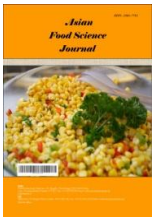

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Nutritional Effects of Full-Fat Soy Flour as an Extender on Cooked Beef Sausage Quality

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Author's contribution

The sole 'author AAO' designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

The effect of full-fat soy flour as an extender on the nutritional composition and sensory properties of cooked beef sausage was investigated. Sausage samples were produced using beef and full-fat soy flour (FFSF) as extender at 5%, 10% and 15% substitution levels while 100% beef sausage served as the control. The proximate, mineral and vitamin composition as well as sensory properties of the formulated sausages were determined using standard methods. Proximate analysis revealed an increase in moisture content (63.66-65.59%), protein (15.87-17.66%) and fat (4.22-6.37%) as beef was partially replaced with FFSF. Ash content also increased but at 15% FFSF, a decrease which was not significantly ($p>0.05$) different from control sample was observed. Crude fibre content was highest for sausage extended with 15% FFSF (1.03%) while carbohydrate content decreased significantly (11.93-7.25%) on partial replacement with FFSF. Mineral results showed a significant ($p<0.05$) increase in magnesium (9.80-15.34 mg/100 g) and decrease in zinc (0.92-0.79 mg/100 g) as beef was partially replaced with FFSF. Calcium, sodium and phosphorus contents of beef sausages extended with 10% FFSF (18.74 mg/100 g, 52.78 mg/100 g and 95.82 mg/100 g, respectively) were significantly ($p<0.05$) higher than other sausage samples. Vitamin analysis also revealed a significant ($p<0.05$) increase in vitamin A (4.23-5.32µg/100g) while vitamin B_3 (0.037-0.033 mg/100 g) and vitamin B_1 (0.023-0.013 mg/100 g) decreased as beef was extended with FFSF. Vitamin C content of sausage extended with 10% FFSF (2.76 mg/100 g) was significantly ($p<0.05$) higher than other samples. This same trend was observed for vitamin B_2

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content of sausage with 15% FFSF (0.034 mg/100 g). FFSF had no significant effect ($p>0.05$) on the sensory properties of the sausages. Thus, the use of full fat soy flour as an extender for cooked beef sausages is feasible as this will reduce the amount of meat used, thereby reducing the cost of the cooked beef sausage and at same time producing nutritious sausages.

Keywords: Full-fat soy flour; extender; beef sausage; nutritional.

1. INTRODUCTION

Sausages are ground meat mixed with fat, salt, preservatives and other seasonings and filled a casing [1]. According to Safe Practices for Sausage Production (SPSP), sausage making is a traditional food preservation technique and the sausage may be preserved by curing, drying or smoking [2]. The consumption of meat and meat products is increasing day by day; but unfortunately, their cost is high. The high cost of meat and meat products is also one of the major factors limiting the average earner and regular usage of meat products [3]. There is therefore need to find ways of reducing formulation cost of meat products so as to reduce their cost while maintaining high biological value and at the same time rendering them affordable to a majority of the population [4].

In the meat industry, there is an increasing interest in use of various non-meat proteins especially plant protein often referred to as "meat extenders" or "meat substitutes". Meat extenders are one of the many non-meat ingredients used in the production of sausage. They are reported to contain significant protein content used in the meat industry with the prime intention of creating meat products at low cost [5]. According to Teye et al. [6], extenders can be used in reducing the formulation cost of meat products. Meat extenders are also utilized as substitutes to gelling substances in processed meat products in order to improve the feel and yield of products by enhancing water binding properties [7]. Non-meat ingredients such as plants, eggs, dairy and microbial products can be incorporated into meat products in order to enhance the nutrient value and decrease the cost of the products [8,9]. Common flours which can be used as extenders include cereals and legumes, soy protein, starch and milk proteins [10]. Cowpea flour has also been used up to 10% inclusion as an extender and this resulted to an improvement in the sensory properties and yield of sausages [11,12].

Several studies have been carried out regarding the production of sausages using diversified meat extenders, such as wheat, mung beans, cowpeas, rice and corn flours [13], mashed potatoes and bread crumbs [14], grain flours, chickpeas and lentils [15]. This indicates that whole soy flour can also be used as an extender in the formulation of meat products. Soybean flour is a significant and cheap source of protein for animal feeds and many packaged meals [16]. As reported by Agume et al. [17], the protein content of soy flour ranged from 35.5–46.0g/100gdryweight (dw). The partial replacement of meat with soybean flour in sausage will make sausage more affordable, as this will cause a reduction in the cost of production. Also, people who restrict their intake of meat sausage because of the problem of heart disease can eat sausage partially replaced with soybean flour as soybean intake has been found to reduce the risk of heart attack, preventing the narrowing and hardening of the arteries, which can cause arteriosclerosis [18]. The objective of this study was to determine the effect of full fat soy flour as an extender on the nutritional quality of cooked beef sausage.

2. MATERIALS AND METHODS

2.1 Materials

Matured seeds of soybean (*Glycine max*) were purchased from Eke-Ukwu Owerri Market, Imo State, Nigeria. Fresh boneless beef chunk and the casing (intestine) were obtained from Afor Ogbe Market in Mbaise, Imo State, Nigeria. The experimental procedure was carried out at the Nutrition and Dietetics Laboratory at Imo State University, Owerri, Nigeria. The reagents used for the analysis were of analytical grade.

2.2 Preparation of Soy Flour

Soybean flour was prepared according to the method described by Bouchenak and Lamri-Senhadji [19] as shown in Fig. 1. Soybean was properly sorted, and soaked in water for 15 min, and the skin robbed off with hand. The dehulled seeds were toasted, and coarsely ground to obtain full-fat soy flour.

2.3 Preparation of Cooked Beef Sausage

The cooked beef sausage was prepared using the method of Behailu and Abebe [20] as shown in Fig. 2 but with modifications. Fresh meat was cut into small cubes, and then minced using an electric grinder. After grinding, non-meat ingredients which included: full-fat soy flour, water, salt, onion, thyme, nutmeg, black pepper and knor seasoning cube were added in their right proportion as shown in Table 1. The full-fat soy flour was also added at different percentages; 5%, 10% and 15% to produce different sausage samples. The meat and non-meat ingredients were placed in a mixer and thoroughly blended (to size of 8 mm) to ensure a uniform distribution of any non-meat ingredients within the product. After blending, the sausage batter was stuffed into casings of 23 mm in diameter and linked at lengths of 15 cm, using a pumping device.

The stuffed casings were separated into uniform segments of equal length, the linking process was accomplished by twisting the casing, and the sausage was ready for cooking at 80±5^{o}C for 45 min. After the cooking, the sausage product was showered with cold water. The cooling process was carefully monitored and controlled. The cooled sausages were then stored in an airtight container until required for analysis. The samples were subjected to sensory evaluation 30 mins after preparation.

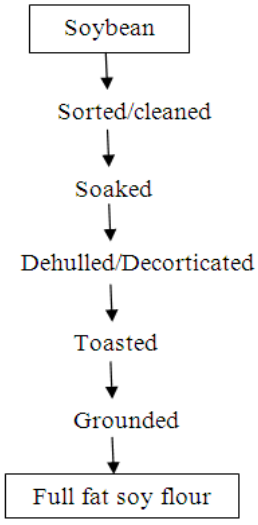

Fig. 1. Flow chart for full-fat soy flour preparation

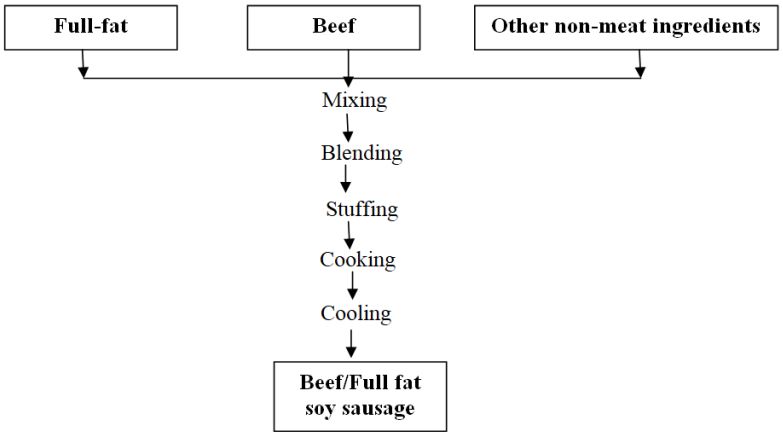

Fig. 2. Flow chat for production of cooked beef/full fat soy flour sausage

Table 1. Recipe formulation for production of cooked beef sausage with blends of meat and full-fat soy flour

Sample (Meat: Soy flour)	Meat (g)	Full fat soy flour (g)	Water (ml)	Salt (g)	Sugar (g)	Onion (g)	Knorr (g)	Mixed spices (g)
A (100:0)	200	0	30	4	2	3	2	3
B (95:5)	190	10	30	4	2	3	2	3
C (90:10)	180	20	30	4	2	3	2	3
D (85:15)	170	30	30	4	2	3	2	3

2.4 Proximate Analysis of the Sausages

The methods described by Onwuka [21] were used to determine the moisture, protein, fat, ash and crude fibre contents of the sausages samples. Moisture content was determined using the oven drying method by drying 5 g of the milled sausage at 130°C for 1 hr in an air oven. Ash content was determined using the muffle furnace method at 550°C for 24 h. Fat content was determined using the soxhlet extraction method while crude protein was determined using the Kjeldahl method. Carbohydrate content was determined by total difference of moisture, crude protein, fat, ash and crud fibre from 100%.

2.5 Mineral Analysis of the Sausages

The resulting ash was dissolved in 100 ml of dilute hydrochloric acid (HCl) and then diluted to 100 ml in volumetric flask using distilled water. The digest obtained from the different samples were used for the mineral analysis. The minerals (phosphorus, calcium, sodium, magnesium and zinc) were determined using the Atomic Absorption Spectrophotometer (Buck Scientific – 210 VGP, USA) as described by Association of Official Analytical Chemists, AOAC [22].

2.6 Vitamin Content Analysis of the Sausages

The method described by AOAC [23] was used to determine the vitamins A, C, B_1, B_2 and B_3 content of the sausages.

2.7 Sensory Evaluation of the Sausages

Sensory evaluation was conducted for the sausage samples using a 30-member semi-trained panelist. The sensory panelists were drawn from students of Imo State University (IMSU) community. They were asked to assess for the aroma, taste, texture, appearance, juiciness, mouth feel and general acceptability of the samples using a 9- points hedonic scale, with 9 indicating 'like extremely', 1 indicating 'dislike extremely' and 5 corresponding to 'neither like nor dislike' [24]. Sensory analysis was conducted according to the ethical guidelines of the International Organization for Standardization [25].

2.8 Statistical Analysis

The scores obtained were added and then the mean was recorded. Analysis of variance (ANOVA) was carried out to determine the difference among the samples using one factor randomized design ANOVA. All analysis was done in duplicate using Turkey's Test for means separation at 5% probability level ($p>0.05$).

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Cooked Sausages

The results for the proximate contents of the cooked beef sausage extended with full fat soy flour are shown in Table 2. Moisture content of the sausages ranged from 63.66-65.59% with the control sausage having the lowest and sausage with 5% full fat soy flour as highest. An increase in the moisture content was observed as beef was extended with full fat soy flour (FFSF). This trend was also reported by Behailu and Abebe [20] for beef meat sausage partially substituted with soybean protein and finger millet flours (50.91-60.52%). The moisture content of the sausage samples were close to that obtained by Agrihotri and Pal [26] for chevon sausage (66.71%).

Protein content of the sausages ranged from 15.87% in control sausage to 17.66% in sausage substituted with 10% full fat soy flour. Similarly, an increase was observed was observed as beef was extended with FFSF. Protein content of sausages formulated with 5 and 15% FFSF were significantly ($p<0.05$) higher than the control sausage. This increase was also reported by Elbakhe et al. [27] for beef sausage extended with wheat germ flour. The increase in protein content is a reflection of full fat soybean flour over beef in terms of protein content and it demonstrated their mutual supplementation effect. The high crude protein content of sausages with full fat soybean flour is indicative of its potential as an extender in cooked beef sausage. The protein content from this study is slightly low when compared with those reported by Behailu and Abebe [20] for beef meat partially substituted with soybean protein and finger millet flours (21.57-25.10%).

There was an increase in the ash content of the sausages as beef was extended with full fat soy flour. However, ash content decreased at replacement levels beyond 10% but this was not significantly ($p<0.05$) different from the control sample. The values ranged from 3.10-4.24% with control sausage as lowest and sausage replaced with 10% FFSF as highest. The increase in ash content of sausage formulations with full fat soy

flour is an indication that these when used in cooked beef sausage production could be important sources of minerals as ash content gives an indication of minerals present. Ash content from this study compared favourably with those of Dharmaveer et al. [28] for chevon sausage (3.00%) and close to the values of 4.46-4.69% for meat sausage partially substituted with soybean protein and finger millet flours as reported by Behailu and Abebe [20].

Extension of cooked beef sausage with full fat soy flour (FFSF) led to an increase in the fat content of the sausages. However, sausage replaced with 10% FFSF was not significantly ($p>0.05$) different from the control sample. The values ranged from 4.22% in sausage replaced with 10% FFSF to 6.27% in sausage replaced with 5% FFSF. The high fat content of sausage formulation with FFSF could be due to the fact that soy flour has a high fat binding property [29] and this could be beneficial in meat applications. This increase was also reported by Omojola et al. [30] for breakfast sausage containing legume flours as binders. The increase in fat content of sausage formulations with full fat soy flour is an indication that these when used in sausage production could be important source of energy for consumers.

Sausages extended with 15% full fat soy flour (FFSF) had significantly ($p<0.05$) higher crude fibre content than those with 5 and 10% FFSF and control sausage. The increase in fiber content may occur because of soybean is a vegetable-based fiber: mixture of amylopectins and cellulosics [29]. The increase in fibre indicates low cooking loss as dietary fiber supplementations increase the bulk and prevent cooking loss in meat products with no or fewer changes in textural parameters by enhancing water binding capabilities. This is also of great economic advantages for both the consumers and producers [31]. Dietary fibre in meat products are also of health benefits and an excellent meat substitutes due to their inherent functional and nutritional effects [32].

Extension of cooked beef sausage with full fat soy flour led to a significant ($p<0.05$) reduction in the carbohydrate content (11.93-7.40%) with control sausage having the highest and sausage extended with 5% full fat soy flour as lowest. This decrease was also reported by Behailu and Abebe [20] for meat sausage extended with soybean protein and finger millet flours (8.84-0.32%).

3.2 Mineral Composition of the Cooked Sausages

The results for the mineral contents of the cooked beef sausage extended with full fat soy flour are shown in Table 3. Extension of cooked beef sausage with full fat soy flour resulted to a decrease in the calcium content. However, at levels of 10%, calcium content was observed to increase and significantly ($p<0.05$) higher than the control sausage. The values ranged from 11.67% in sausage extended with 15% to 18.74% in sausage extended with 10% FFSF. Raw beef contains 5.4mg/100g calcium [33]. The calcium content of beef sausages samples observed in this study is higher than what is reported for raw beef. This may be attributed to concentration during processing. Calcium content from this study is within the range of values of 6 – 20 mg/g for calcium content of 8 Swiss cooked sausages reported by Schmid et al. [34]. Calcium in synergy with other minerals and protein is needed for proper bone formation with calcium acting as principal contributor. It is also essential in blood clotting, muscles contraction and in metabolic processes [35].

Fresh beef reportedly contains 69 mg/100g sodium [33]. The sodium content of sausages samples observed in this study is higher than these values. This might still be attributed to concentration during processing. Extension of the beef sausages with full fat soy flour at levels up to 15% caused the sodium content to increase significantly ($p<0.05$). This observation is illustrated by control sausage sample without soy flour which contains 49.69 mg/100 g, but upon replacement of beef with up to 15% full fat soy flour, the sodium content increased to 51.75 mg/100 g. The sodium content of the sausages from the study is higher than the recommended dietary allowance (RDA) for sodium which is 1.5g according to Morakinyo et al. [36]. These values are low when compared to the values of (759–929 mg) recorded for 8 Swiss sausages, as reported by Schmid et al. [34] and 680–840 mg/100 g for 16 sausages in Australia reported by of Judy et al. [37].

The magnesium content of raw beef has been reported to be about 24.5 mg/100 g. The magnesium content of sausages was lower than this value, suggesting that cooking reduced the magnesium content of sausages made from beef. Magnesium content of the sausages was observed to increase significantly ($p<0.05$) following extension with full fat soy flour with sample extended with 10% soy flour as highest

and control sample as lowest. These values were comparable with the study of Schmid et al. [34] who recorded that the magnesium content of cooked sausage averaged between 11 and 18 mg/100 g for 8 Swiss sausages.

The extension of cooked beef sausage with 5% soy flour resulted to a decrease in the phosphorus content of the sausages. However, at levels of 10%, the phosphorus content was observed to be significantly ($p<0.05$) higher than the control sample. These values were higher than the range of values of 170– 210 mg/100 g for 16 sausage samples in Australia reported by Judy et al. [37].

Zinc content of the sausages ranged from 0.79-0.90% with sausage extended with 10% soy flour as lowest and control sausage as highest. Zinc content from this study was low when compared to the study of Judy et al. [37] for raw, pan-fried without oil and barbecued beef sausages (1.8-3.4 mg/100 g). Zinc is an important micronutrient needed for healthy skin, reproductive and immune function [38].

3.3 Vitamin Content of the Cooked Sausages

Vitamin content of the cooked beef sausages extended with full fat soy flour is shown in Table 4. Extension of the cooked beef sausage with full fat soy resulted to a significant ($p<0.05$) increase in the vitamin C content. However, vitamin C content decreased significantly ($p<0.05$) at levels above 15%. Values ranged from 1.85mg/100g in sausage extended with 15% soy flour to 2.76 mg/100 g in sausage extended with 10% soy flour. Schmid et al. [34] reported higher vitamin C values for Vienna sausage (19.5 mg/100 g) pork sausage (34.6 mg/100 g).

Vitamin A content of the sausages extended with 10 and 15% full fat soy flour (5.32 and 4.49mg/100g, respectively) were observed to be significantly ($p<0.05$) higher than control beef sausages and sausage extended with 5% soy flour. This indicates that the use of full fat soy flour as an extended improved the vitamin A content of the beef sausages.

Partial replacement of beef sausage with full fat soy flour resulted to a significant ($p<0.05$) decrease (0.023-0.013 mg/100 g) in the Vitamin B_1. These values were comparable with the values reported by Judy et al. [37] for some retail samples of Australian beef sausages (<0.02-0.03 mg/100 g). Similarly, partial replacement of beef with full fat soy flour resulted to a decrease in vitamin B_2 content of cooked sausages but increased significantly ($p<0.05$) at level of 15%. Beef sausages extended with 5 and 10% full fat soy flour were not significantly ($p>0.05$) different from the control beef sausage while beef sausage extended with 15% full fat soy flour had significantly ($p<0.05$) higher vitamin B_2 content than the other samples. These values were slightly low when compared with the study of Judy et al. [37] for some retail samples of Australian beef sausages (0.07-0.09 mg/100 g).

Vitamin B_3 content of the beef sausages which ranged from 0.0034-0.037 mg/100 g was observed to decrease as beef was extended with full fat soy flour. These values were very low when compared with the study of Judy et al. [37] who reported vitamin B_3 of some retail samples of Australian beef sausages to be in the range of 3.3-4.4 mg/100 g).

3.4 Sensory Evaluation of the Cooked Sausages

The mean sensory scores of cooked beef sausages extended with full fat soy flour (FFSF) are above shown in Table 5. Taste and juiciness of the cooked beef/full fat sausages ranged from 5.90-6.47 and 6.20-6.73, respectively. Beef sausages extended with 10% FFSF was more preferred for taste while sausage with 15% FFSF as extender was more preferred for juiciness. However, no significant ($p>0.05$) differences were observed for juiciness. Taste of control sausage and sausage extended with 15% FFSF were significantly ($p<0.05$) similar while samples extended with 5 and 10% FFSF were significantly ($p<0.05$) different. A decrease in taste of the sausages was observed as substitution of FFSF increased, but beyond 10%, mean scores for taste were higher than the control sample.

Mouth feel and texture of the sausages ranged from 6.43-6.67 and 6.43-6.67, respectively with beef sausage extended with 10% FFSF as most preferred for mouth feel while control beef sausage was rated most preferred for texture. The result also indicated that extension of beef sausage with full fat soy flour had no significant ($p>0.05$) effect on the mouth feel and aroma of the cooked sausages.

Table 2. Proximate composition of the cooked sausages

Sample	Moisture (%)	Protein (%)	Ash (%)	Fat (%)	Crude Fibre (%)	Carbohydrate (%)
A	63.66±0.14^{c}	15.87±0.04^{b}	3.31±0.09^{b}	4.32±0.04^{c}	0.91±0.05^{b}	11.93±0.30^{a}
B	64.87±0.03^{b}	17.28±0.03^{a}	3.47±0.15^{b}	6.27±0.02^{a}	0.88±0.02^{b}	7.25±0.05^{c}
C	63.77±0.03^{c}	16.13±0.54^{b}	4.24±1.15^{a}	4.22±0.03^{c}	0.83±0.02^{b}	10.81±0.56^{b}
D	65.59±0.11^{a}	17.66±0.16^{a}	3.10±0.30^{b}	5.34±0.06^{b}	1.03±0.01^{a}	7.40±0.24^{c}
LSD	0.298	0.884	0.452	0.1301	0.081	1.118

Values are means of duplicate determination ± SD. Values bearing different letters in the same column are significantly different (p<0.05). Key: A= 100% Beef. B=Beef/Soy flour (95:5%). C= Beef/Soy flour (90:10%). D= Beef/Soy flour (85:15%). LSD= Least significant difference

Table 3. Mineral content of the cooked sausages

Samples	Calcium (mg/g)	Sodium (mg/g)	Magnesium (mg/g)	Phosphorus(mg/g)	Zinc (mg/g)
A	15.31±0.03^{b}	49.69±0.09^{c}	9.80±0.09^{d}	91.53±0.08^{b}	0.90±0.01^{a}
B	12.87±0.03^{c}	48.82±0.07^{d}	13.74±0.02^{b}	89.77±0.03^{c}	0.82±0.01^{c}
C	18.74±0.06^{d}	52.78±0.02^{a}	15.34±0.02^{a}	95.82±0.02^{a}	0.79±0.01^{d}
D	11.67±0.07^{d}	51.75±0.12^{b}	11.48±0.03^{c}	83.82±0.02^{d}	0.85±0.01^{b}
LSD	0.0816	0.2535	0.1423	0.1350	0.016

Values are means of duplicate determination ± SD. Values bearing different letters in the same column are significantly different (p<0.05). Key: A= 100% Beef. B=Beef/Soy flour (95:5%). C= Beef/Soy flour (90:10%). D= Beef/Soy flour (85:15%). LSD= Least significant difference.

Table 4. Vitamin content of the cooked sausages

Sample	VIT-C (mg/100g)	VIT-A (μg/100g)	VIT-B_1 (mg/100g)	VIT- B_2 (mg/100g)	Vit-B_3 (mg/100g)
A	1.93±0.01^{c}	4.23±0.03^{c}	0.023±0.00^{a}	0.029±0.01^{b}	0.037±0.00^{a}
B	2.15±0.01^{b}	4.17±0.01^{c}	0.019±0.01^{b}	0.026±0.00^{b}	0.033±0.00^{b}
C	2.76±0.06^{a}	5.32±0.06^{a}	0.016±0.00^{c}	0.027±0.00^{b}	0.036±0.00^{ab}
D	1.85±0.01^{d}	4.49±0.11^{b}	0.013±0.00^{d}	0.034±0.00^{a}	0.036±0.00^{ab}
LSD	0.245	0.1497	0.0021	0.0043	0.0034

Values are means of duplicate determination ± SD. Values bearing different letters in the same column are significantly different (p<0.05). Key: A= 100% Beef. B=Beef/Soy flour (95:5%). C= Beef/Soy flour (90:10%). D= Beef/Soy flour (85:15%). LSD= Least significant difference.

Table 5. Panelist mean scores for sensory qualities of the cooked sausages

Sample	Taste	Juiciness	Mouth feel	Texture	Aroma	Appearance	Overall Acceptability
A	6.13^{ab}	6.57^{a}	6.50^{a}	6.67^{a}	6.43^{a}	6.83^{a}	7.10^{a}
B	5.90^{b}	6.20^{a}	5.87^{a}	6.60^{a}	6.90^{a}	6.30^{a}	6.97^{a}
C	6.90^{a}	6.43^{a}	6.87^{a}	6.50^{a}	7.03^{a}	7.00^{a}	7.23^{a}
D	6.47^{ab}	6.73^{a}	6.50^{a}	6.43^{a}	6.83^{a}	7.17^{a}	7.47^{a}

Values bearing different letters in the same column are significantly different (p<0.05). Key: A= 100% Beef. B=Beef/Soy flour (95:5%). C= Beef/Soy flour (90:10%). D= Beef/Soy flour (85:15%)

Aroma of the cooked beef sausages ranged from 6.43-7.03 with sausage extended with 10% as most preferred while control beef sausage was least preferred. Appearance and overall acceptability of the cooked sausages extended with 15% full fat soy flour were more preferred with mean scores of 7.17 and 7.47, respectively. Similarly, the use of full fat soy flour as an extender had no significant (p>0.05) effect on the aroma, appearance and overall acceptability of the cooked beef sausages. This result therefore showed that all the cooked beef sausages were liked by the panelists and the use of full fat soy flour improved its sensory properties. The result from this study also reflects the ability of using full fat soy flour as an extender without negatively affecting the sensory properties of cooked beef sausages. This same trend was also reported by

Ammar [39] who concluded that the incorporation of mustard flour into beef burger patties had no negative effect on sensory properties of beef burger. Showkry [40] also reported that the beef burger containing quinoa flour (QF) exhibited an excellent sensory acceptance especially the texture, tenderness and juiciness which appeared to be reinforcement by adding QF to the beef burger.

4. CONCLUSION

The use of full-fat soy flour at higher levels as an extender in cooked beef sausage caused increased in moisture, fat, ash, crude fibre and protein contents with a decrease in carbohydrate content. Beef sausage extended with full-fat soy flour was found to be rich in minerals such as magnesium, calcium, sodium and phosphorus contents with low content of zinc as compared with the control beef sausage. Vitamins A, B_2 and C were also observed to be higher in beef sausages extended with full-fat soy flour while vitamins B_1 and B_3 were low. It can be concluded that the partial replacement of beef with full fat soy flour at 5% to 15% resulted in producing sausages without detrimental effect on the sensory attributes besides improving its nutritional quality. This study contributes to literature by providing an extender for cooked beef sausage which is relatively cheap in economic production and at the same time providing nutritious sausages. The utilization of full fat soy flour as a non-meat ingredient will reduce the amount of meat used, thereby reducing the cost of the cooked beef sausage.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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