresh T1, T2 and CT sausages were thermal processed using microwave and oven-grilling cooking methods. The results showed significant difference in moisture, protein, lipid and ash content of raw and cooked sausages across treatments. Raw sausage fortified with EMW had higher protein and lower lipid contents compared to control treatment (90/10, CT). Cooking of the sausage significantly decreased moisture and increase lipid, protein and lipid content, with microwaved sausage having higher values. The results of sensory quality showed that beef sausage fortified with EMW were all acceptable to consumers, irrespective of the cooking methods used. The distribution of consumers who liked the appearance, colour, texture and flavour of the sausage meat containing EMW were higher than those who dislike the products. Therefore, this study shows that EMW could be successfully used in meat industry to improve quality of sausage during production.

[a] *alaoboo@gmail.com* *https://orcid.org/0000-0001-5583-318X* | [b] *anddele2013@gmail.com>* *http://orcid.org/0000-0002-4712-0398*

Introduction

Throughout the continent, one or more processed meat products such as sausage, nuggets and meatball are extensively consumed on daily basis, although they may be costly at times (Elbakheet et al., 2017, Carballo, 2021). To ensure consistent availability of these products including sausage, researchers are working hard to reduce the cost of production by producing different varieties without compromising their nutritional and sensory quality (Hall, 2015; Carballo 2021). The processing of sausage involves the addition of different food components (ground lean meat, animal fat, salt, spices, and other flavouring ingredients) that could enhance digestibility and human well-being (Alao et al., 2021). The combination of these components also provide functional properties that improve the structure, nutritional and health qualities of the finished products (Fernández-Ginés et al., 2005).

Processing of animal carcass at the abattoir involves the production of substantial amount of edible animal by-products/wastes which could be blended with lean meat to make good sausages and reduce cost of production (Alao et al., 2017). In fact, some studies have revealed that some edible by products such as liver and blood could be used either partly or wholly during the making of sausage meat (Estévez et al., 2005; Yun-Sang and Cheon-Jei, 200; Amaral et al., 2013; Silva et al., 2013). The blending of lean meat with offals (liver, kidney, heart) and other meat products (edible meat waste) can also provide a rich animal protein with a better flavour. In Finland, liver sausage is considered appealing and approved by the general public whereas liver paˆte´s are customarily prepared in France and Spain (Estévez et al., 2005). In this regard, the act of using edible meat by products in meat processing has been very effective in producing sustainable meat production system (Jayathilakan et al., 2012; Lobato et al., 2014).

However, the amount of the edible meat by-products that has been utilized is to a greater degree smaller as compared to the amount produced at the abattoir. An example is the recovery of edible meat waste for sausage production (Alao et al., 2021). The edible meat waste refers to meat waste generated during the cutting and trimming of the meat at processing unit in the abattoir (Alao et al., 2021). This edible meat waste possess inherent capability to be used on a large scale in the meat processing industry for value-addition without any threat to nutritional content and consumer's acceptability (Alao et al., 2021).

After production, different culinary methods such as grilling, microwave cooking, oven grilling and frying are employed for cooking sausages (Singh et al., 2015; Adam and Abugroun, 2015). The type of cooking methods used usually contribute to the adhesion properties, tenderness and sensory properties of the sausage meat (Obuz et al., 2003; Koziol et al., 2016). Although the consumers' decision and overall judgement are influenced by the tenderness of meat and other factors such as flavour, juiciness, appearance, price, colour and food safety (Troy and Kerry, 2010). Therefore, the objective of this study was to determine the nutritional content, sensory quality and consumer acceptability of sausage meat fortified with edible meat wastes and thermal treated using microwave and oven-grilling cooking methods.

Materials and Methods

Study Site and ethical statement

The study was carried out in Meat Science laboratory, Department of Livestock and Pasture Science, University of Fort Hare, South Africa. Before the commencement of the experiment, permission was obtained and approved by the University of Fort Hare's Research Ethics Committee (UREC) with certificate reference number MUC341SBAB01.

Sample Collection and Beef Sausage Production

The lean beef meat and edible meat waste (EMW) for production of the novel beef sausage were collected separately from slaughtered cattle at the commercial abattoir in East London in Eastern Cape Province of South Africa. The fresh meat samples were stored in a cooler box and transported immediately to Meat Science laboratory for sausage production. In production of sausage, the lean beef and edible meat waste samples were combined in ratio 50:50 and 30:70 and designated as T1 and T2 respectively, while the control contained 90% lean meat and 10% fat as CT. Each meat sample was spiced, mixed and minced through a 5mm plate using a mincer (TC22 EL ELEG.PLUS, Italy) and processed within 24 hours following their storage at 4^{o}C. The meat samples were then pumped and stuffed lightly into 25mm diameter sheep sausage casing (Freddy Hirsch Company, Capetown. South Africa) with Tre-spade sausage filler tool.

The meat samples were thermal processed using microwave and oven-grilling cooking methods. In microwave method, fresh sausage samples (T1-MW, T2-MW and CT-MW) were cooked at 80^{o}C for 4min. During oven-grilling (T1-OV, T2-OV and CT-OV), doneness was determined by inserting a probe thermometer (Thermo-pro TP- food thermometer) into geometrical centre of the sausage to measure its internal temperature. The samples were considered done when the digital thermometer gave an alarm and flashed green light. The samples were cooled at room temperature, vacuumed packed and stored at 80^{o}C until the laboratory analysis was carried out.

Determination of proximate content and Warner-Bratzler shear force (WBSF)

The raw and cooked meat samples were analysed in triplicates for determination of moisture, ash, fat and crude protein content using method described by AOAC. Warner–Bratzler shear force (WBSF) values were determined on meat samples as indicators of tenderness using instron machine. Coring was obtained using hand-held coring device to make round core of about 10mm from the cooked samples. About 3 core was obtained at the center of each sample of the sausage. Shearing was done using Warner-Bratzler shear machine, with the speed of 400mm/min. The thickness of the vee-shaped cutting blade was about 1.02mm. The cored sausage was placed on the machine and cutting blade was used to cut through the sample. The maximum force (N) required to shear for each specimen was measured and the mean was recorded for tenderness.

Sensory Analysis of the meat sausage

A total of 60 untrained panellists (staff and students) were recruited and asked to rate their attributes on a 9-point hedonic scale, with 1 being "disliked extremely" and 9 being "liked extremely" in the middle "neither like nor dislike". The six most widely used sausage sensory characteristics were selected and panelists were asked to score each sample for overall likeness as well as the acceptability of appearance, flavour, taste, texture, and juiciness using a 9 hedonic scale. Before evaluation, the sausages were cut into slices of approximately 4 mm thickness and served at room temperature on white paper plates. The sausage samples were named according to their mixing ratio and cooking methods. Fresh clean water was provided for rinsing the palate before each sample was tested. For each sample, the panellists were expected score the overall acceptability as well as the acceptability of appearance, flavour, taste, hardness and juiciness.

Statistical analysis

The Statistical Analysis System (SAS version 9.1.3 of 2007) was used for all the analyses. PROC GLM procedure of SAS was used to consider the effects of the types of cooking used (microwave and oven-grill) and meat type (90/10, 30/70, and 50/50) on the nutritional content and tenderness of beef sausage. Significant differences between the least square means for cooking methods were performed using the Fishers' least significance difference (LSD) method of SAS, with a significance level of $P<0.05$. Data generated on sensory quality were analysed and summarized as frequencies of respondent profiles on consumer's acceptability.

Results and Discussion

Sausage meat is one of the most widely utilized meat products among all processed meats because they can easily be produced from different meat types and varieties of meat products including edible meat waste and edible offal (Alao et al., 2021). The result of the proximate analysis of the uncooked and cooked meat sausage is presented in table 1 and 2. The moisture content of the uncooked sausage ranges from 63.54 to 70.34% with CT (90/10 meat sausage) having the highest value (70.34%, Table 1, ($P<0.05$). The increase in moisture content of the

T3 may the attributed to the presence of higher amount of lean meat (90%) compared to other treatments. Study has showed quality sausage with high lean meat tend to have higher moisture content compared to less lean meat sausage (Cashman, 2017; Cunningham et al., 2015). This results is in contrast with finding of Youssef et al. (2012) who reported that high-fat patties had lower moisture content than low-fat patties. In table 2, the cooked sausages treatments had the lowest moisture contents which ranged from 53.36 to 56.3% compared to the uncooked sausage ($P<0.05$). The results indicated that, uncooked sausage contained higher level of moisture than cooked sausage. The decline in moisture content can be as a result of evaporation during the cooking process as the temperature rises (del Pulgar et al., 2012). Earlier study has shown that majority of water loss during cooking is due to temperature-induced denaturation or structural changes in meat proteins (Pang et al., 2021). This result is in agreement with report of Youssef et al. (2012) who found that cooked meat sampled had lower moisture content compares to uncooked samples. Also, the results from this study also showed that cooking methods had a significant effect on moisture content of the sausages ($P<0.05$). The oven-grilled samples had the highest moisture contents (57.55%) as compared to microwaved samples (51.37%). It was also observed that the interaction of sausage treatment with cooking methods was significant at $P<0.05$ with the water content of the treatments. This result is similar to report of Janicki and Appledorf (2007) who found that beef patties cooked by microwave had lower moisture content than other cooking methods.

The amount of lipid content in raw sausages for T1 (30/70), T2 (50/50) and C3 (90/10) were 11.29%, 7.49% and 13.91%, respectively, with T3 having the highest value (table 2). This is suggesting that edible meat wastes used in this study as fat replacer contain moderate amount of lipid content compared to animal fat used. Moreover, the value of lipid recorded in this study fall within the range of standard fat content for meat sausage (Lee et al. 2015). In comparison with raw sausage, cooking methods increased the lipid content of meat sausage with microwaved samples having higher content (13.05%) than oven-grilled samples (8.58%)(table 2). The increase of lipid content in the microwaved sausage can be attributed to its ability to reduce moisture loss and increase amount of extractable lipids in the muscle samples compared to other cooking methods. This result is in line with findings of Alfaia et al. (2010) who reported a significant differences ($P<0.05$) in total lipid content of microwaved sausage compared other treatments. In contrast, Janicki and Appledorf (2007) and Youssef et al. (2012) reported that meat samples cooked using microwave and grilling, respectively, had lower fat content compared to other cooking method. Generally, different studies have shown that cooking and cooking methods can increase the lipid and protein content of meat compared to uncooked meat (Cunningham et al., 2015; Falowo et al., 2017).

The ash content of the raw sausage significantly increased in T1 (4.41%) and T2 (4.38%) compared to CT (3.64%). Ash value is known as a pointer of total mineral content in a sample. This result is suggesting that sample T1 and T2 could possessed more mineral content than sample T3. However, the value of ash increased in the cooked sausage treatments with T1 (30/70), T2 (50/50) and CT (90/10) having 5.47%, 5.79% and 8.71%, respectively ($P<0.05$). This is indicating that cooking could lead to significant changes in ash content of meat samples. For instance, cooking with a microwave (5.06%) and oven-grilling (8.25%) increased the ash content of the cooked sausage. These results are in agreement with Lopes et al. (2015) who reported that microwave and grilling are dry cooking methods and may be responsible for greater retention of ash compared to other cooking methods that involved cooking in water.

The protein content in the uncooked sausages was significantly higher in T1 (30/70) 13.9% and T2 (50/50) 19.34% compared to CT (90/10) 11.02%. This is unexpected as protein content in CT should be higher since it contained larger proportion of lean meat than other treatments. This is suggesting that edible meat wastes are rich in nutrient and could be used to enhance the nutritional quality of meat sausage. The results further showed that cooking significantly increased the protein content of the meat sausages with T1 (26.13%) and T2 (26.17%) having the higher values compared to CT (21.04%)($P<0.05$). This showed that cooking and cooking methods had a significant effect on the protein retention in the meat samples. These results are similar to the findings of Youssef et al. (2012), Cunningham et al. (2015) and Karimian-Khosroshahi et al. (2016) who reported that cooking reduces moisture content and subsequently increase the concentration of lipid and protein.

Figures 1abc and 2abc show the results obtained from the sensory analysis and indicates the differences between the appearance, colour, texture, flavour and overall acceptance attributes of the sausage meats containing edible meat waste and control treatment. The results revealed that sausages containing edible meat waste were all acceptable to the consumers, irrespective of the cooking methods used, when compared to control treatment. This result is in accordance with findings of Magoro et al. (2020) who reported no significant difference in sensory quality of sausage meat formulated with edible offal compared to control group. However the distribution of those who liked the appearance, colour, texture and flavour of the sausage meat were higher than those who dislike the products. This indicates that edible meat wastes can be successfully used in meat industry to replace fat in sausage production. Also, report has shown that edible meat waste consists of carbohydrates, proteins and fat based constituents that are needed for fat substitutes in sausage production (Weiss, 2010). Furthermore, the percentage of consumers who liked T1-MW (84.7%) were higher than those of T2-MW (65.5%) but comparable to those on T1-MW (83.1) (Table 1). The decrease in acceptability of T2-MW may be as a result of aroma of the edible meat waste which may affect the sensory attributes and thus, reduce the acceptability of the sausage (Alao et al. 2021). Similarly, the percentage of consumers that liked T1-OV (56.1%) were the same with that of T2-OV (56.9) (Table1) but lowered than those of CT-OV. This suggests the consumers preferred microwaved meat sausage more than the oven-grilled sausages. However, the tenderness of sausage treatments are significantly different from one another at $P<0.05$ and there was an interaction between the tenderness of the sausage samples and cooking methods at $P<0.01$ (figure 3). The texture and overall acceptability of sausages formulated with edible meat waste were all tender and acceptable by panelists,

Table 1. Proximate composition of raw sausage made with edible meat waste as fat replacer

Parameters	Sausage Type			SEM	P-Value
(%)	CT (90/10)	T1 (30/70)	T2 (50/50)		
Lipid	13.91[a]	11.29[b]	7.49[c]	0.21	0.0001
Ash	3.64[c]	4.41[a]	4.38[b]	0.11	0.0001
Moisture	70.34[a]	65.37[b]	63.54[c]	0.11	0.0001
Crude Protein	11.02[c]	13.9[b]	19.34[a]	0.36	0.0001

CT 90/10 (Control, 90% lean beef +10%Fat), T1 50/50 (50% lean beef+50% edible meat waste), T2 30/70 (30% lean beef+70% edible meat waste)

Table 2. Proximate composition of raw sausage made with edible meat waste as fat replacer using different cooking methods

Parameters	Sausage Type (S)			Cooking Type (C)		SEM	P- Value		
(%)	CT (90/10)	T1 (30/70)	T2 (50/50)	Microwave	Oven-G		S	C	S x C
Lipid	10.29[b]	11.87[a]	10.29[b]	13.05	8.58	0.10	0.0001	0.0001	0.0001
Ash	8.71[a]	5.47[c]	5.79[b]	5.06	8.25	0.45	0.0001	0.0001	0.0001
Moisture	56.3[a]	53.73[b]	53.36[c]	51.37	57.55	0.18	0.0001	0.0001	0.0001
Crude Protein	21.04[c]	26.13[b]	26.17[a]	27.49	21.41	0.68	0.0001	0.0001	0.0001

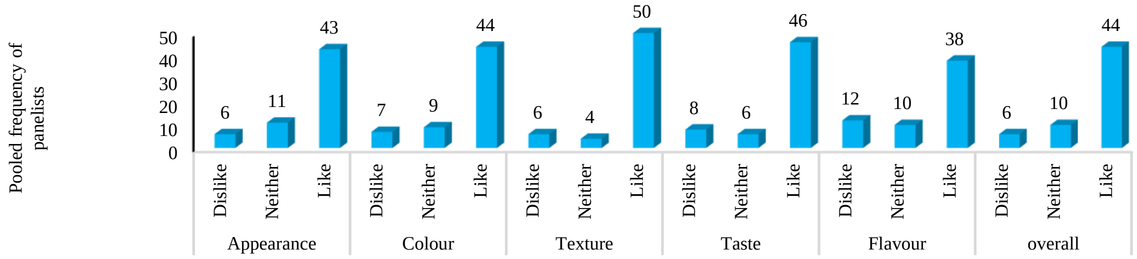

Figure 1a. Distribution of panellists who liked 10% fat CT-MW sausage

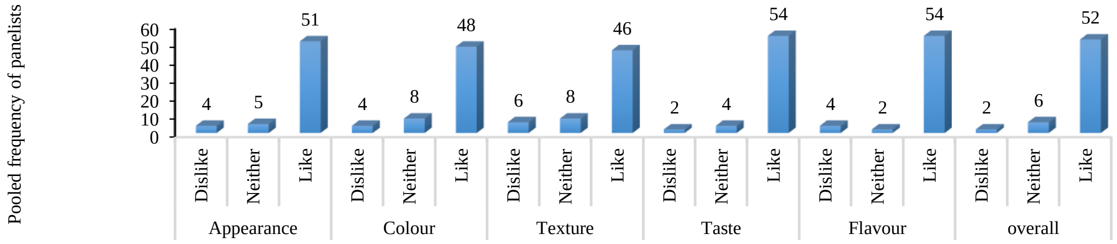

Figure 1b. Distribution of panellists who liked 50% T1-MW sausage

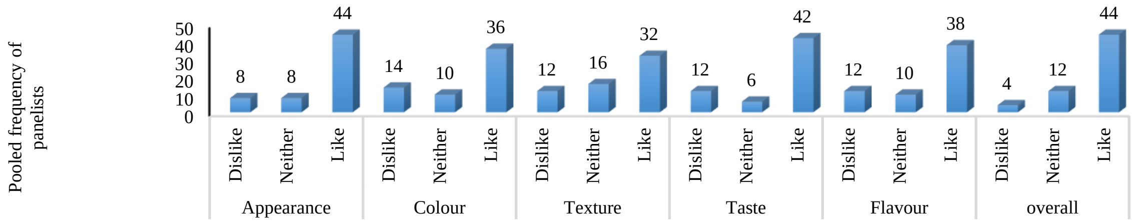

Figure 1c. Distribution of panellist who liked 70% T2-MW sausage

10% fat CT = 90% lean beef +10%Fat, 50% T1= 50% lean beef+50% edible meat waste, 70% T2 = 30% lean beef+70% edible meat waste, MW: Microwave

Table 3. Percentage of panellists that liked cooked beef sausage

Cooking method (C)	Treatments (T)	%
Microwave	CT-MW 90/10	83.1
	T1-MW 50/50	84.7
	T2-MW 30/70	65.5
Oven-grilling	CT-OV 90/10	73.6
	T1-OV 50/50	56.1
	T2-OV 30/70	56.9

CT 90/10 (Control, 90% lean beef +10%Fat), T1 50/50 (50% lean beef+50% edible meat waste), T2 30/70 (30% lean beef+70% edible meat waste)

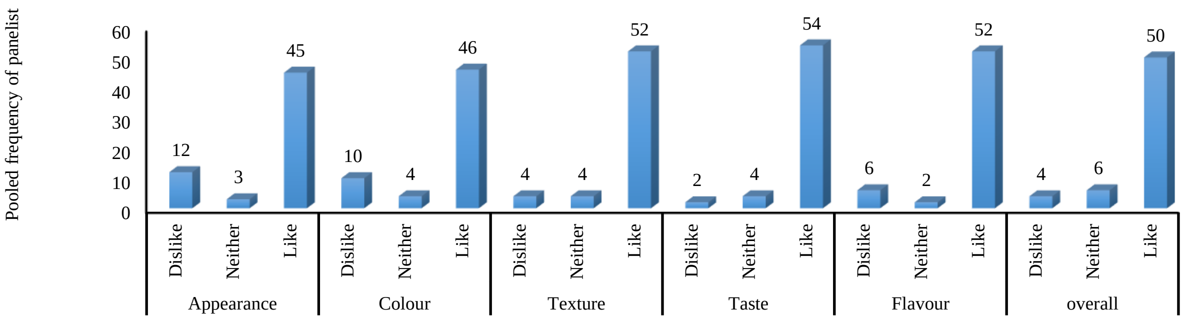

Fig 2a: Distribution of panellists who liked 10% fat CT-OV sausage

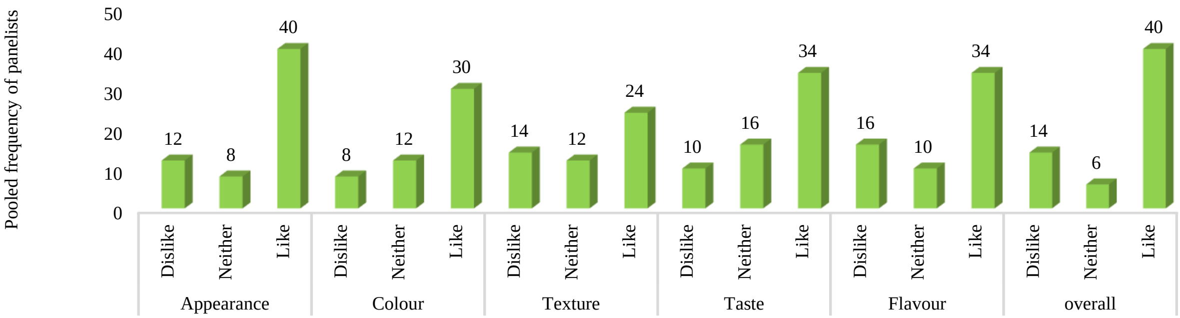

Fig. 2b: Distribution of panellists who liked 50% T1-OV sausage

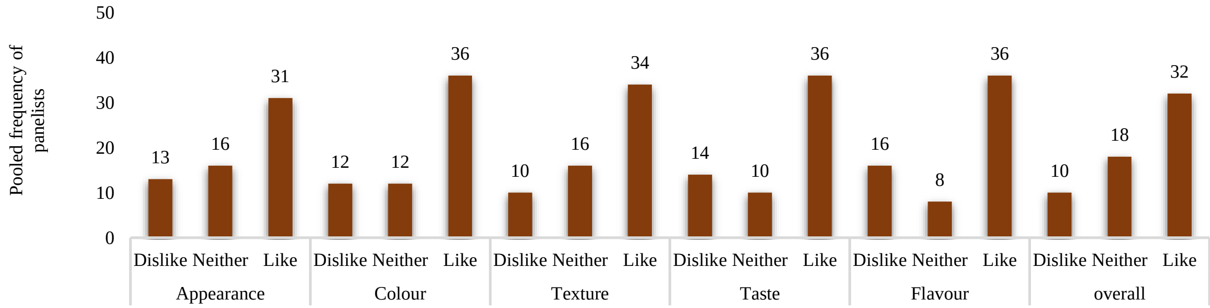

Fig. 2c: Distribution of panellists who liked 70% T2-OV sausage

10% fat CT = 90% lean beef +10%Fat, 50% T1= 50% lean beef+50% edible meat waste, 70% T2 = 30% lean beef+70% edible meat waste, OV: Oven grilled

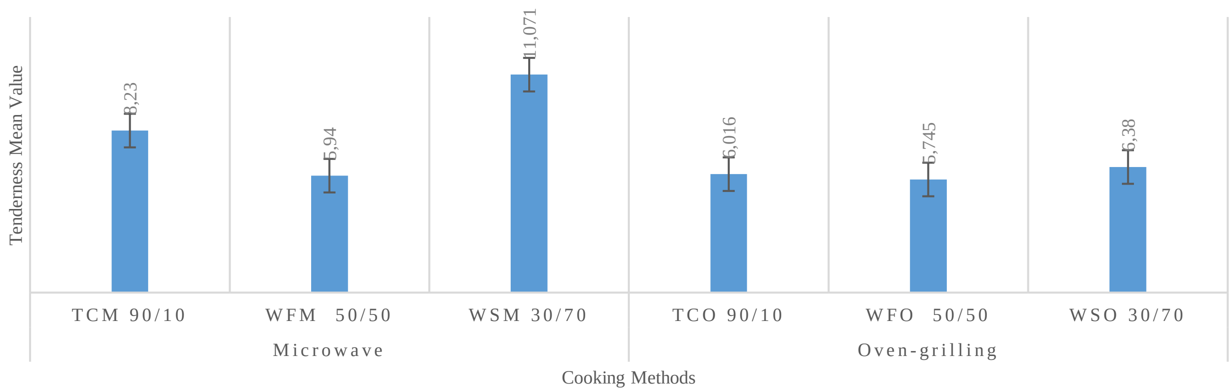

Figure 3. Effect of cooking methods on shear force values of meat sausages

CT 90/10 (Control, 90% lean beef +10%Fat), T1 50/50 (50% lean beef+50% edible meat waste), T2 30/70 (30% lean beef+70% edible meat waste)

Conclusion

Sausage is one of the important meat products that are in high demand throughout the world and this is likely to increase in the coming years. Unfortunately, the cost of the meat products such as sausage are sometimes on the high side. The results of the study also showed that, edible meat waste could be successively as fat replacer in beef sausage production without compromising it nutritional quality. The use of microwave during cooking will help to preserve the nutritional content of meat. Furthermore, this study has shown that the replacements of fat with edible meat waste in sausage production has overall acceptance in most of the attributes scored (colour, appearance, taste, texture and flavour) and these were above the desirable average. Thus, the utilization of the edible meat waste in production of sausages has the potential to increase profitability in meat industry and minimise meat waste in the industry.

Acknowledgments

The authors are grateful to the Govan Mbeki Research and Development Centre (GMRDC), University of Fort Hare, South Africa and Livestock Feeds Plc 1 Henry Carr Street, Ikeja, Lagos, Nigeria, for providing financial assistance

References

Adam YSI, Abugroun HA. 2015. Evaluation of Traditional Cooking Methods on Eating Meat Characteristics and Chemical composition. Journal of Agriculture and Veterinary Science, 8: 12-17. doi: 10.9790/2380-08421217

Alao BO, Falowo AB, Aladejana EB. 2021. Effect of Cooking Oil on the Fatty Acid Profile of Beef Sausage Fortified with Edible Deboned Meat Waste. International Journal of Food Science, 2021:8 doi.org/10.1155/2021/5592554

Alao BO, Falowo AB, Chulayo A, Muchenje V. 2017. The Potential of Animal By-Products in Food Systems: Production, Prospects and Challenges. Sustainability, 9: 1089 doi:10.3390/su10093323

Alfaia CM, Alves SP, Lopes AF, Fernandes MJ, Costa AS, Fontes CM, Castro ML, Bessa RJ, Prates JA. 2010. Effect of cooking methods on fatty acids, conjugated isomers of linoleic acid and nutritional quality of beef intramuscular fat. Meat Science, 84: 769-777. doi: 10.1016/j.meatsci.2009.11.014.

Association of Official Analytical Chemists (AOAC), 2000. Official methods of analysis of the association of official analytical chemists, 17th ed. Association of Official Analytical Chemists, Washington, D. C. USA.

Association of Official Analytical Chemists (AOAC), 2005. Official methods of analysis, association of official analytical chemist, 17th ed. Association of Official Analytical Chemists, Washington, D.C. USA.

Carballo J. 2021. Sausages: Nutrition, Safety, Processing and Quality Improvement. Foods, 10(4): 890, doi.org/10.3390/foods10040890

Cashman C. 2012. Water in meat and poultry products. https://meatscience.org/TheMeatWeEat/topics/fresh-meat/article/2017/04/12/water-in-meat-and-poultry-products

Cunningham J, Nguyen V, Adorno P, Droulez V. 2015. Nutrient composition of retail samples of Australian beef sausages. Nutrients, 7(11): 9602-9617, doi: 10.3390/nu7115491

del Pulgar JS, Gázquez A, Ruiz-Carrascal J. 2012. Physico-chemical, textural and structural characteristics of sous-vide cooked pork cheeks as affected by vacuum, cooking temperature, and cooking time. Meat science, 90: 828-835. doi: 10.1016/j.meatsci.2011.11.024.

do Amaral DS, da Silva FAP, Bezerra TKA, Guerra ICD, Dalmás PS, Pimentel KML, Madruga MS. 2013. Chemical and sensory quality of sheep liver pâté prepared with ‘variety meat’. Semina: Ciências Agrárias, 34(4): 1741-1752, doi:10.5433/1679-0359.2013v34n4p1741

Elbakheet IS, Elgasim AE, Algadi MZ. 2017. Proximate composition of beef sausage processed by wheat germ flour. *Journal of Food Processing and Technology*, 8:11, doi: 10.4172/2157-7110.1000704

Estevez M, Ventanasa S, Cava R. 2006. Effect of natural and synthetic antioxidants on protein oxidation and colour and texture changes in refrigerated stored porcine liver pate. Meat Science, 74: 369–403, doi:10.1016/j.meatsci.2006.04.010

Falowo AB, Muchenje V, Hugo A. 2017. Effect of sous-vide technique on fatty acid and mineral compositions of beef and liver from Bonsmara and non-descript cattle. Annals of Animal Science, 17 (2): 565, doi: 10.1515/aoas-2016-0078

Fernández-Ginés JM, Fernández-López J, Sayas-Barberá E, Pérez-Alvarez J. 2005. Meat products as functional foods: A review. Journal of food science, 70. doi/10.1111/j.1365-2621.2005.tb07110.x

Hall NG. 2015. *Sustainable red meat from a nutrition perspective* (Doctoral dissertation, University of Pretoria). https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/fat-substitute

Janicki LJ, Appledorf H. 2017. Effect of broiling, grill frying and microwave cooking on moisture, some lipid components and total fatty acids of ground beef. Journal of Food Science, 39 (4): 715 – 717, doi:10.1111/j.1365-2621.1974.tb17964.x

Jayathilakan K, Sultana K, Radhakrishna K, Bawa AS. 2012. Utilization of by-products and waste materials from meat, poultry and fish processing industries: a review. *Journal of food science and technology*, 49: 278-293, doi.org/10.1007/s13197-011-0290-7

Karimian-Khosroshahi N, Hosseini H, Rezaei M, Khaksar R, Mahmoudzadeh M. 2016. Effect of different cooking methods on minerals, vitamins, and nutritional quality indices of rainbow trout (oncorhynchus mykiss). International Journal of food properties, 19: 2471-2480, doi.org/10.1080/10942912.2015.1039028

Koziol K, Palka S, Migdal L, Derewicka O, Kmiecik M, Maj D, Bieniek J. 2016. Analysis of the texture of rabbit meat subjected to different means of heat treatment. Scientific Annals of Polish Society of Animal Production, 12 (1): 25-32

Lee HJ, Jung EH, Lee SH, Kim JH, Lee JJ, Choi YI. 2015. Effect of replacing pork fat with vegetable oils on quality properties of emulsion-type pork sausages. Korean journal for food science of animal resources, 35(1): 130-136, doi: 10.5851/kosfa.2015.35.1.130

Lobato JFP, Freitas A, Devincenzi T, Cardoso LL, Tarouco JU, Vieira RM, Dillenburg DR, Castro I. 2014. Brazilian beef produced on pastures: sustainable and healthy. Meat science, 98: 336-345.

Magoro MM, Zondagh BI, Jooste PJ, Morey L. 2012. Sensory analysis of cooked fresh meat Sausages containing beef offal. Journal of Family Ecology and Consumer Sciences, 40: 2012

Obuz E, Dikeman ME, Loughin TM. 2003. Effects of cooking method, reheating, holding time, and holding temperature on beef longissimus lumborum and biceps femoris tenderness. Meat science, 65: 841-851, doi.org/10.1016/S0309-1740(02)00289-9

O'Sullivan MG. 2017. Nutritionally Optimised Low Fat Foods. In Handbook for Sensory and Consumer-Driven New Product Development.

Pang B, Yu X, Bowker B, Zhang J, Yang Y, Zhuang H. 2021. Effect of meat temperature on moisture loss, water properties, and protein profiles of broiler pectoralis major with the woody breast condition. Poultry Science, 100(2): 1283-1290, doi.org/10.1016/j.psj.2020.10.034

Silva FAP, Amara DS, Guerra CD, Dalmás S, Arcanjo NMO, Bezerra TKA, Beltrão Filho EM, Moreira RT, Madruga MS. 2013. The chemical and sensory qualities of smoked blood sausage made with the edible by-products of goat slaughter Meat Science 94: 34-38, doi.org/10.1016/j.meatsci.2013.01.004

Singh T, Chatli MK, Kumar P, Mehta N, Malav OP. 2015. Effect of different cooking methods on the quality attributes of chicken meat cutlets. Journal of Animal Research, 5: 547, doi:10.5958/2277-940X.2015.00092.3

Troy DJ, Kerry JP. 2010. Consumer perception and the role of science in the meat industry. Meat science, 86: 214-226, doi.org/10.1016/j.meatsci.2010.05.009

Weiss J, Gibis M, Schuh V, Salminen H. 2010. Advances in ingredient and processing systems for meat and meat products. Meat science, 86: 196-213, doi.org/10.1016/j.meatsci.2010.05.008

Youssef MK, Mostafa BM, Seliem MA, Hashem AM. 2012. Assessment of the Nutritional Status of Beef and Low-Fat Beef Burger. Frontiers in Science. 2(5): 101-118, doi:10.5923/j.fs.20120205.03

Yun-Sang C, Cheon-Jei K. 2009. Physicochemical and Sensory Characterization of Korean Blood Sausage with Added Rice Bran Fiber. Food Science of Animal Resources, 29 (2):260-268, doi:10.5851/kosfa.2009.29.2.260

.