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REPLACEMENT OF FULL-FAT SOY FLOUR AS EXTENDER ON SENSORY AND PHYSICOCHEMICAL PROPERTIES OF SMOKE-DRIED SAUSAGE

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ABSTRACT

This study examined the replacement of full-fat soy flouras extender on the physicochemical and sensory properties of smoke-dried sausage. Beef, soybean, spices, seasonings,etc.were bought. Sausages were processed with the addition of full-fat soy flour to meat at 5%, 10% and 15% with 0% as control,and then smoke-dried. Sensory and physicochemical properties were determined. Data generated were analyzed. Results showed that product D had the highest score (4.70) for colour. Products A (4.70) and D (4.70) had the best texture. Product A had the best taste (4.90). Product D had the least moisture content (10.60%), this was followed by product C (14.26%) and B (14.81%) respectively. The lowest ash content (8.65%) was recorded in Product A. The presence of soy flour in sausage results in increased ash content. Product D had the highest fat content (10.32%), followed by Product A (8.27).The pH range for these products was between 5.6-6.23. The full-fat soy flour extenders increased vitamin $B_2$with increasing soy flour from 5% (0.035 mg/100g) to 15% (0.042 mg/100g). Vitamin B_2 in full-fat soy sausage was higher than sausage without soy flour (0%). Vitamin B_2 ranged from 0.031-0.042 mg/100g.The inclusion of soy flour in sausage production for economic, higher nutritive content and sensory properties should be at 15%.The utilization of full-fat soy flour as a non-meat ingredient will reduce the amount of meat used; thereby reduces the cost of smoke-dried sausage.

Key Words: Colour, Vitamins, pH, Products, Processing

INTRODUCTION

Glycine max commonly known as soybeanor soya bean in North America, is a species of legume native to East Asia, widely grown for its edible bean which has numerous uses. Soybean meal is a significant and cheap source of protein for animal feed and many packaged meat. For example, soybean products such as textured vegetable protein (TVP) are ingredients in many meat and dairy substitutes (1). The bean contains significant amount of phytic acid, dietary minerals and B vitamins. Soy vegetable oil used in food and industrial application is another product of processing the soybean crop.

Traditional non-fermented food uses of soybean include soymilk from which Tofu and Tofu skim are made. Fermented soy foods include soy source, fermented bean paste, Natto and Tempeh. The main countries growing soy beans are the United States (32%), Brazil (31%) and Argentina (18%) (1).Protein and soy bean oil content account for 56% of dry soybean by weight (36% protein and 20% fat). The remainder consists of 30% carbohydrate,9% water and 15% ash. Soybean comprises approximately 8% seed coat or hull, 90% cotyledon and 2% hypocotyls axis or germ (2).

Sausage is derived from the Latin word 'Salsus' meaning salted or preserved by salting or 'Salsicia' meaning something salted. Sausage was originally applied to cured or salted meat. In the olden days, there were no refrigeration for meat preservation and sausage-making was a way to solve this problem.

Sausage-making evolved as an effort to economize and preserve meat which could not be consumed immediately after slaughter. This practice could be traced back to the ancient Greeks and Romans who made sausages which were usually plain and spiced (3).

Sausage is a cylindrical meat product usually made from ground meat, often pork, beef, or veal (the flesh of a calf) along with salt, spices and other flavourings and bread crumbs, with a skin around it. Typically, a sausage is formed in a casing traditionally made from intestine, but sometimes synthetic materials. Sausages that are sold uncooked are usually cooked in many ways, including pan frying, broiling and barbecuing. Some sausages are cooked during processing and the casing may then be removed. Sausage-making is a traditional food-processing preservation technique. It may be preserved by curing, drying (often in association to preservation) smoking or freezing. Some cured or smoked sausages can be stored without refrigeration. Most cured sausages must be refrigerated or frozen prior to cooking. There is a huge range of national and regional varieties of sausage which differ by their flavourings and spicing ingredients (garlic, pepper etc.), the meat used in them and their method of preparation (4).

When the food processing industry produces sausages for a low price point, almost any part of the animal can end up in sausages, varying from cheap fatty specimens stuffed with meat blasted off the carcasses (mechanical recover meat MRM) and rusk. On the other hand, the finest quality contain only choice cut of meat and seasonings. In Britain, meat declared on labels could in thepast contain fat, connective tissue and mechanical recovered meat. These ingredients may still be used, but must be labeled as such and up to 10% water may be included without been labeled. Sausage are emulsion type products, they are composed of solid fat and stabilizing them in water. The objective of this study is to look at the effect of replacement levels of full-fat soy flour on the physicochemical characteristics of smoke-dried sausage.

MATERIALS AND METHODS

Source of materials

Fresh muscle and large intestine of cow were obtained from a clean abattoir at Aviele,Auchi in Edo State, Nigeria. Soy flour, flavor enhancer, spices,salts and other materials were obtained at Uchi market, Etsako-West, Edo State, Nigeria.

Preparation of soy flour

Soy flour was prepared according to method described by (5) as shown in Fig 1. Soybean was properly sorted and soaked in water for 15mins, and skin robbed off with hand, the dehulled seeds were toasted and coarsely ground to obtain full-fat soy flour.

Steps in the Production of Meat Sausage

Raw meat

Raw materials used were of high quality and subjected to microbial analysis; all ingredients were properly weighted prior to mixing. The fresh lean meat was well trimmed to a level of less than 10% of non-trimmable fat and connective tissue, the trimmed lean meat thus being practically free from sinews and gristle and entirely free from ligament, bones and cartilage particles. The selection of meat was such that the meat had a good water-binding capacity.Twenty (20%) of the fat was needed for good texture, taste and flavour.

Meat grinding

The fist-size chunks (1kg) of lean meat and fatty tissues were ground by a grinder (Kitchen FGA Food Grinder) for 10 minutes. Tripe and filler meats were well ground. Curing salts were then added and then mixed in a mechanical mixer (KitchenAid 5-Quart Artisan Series

Mixer) to ensure that the ingredients are well dispersed. The curing process took place over night in a chiller at 3°C (6).

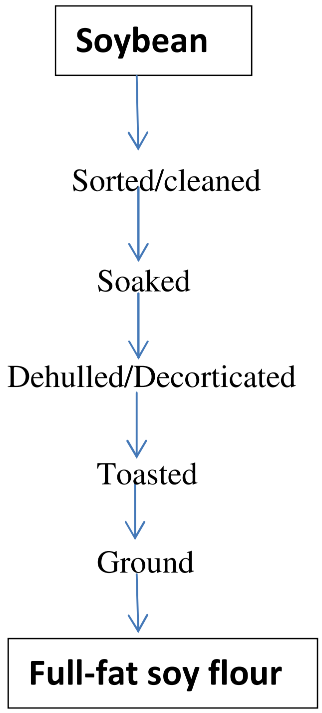

Fig.1. Flow chart for full-fat soy flour preparation

Mincing

After grinding, the meat was minced into a very fine particle size for easy protein extraction. Protein has the function of biding the water surrounding fat droplets and keeping them dispersed. Prior to mincing the lean meat was chopped for a sufficient period (8minutes). All water was taken up by the disintegrated and homogenized meats. The curing ingredients were dissolved in 20ml of warm water before been added. Minced meat was mixed with spices, seasonings, salts, sugar and soy flour in a mixer .to have a uniform mixture. It was then transferred into a stuffer to be stored in a casing (large intestine) which was obtained from a known ruminant animal (cow) (6).

Filling

Before filling into casing, oxygen was excluded from the mixture by AK6200 Vacuum Filling Machine and the temperature of the mixture was 2°C. Natural casing made from intestine of slaughtered cow was used.It was washed thoroughly in and out, and soaked in solution of salt to prevent microbial contamination. Salt was removed by rinsing casings in running water and then soaked for 1hour prior to use in order to make casing soft. Minced meat and non-meat were stuffed into casing. Casing also help to minimizes product weight loss during cooking (7).

Smoke-dryingand Packaging

The sausage was immediately smoke-dried in a standard smoking kiln that uses charcoal. The products were packaged in plastic film after cooling in order to retain quality, extend shelf life, to prevent microbial contamination and prevent physical as well as chemical changes.

Table 1:SausageFormulation

	Replacement levels of soy flour			
Meat and Ingredients	A=0%	B=5%	C=10%	D=15%
Meat (g)	1000	900	800	700
Soy flour	-	100	200	300
Sodium chloride	30	30	30	30
Sugar	30	30	30	30
Phosphate	0.01	0.01	0.01	0.01
Ginger	15.0	15.0	15.0	15.0
Thyme	15.0	15.0	15.0	15.0
Curry	15.0	15.0	15.0	15.0
Nutmeg	15.0	15.0	15.0	15.0
Pepper	15.0	15.0	15.0	15.0
Water	20.0	20.0	20.0	20.0
Total	1155	1155	1155	1155

Proximate Composition

Moisture content of products was determined by drying the product at 105^{o}C in a drying oven till a constant weight was attained (8). Ash content was determined using a muffle furnace at 550^{o}C for 8hours by AOAC method (9). Protein content was determined by (10) Kjeldahl method by first determining the percentage nitrogen content and then converted to % crude protein by multiplying with the factor 6.25. Crude fiber was determined by acid-alkali hydrolysis (10). Carbohydrate was calculated by difference (10).

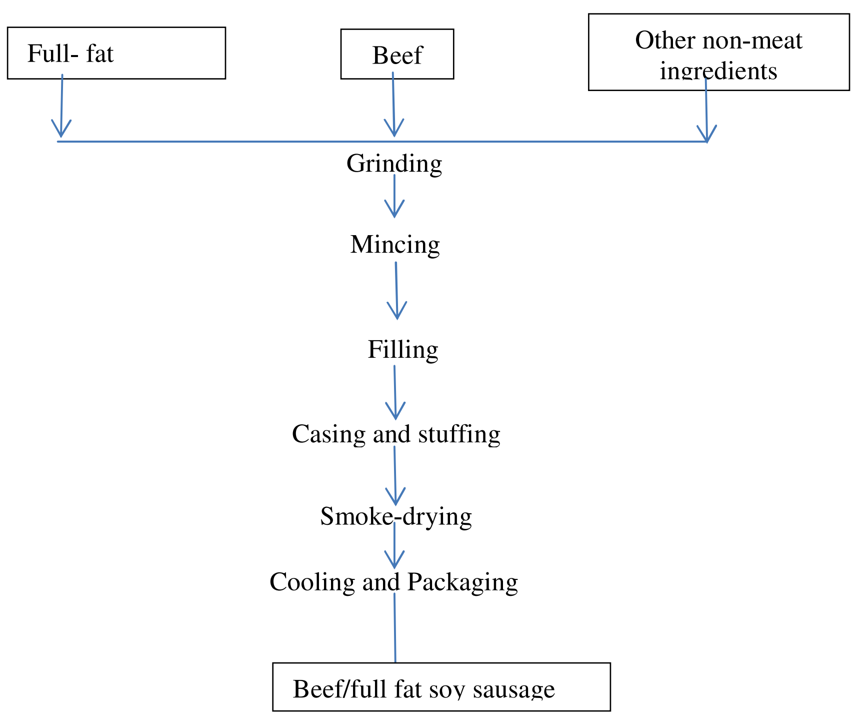

Fig.2. Production of smoke-dried beef/full-fat soy flour sausage

Mineral content Determination

Analyses of mineral content were carried out using an Atomic Absorption Spectrophotometer (Perkin Elmer Analyst 200) according to the method of (9).

Vitamin Determination: The method described by (10) was used to determine the vitamins content of the sausages.

pH Determination

The pH was determined on dispersion of 5 gram of ground sausage in 50ml of distilled water to form a homogenized mixture, later a pocket pH meter was used for measurement of the pH value (11).

Sensory Evaluation

Ten semi-trained panelistsfrom Food Technology Department evaluated the smoke-dried sausage samples for colour, taste, texture, juiciness and overall acceptability using 9-point Hedonic scale, where 1=extremely dislike and the highest point 9=extremely like (12).

Statistical Analysis

Data generated were subjected to analysis of variance (ANOVA) in a randomized complete block design. Duncan's multiple range test was applied to indicate where significant differences occurred usingGenstat statistical software package; 2005, 8th Edition (Genstat Procedure Library Release PL16).

RESULTS

Table 2: Sensory Evaluation of Smoke-Dried Sausage Meat Products

	Replacement levels of soy flour				
Sensory evaluation	A=0%	B=5%	C=10%	D=15%	SED
Colour	4.60^a	3.20^b	3.20^b	4.70^a	0.22
Texture	4.70^a	3.20^b	3.30^b	4.70^a	0.23
Taste	4.90^a	3.10^c	3.30^c	4.30^b	0.19
Juiciness	4.80^a	3.10^b	3.40^b	4.60^a	0.17
Acceptance	4.90^a	3.30^b	3.50^b	4.60^a	0.20

Means with the same superscript along the rows are not significantly different (p>0.05)

SED=Standard error of deviation

Table 3: Proximate properties of smoke-dried sausage

Replacement levels of soy flour					
Proximate	A=0%	B=5%	C=10%	D=15%	SED
Moisture (%)	14.89^a	14.26^b	14.81^a	10.60^c	0.02
Protein(%)	65.23^d	67.50^a	66.33^b	65.77^c	0.21
Ash (%)	8.65^c	9.01^b	9.79^a	9.09^b	0.01
Fat (%)	8.27b	6.88^b	9.62^b	10.32^a	0.10
Fiber (%)	0.18^d	0.80^b	0.48^c	1.03^a	0.06
Carbohydrate (%)	2.59^b	1.55^c	0.96^d	3.19^a	0.23

Means with the same superscript along the rows are not significantly different (p>0.05)

Table 4: Mineral content of smoke-dried sausage (mg/100g) and pH

	Replacement levels of soy flour				
Minerals/pH	A=0%	B=5%	C=10%	D=15%	SED
Calcium	24.14^{a}	22.32^{b}	24.16^{a}	23.73^{b}	0.06
Magnesium	12.17^{c}	14.48^{a}	11.30^{a}	12.73^{b}	0.70
Potassium	11.45^{a}	113.3^{a}	93.9^{b}	100.4^{b}	5.20
Phosphorous	17.50^{c}	18.22^{b}	20.14^{a}	16.36^{d}	0.14
pH	5.60^{b}	6.23^{a}	6.13^{a}	6.17^{a}	0.17

Means with the same superscript along the rows are not significantly different (p>0.05)

Table 5: Vitamin content of smoke-dried sausage

	Replacement levels of soy flour				
Vitamins	A=0%	B=5%	C=10%	D=15%	SED
Vitamin A (µg/100g)	4.27^{b}	4.14^{c}	5.73^{a}	4.32^{b}	0.022
Vitamin B_1 (mg/100g)	0.027^{a}	0.018^{b}	0.014^{c}	0.01^{d}	0.001
Vitamin B_2 (mg/100g)	0.031^{c}	0.035^{b}	0.039^{a}	0.042^{a}	0.001
Vitamin B_3 (mg/100g)	0.047^{a}	0.042^{b}	0.045^{ab}	0.047^{a}	0.002
Vitamin C (mg/100g)	1.96^{c}	2.18^{b}	2.96^{a}	1.63^{ad}	0.005

Means with the same superscript along the rows are not significantly different (p>0.05)

DISCUSSION

Sensory evaluation of smoke-dried sausage

The analysis of variance showed significant difference (p<0.05) among the various products based on treatment applied.

Product D had the highest score (4.70) for colour although, it was not significantly different (p>0.05) from product A (4.60). Products B and C had the same score (3.20) and were not significantly different (p>0.05). The best colour observed in Product D could be attributed to the characteristic bright colour of soy beans and the inclusion level at 15%. These results showed that when soybean is added to minced meat at 15% the end product could be better compared to whole meat (100%). (13) reported that colour is an important consideration in the consumer perception of meat and this will always affect marketing of products. The brown colour of the sausage products was due to the Millard reaction which occurred as a reaction between protein and sugar at high temperature during smoke processing (14). This work is not different from the work of Iwanegbe and Omonigho(2020) who had better colour when soy flour was added to meat in sausage production, it shows that when plant materials are added to meat, there is positive impact on colour (7).

Products A (4.70) and D (4.70) had the best texture, these products were not significantly different (p>0.05). Product C (3.30) was not significantly different (p>0.05) from Product B (3.20). These results showed that the addition of soy flour to sausage at 15% level of inclusion gives better texture.
Taste is the main criterion that makes products to be liked or disliked. Product A had the best taste (4.90), it was significantly different (p<0.05) from other products. Product D had 4.30, this was followed by Product C (3.30) these results showed that the taste of sausage with soybean inclusion changes when the level of inclusion of soybean increases (10% = 3.30 and 15% = 4.30). The results showed that soy flour improves the taste of sausage because of the high fat content resulting in high level of juiciness. (15)

reported that aroma and flavor are the most important attributed that influence the sensory properties of a meat product extended with non-meat protein additions.

The overall acceptance showed that product A had the highest score (4.90). Although, it was not significantly different (p>0.05) from Product D, next was Product C (3.50), the least was from Product B (3.30). The products were all accepted. But this study particularly indicated that inclusion level up to 15% was most acceptable for smoke-dried sausage. (16) reported that smoke-drying as a processing method does not have adverse effect on the quality and overall acceptability of meat products rather it enhances acceptance of products.

According to Malaysian Food Regulation, the amount of actual meat in manufactured meat product like sausage should not be less than 65%. As a major ingredient in sausage the percentage of meat used in the formulation in this study were within the permissible limit that is the minimum percentage of meat was 70% (17)

Proximate composition of smoke-dried sausage

The results from the proximate properties of sausage with different levels of soy flour inclusion showed that moisture content ranged from 10.60-14.89% (Table 3). Product D had the leastmoisture content (10.60%) , this was followed by Product C (14.26%), next was Product B (14.81%).Product C was not significantly different (p>0.05) from Product A (14.89%)..Decreased in moisture was observed as beef was extended with full-fat soy flour from 10% (14.81%) to 15% (10.60%). These results showed that the higher the soybean inclusion, the lower the moisture content.

The protein content showed significant difference (p<0.05) in full-fat sausages from sausage without soy flour (0%). An increase was observed in protein as beef was extended with full-fat soy flour. This was also reported by (18) for sausage extended with wheat germ flour.The protein from this study was higher than protein reported by (19) for beef meat partially substituted with soy protein and finger millet flour (21.57-25.10%). The protein content ranged from 65.23-65.77%.

The ash content showed that sausage with 10% soybean had the highest ash content (9.79%)and was significantly different (p<0.05) from other products, this was followed by Product D (9.09%) and Product B (9.01%) which was not significantly different (p>0.05) from each other. The lowest ash content was observed in ProductA(8.65%). These results showed that the presence of soybean in sausage results in increasein ash content from 5%-10%. The ash value ranged from 8.65-9.79% with control sausage having the least ash content (8.65%). This is an indication that soy flour inclusion in sausage is an important source of mineral. Ash content from this study compared greatly with those of (20) for chevonsausage (3%) and more than the values of 4.46-4.69% for meat sausage partially substituted with soybean protein and finger millet floursas reported by (19).

Product D had the highest (10.32%) fat content and was significantly different (p<0.05) from otherproducts. This was followed by Product C (9.62%), Product A (8.27%) and Product B (6.88%). Fat content increased in sausage extended with full-fat from 5% -15% soy flour inclusion levels. The high fat content could be due to the fact that soy flour has a high fat binding property (21) and this is beneficial in meat applications. This increase was also reported by (22) for breakfast sausage containing legume flours as binders. The increase in fat content of sausage formulation with full fat soy flour is an indication that when used in sausage production could be important source of energy for consumers.

The sausage extended with 15% full fat was significantly (p<0.05) higher in crude fiber content than other products. The increasein fiber content may occur because soybean is a plant based fiber: mixture of amylopectins and cellulosics. Dietary fiber in meat products are of health benefits and an excellent meat substitute due to their inherent functional and nutritional effects. The fiber observed in all these products was as results of the plant materials used as soy flour as well as seasonings (ginger, thyme etc.).

There was significant difference (p<0.05) in the carbohydrate content of these products. 15% soy flour extended sausage had the highest carbohydrate value (3.19%), the least was sausage extended with

10% soy flour (0.96%). The carbohydrate values ranged from 0.96 - 3.19%. Carbohydrate value decreased for full fat sausage extended at 5-10% (1.55 – 0. 96%) soy flour. This decrease was reported by (19) for meat sausage extended with soybean protein and finger millet flours (8.84-0.32%).

Mineral content of smoke-dried sausage

The calcium content (Table 4) for Product A (24.14mg/100g) and Product C (24.16mg/100g) were not significantly different (p>0.05) also Product B (22.32mg/100g) was not significantly different (p>0.05) from product D (23.73mg/100g). There was increased in calcium of full fat sausage extended with soy flour at 5-10% (22.32 - 24.16%). At 10% inclusion of soy flour calcium content increased more than the control although not significant (p>0.05). Calcium value in this study ranged from 22.32-24.16%. Calciumin synergy with other minerals and protein is needed in human diet for strongbones and teeth.

Product B(14,48mg/100g)had the highest magnesium; this was followed by Product D(12.73mg/100g).The magnesium content of raw beef has been reported to be about 24.5 mg/100g. But the magnesium content of sausage in this study was lower than this value (24.5 mg/100g), suggesting that processing reduces the magnesium content of sausage made from beef.Magnesium in this study ranged from 11.30-14.48%. Magnesium is needed for transmission of nervesimpulse, body temperature regulator and energy production in the body.

Potassium content in Product A (114.5mg/100g) and Product B(113.3mg/100g) were not significantly different (p>0.05). Product C (93.9mg/100g) had the lowest potassium content. Potassium content decreased for full fat soy flour from 5% (113.3mg/100g) -10% (93.9mg/100g). Potassium is needed for regulating the water balance and the acid based in the blood and tissue.

The highest phosphorus was observed in Product C (20.14mg/100g) and was significantly different (p<0.05) from other products, this was followed by Product B (18.22mg/100g). The least was Product D (16.36mg/100g). Phosphorus content increased in full fat soy flour extended sausage at 5% (18.22mg/100g) -10% (20.14mg/100g). Phosphorus in this study ranged from 16.36-20.14mg/100g. Magnesium is needed with calcium to help build bones.

pH of smoke-dried sausage

The least pH (Table 4) was observed in product A (5.6) and this was significantly different (p<0.05) from other products. There was no significantly different (p>0.05) in the pH value of product B (6.23), Product C (6.13) and Product D (6.17). These results showed that these products have good shelf stability. The pH range for these products was between 5.6-6.23. The results showed that these products are low acid food and are shelf stable due to vacuum filling as well as appropriate packaging. According to (23) a longer shelf life of sausage is achieved through vacuum filling. Packaging meat and meat products with appropriate plastic film and laminates plays significant role in retention of the quality and extension of shelf life during refrigerated storage (24).

Vitamin content of smoke-dried sausage

There was significant differences (p<0.05) in the vitamins A content of the sausage (Table 5). The results showed that Product C (5.73 µg/100g) had the highest vitamin A and was significantly different (p<0.05) from other sausages, this was followed by Product C (4.32 µg/100g), next was Product A(4.27 µg/100g), the least was Product B (4.14 µg/100g). Vitamin in full fat extended sausage increased in 5% (4.14 µg/100g) - 10% (4.32 µg/100g) soy flour sausage. This showed that the use of full fat soy flour as an extender improved vitamin A content of beef sausage.

Vitamin B_1 was significant difference (p<0.05) in the products. Vitamin B1 content decreased significantly (p<0.05) in full fat soy sausage from 5% (0.018 mg/100g), 10% (0.014 mg/100g) to 15% (0.001 mg/100g) but increased significantly (p<0.05) at 5% (0.018 mg/100g). The values were comparable with the values reported by (25)for some retail samples of Australian beef sausage (0.07-0.09mg/100g).

Vitamin B_2 was significant difference ($p<0.05$) in the sausages. The full fat soy flour extenders increased with increasing soy flour from 5% (0.035 mg/100g), 10% (0.039 mg/100g) to 15% (0.042 mg/100g). Vitamin B_2 in full fat soy sausagewas higher than sausage without soy flour (0%). Vitamin B2 ranged from 0.031-0.042 mg/100g

Vitamin B_3 increased in full fat soy sausage from 5% (0.042), 10% (0.045) to 15% (0.047). 15% and 0% soy flour sausages were not significantly different ($p>0.05$) in vitamin B_3. Vitamin B_3 ranged from 0.042 -0.047mg/100g

The Vitamin C in the full fat soy flour sausage reduced significantly ($p<0.05$) from 10% (2.96 mg/100g) to 15% (1.63 mg/100g). The lowest vitamin C was observed in 0% (1.96 mg/100g) non soy sausage. Vitamin C in this study ranged from 1.63 to 2.96 mg/100g.

CONCLUSION AND RECOMMENDATIONS

From the study, the results on sensory evaluation revealed that 15% sausage with soy flour was preferred. In terms of proximate properties, ash, moisture, protein and fat contents showed that sausage with 15% soy flour was also preferred. Vitamins such as B_2 and B_3were higher in full fat soy sausage at 15%. The importance oftheuse of soy flour as an extender for sausage cannot be over emphasized based on its nutritional qualities and relatively cheaper for economic production. 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 smoke-dried beef sausage.

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