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SENSORY AND NUTRITIONAL QUALITIES OF FRANKFURTER SAUSAGES WITH SWEET POTATO AS EXTENDER

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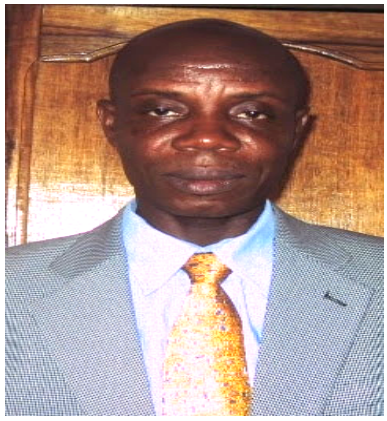

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ABSTRACT

This study investigated the effects of three varieties of sweet potatoes: orange, purple and white-fleshed sweet potato purees on the sensory, nutritional and oxidation rate of frankfurter sausages. The study was conducted at University for Development Studies (UDS), Tamale. The products formulations took place at the Meat processing unit of UDS, while chemical and microbiological analyses were carried out at laboratories of University for Development Studies, Nyankpala Campus. A complete randomized design was used. Spices were randomly assigned to the minced meat and each treatment was replicated three times. The sweet potato purees were added to 2kg of meat at 0%, 10%, and 15% each. Sensory attributes of products did not differ significantly ($P>0.05$) when puree was incorporated in frankfurter sausages except overall liking which was significantly higher ($P<0.05$) on the first day of production. The peroxide value of TO was significantly ($P<0.05$) higher throughout the period of storage than the other formulations. The peroxide value of the products ranged from 4.0 to 4.8meq/kg. There were significant differences ($P<0.05$) in pH and moisture. Among products, OFP_1 10% had the lowest value whiles OFP_2 15% had the highest pH value. Except for crude fat content all proximate parameters taken into accounts were significantly affected ($p < 0.05$) among various formulations. The protein content ranged from 18.52-20.78% whiles ash and fat ranged from 5.15-6.80% and 15.62-17.50%, respectively. There was a significant reduction in protein content as sweet potato inclusion increased from (0%, 10% and 15%). The moisture content of sweet potato frankfurter sausage ranged from 56.15-66.45%. The inclusion level of 15% was found to have higher values to 10% inclusion level. However, significant differences ($P<0.01$) were observed among treatments for all minerals studied. Iron and zinc contents among formulations were all significantly different ($P<0.01$) from each other. The sweet potato puree did not negatively affect the sensory and nutritional qualities of frankfurter sausages.

Key words: Frankfurter sausage, extender, sweet potato, sensory attributes, nutritional, oxidation

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INTRODUCTION

Meat can be defined as the whole or part of the carcass of any animal slaughtered, but does not include eggs, or fetuses [1]. Meat is also a better source of various micronutrients: low-fat pork contains 1.8 mg iron, 2.6 mg zinc; and pig's liver contains 360 mg magnesium, 20 mg iron and 60µg selenium per 100 g [2]. Products from meat processing industries are widely accepted by meat consumers due to the increasing demand for fast and convenient meals [2]. The world faces the problem of shortage of food supply, which results in malnutrition problem and its consequences are more felt in the undeveloped countries [3].

Processing of raw meat into finished products adds value, increases the yield, extends the shelf life and also serves as a source of income generation [4]. Extenders are used in meat products to improve meat particles cohesion, increase processing yield and increase dietary fiber to improve texture and reduce cost [5].

As in the quest of reducing cost of production, sweet potato which is readily available and relatively cheaper than meat can serve as an extender in sausages. It has been observed that stored tubers had higher levels of antioxidant activity than fresh tubers [6]. Sweet potato varies in carotenoid concentration. The primary vitamin A-forming carotenoid in sweet potatoes is beta-carotene [7]. Sweet potatoes are a rich source of energy, antioxidants and vitamins which is of a high value to humans [8]. Several other authors [9] and [10] reported that sweet potatoes are an excellent source of fibre and minerals which are important in reducing blood cholesterol and aiding digestion. Sweet potatoes have a percentage of insoluble fibre which is capable of preventing colon cancer, diverticular disease and constipation [11]. The high cost of meat products is a major challenge in meat processing. This research sought to address this problem by combining sweet potato and meat to produce frankfurter at a reduce cost. This study, therefore, seeks to investigate the use of sweet potato puree as an extender in frankfurter sausages.

MATERIALS AND METHODS

Study site

The study was conducted at the University for Development Studies (UDS), Tamale. The products formulations took place at the Meat processing unit of UDS, while microbiological and chemical analyses were carried out at laboratories of University for Development Studies, Nyankpala Campus and Kwame Nkrumah Science and Technology, Kumasi, respectively.

Experimental design

Completely randomized design was used in all the trials. The spices were randomly assigned to the minced meat and each treatment was replicated three times. Treatment means of the various levels of ingredients were compared against their respective controls.

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Processing of sweet potato puree

The orange, white and purple fleshed sweet potato used for the experiment were purchased from farmers in Kumbugu. They were peeled chopped into smaller sizes (4mm) and cooked for 15mins. They were then allowed to cool down at room temperature mashed/blended into puree and stored frozen at -2ºC.

Sausage formulations

Seven kilogram each of beef and pork was used for the experiment. The meat was thawed for 3 hours at a temperature of 1°C and minced using a 5mm-sieve table top mincer (Taller Ramon, Spain). The minced meat was divided into two kilogram each, which was mixed with 1.0g black pepper, 1.0g white pepper, 0.5g red pepper, 2.0g mixed spice (Adobe®) and 15g curing salt. The spices were measured into a container and mixed thoroughly before adding it to the minced meat.

Control: whole beef, WFP1: white flesh sweet potato, WFP2 15% white flesh sweet potato, OFP1: orange flesh sweet potato OFP2 15%: orange flesh sweet potato, PFP1 10%: purple flesh sweet potato and PFP2 15%: purple flesh sweet potato.

Comminution of meat

Potato purees were included at 0, 100 and 150 (g/kg) to the various sausage formulations. The minced meat was comminuted in a 3-knife, 30litres- capacity bowl chopper (Tallers Ramon, Spain) into a meat butter at a final temperature of 16°C.

Crushed ice was added to each set of products during comminution to obtain the desired consistency and temperature of meat butter, and to minimise the risk of fat separation from the muscles. The meat butter was immediately stuffed into natural casings, using a hydraulic stuffer (Talleres Rammon, Spain) and manually linked into equal length of about 10cm.

The sausages were hung on smoking racks and smoked with charcoal and groundnut husk in a Laint smoker for 45 minutes and scalded to a core temperature of 70°C. They were then cooled in cold water and hung on racks for adhering water to drain before packaging and stored in deep freezer condition for sensory evaluation.

Sensory evaluation of the products

A total of 12 panelists were selected from the students and staff of UDS Nyankpala Campus and trained according to the British Standard Institution guidelines [12] for the evaluation of the products. The panelists were made up of 6 females and 6 males. The panelists evaluated the products for colour, aroma, flavour liking, juiciness, texture, taste and overall acceptability of the sausages. A 9-point hedonic scale (*1= Extremely dislike to 9 = Extremely like*). Sensory evaluation was carried out on day 1, 7 and 14 of storage to determine the effect of storage period on the sensory characteristics of the products.
Colour: 1= Extremely dark 2=Very dark 3= Moderately dark 4= Slightly dark 5= Intermediate 6= Slightly pale 7= Moderately pale 8= Very pale 9= Extremely pale
Aroma: 1= Extremely offensive 2= Very offensive 3= Moderately offensive 4= Slightly offensive 5= Intermediate 6= Slightly pleasant 7= Moderately pleasant 8= Very pleasant 9= Extremely pleasant

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Flavour liking: 1= Dislike extremely 2= Dislike very much 3= Dislike moderately 4= Dislike slightly 5= Intermediate 6= Like slightly 7= Like moderately 8= Like very much 9= Like extremely
Tenderness: 1= Very tough 2= Moderately tough 3= Slightly tough 4= Slightly tough 5= Intermediate 6= Slightly soft/tender 7= Moderately soft/tender 8= Very soft/tender 9= Extremely soft/tender
Texture: 1= Extremely rough 2= Very rough 3= Moderately rough 4= Slightly rough 5= Intermediate 6= Slightly smooth 7= Moderately smooth 8= Very smooth 9= Extremely smooth
Taste: 1= Extremely bitter 2= Very bitter 3= Moderately bitter 4= Slightly bitter 5= Intermediate 6= Slightly sweet 7= Moderately sweet 8= Very sweet 9= Extremely sweet
Overall liking: 1= Dislike extremely 2= Dislike very much 3= Dislike moderately 4= Dislike slightly 5= Intermediate 6= Like slightly 7= Like moderately 8= Like very much 9= Like extremely.

Preparation of products for sensory analyses
The stored products were removed from the refrigerator and allowed to thaw for three hours under normal room temperature. They were then warmed in an electric oven (Turbonfan, Blue seal, UK), sliced into 2cm thickness and wrapped with coded aluminium foil.

Laboratory analyses
Analysis to determine the crude protein, crude fat, moisture, pH, mineral and peroxide values of the products were carried out to establish the nutritive value of the products. Analyses were done according to the methods of International Association of Official Analytical Chemists [13] methods. Analyses were done in triplicates. All reagent used were of analytical grades. For the determination of pH, 10g frankfurter sausage each treatment was ground with laboratory mortar and pestle, homogenized with 50ml distilled water and pH values were measured with digital pH-meter (CRISON, Basic 20, Spain).

Statistical analysis
All data collected were analysed using the general linear model (GLM) the Analysis of variance (ANOVA) of genstat statistical package, Edition.

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RESULTS AND DISCUSSION

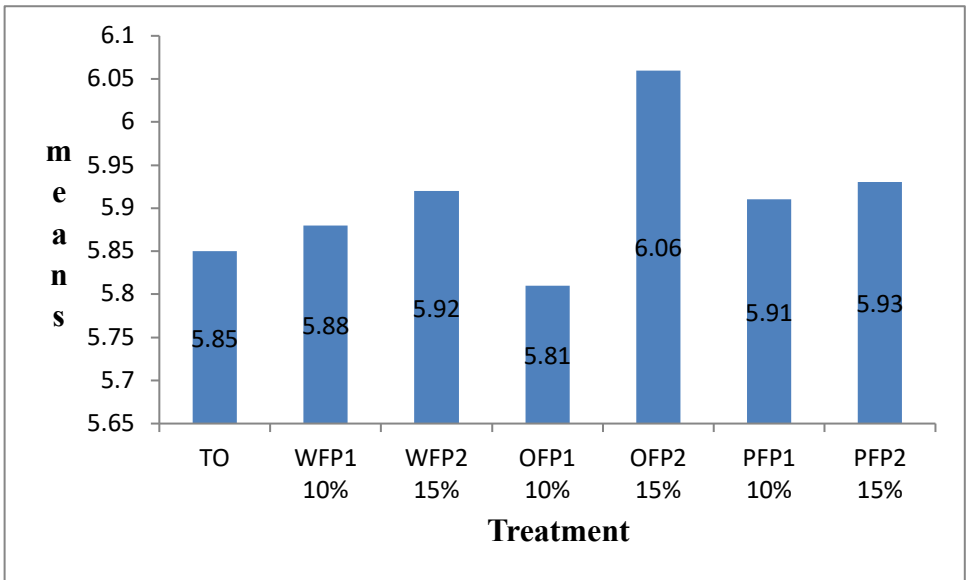

Figure 1: pH of sweet potato frankfurter sausages

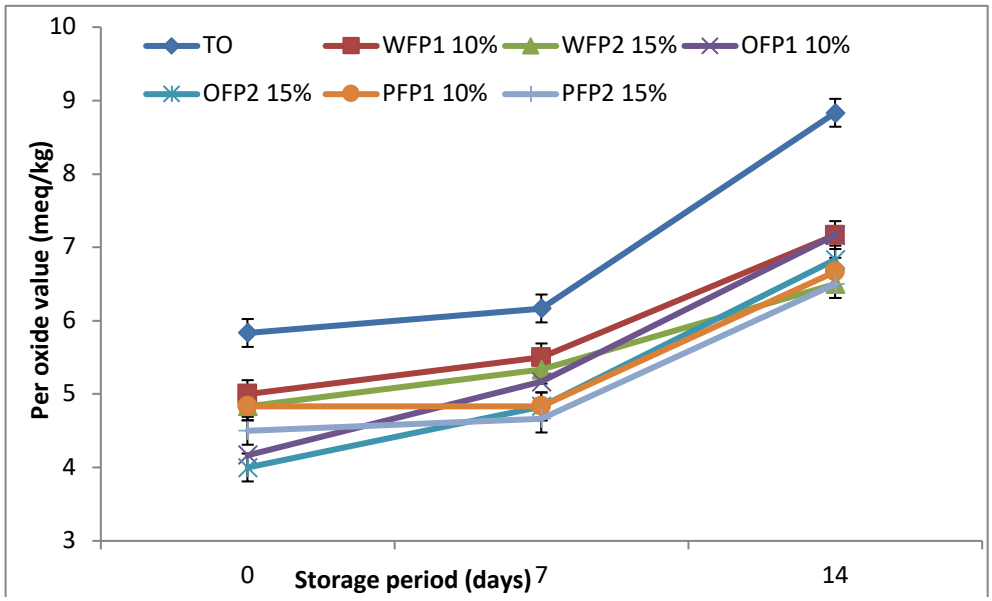

Fig. 2: Peroxide value of frankfurter sweet potato sausage

Sensory characteristics of sweet potato frankfurter sausages

There was significant improvement in terms of general acceptability of the products with the inclusion of potato puree on day 1. Lack of significant differences among treatment means in terms of sensory characteristics of the product which indicates that frankfurter with sweet potato puree extender would equally be preferred by consumers as the control.

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Protein, Fat Moisture, Ash content and pH of sweet potato frankfurter sausages

There was a significant reduction in protein content as sweet potato inclusion increased from (0%, 10% and 15%). The difference in protein content was due to the addition of the potato. It has been reported by other workers [14] that adding substances which are low in protein will result in low protein content.

Sweet potato is known to have low amount of fat. The fat content of the sweet potato frankfurter sausage was not negatively affected. Consumers tend to believe that potatoes are high in calories and in fat compared with other carbohydrate sources such as rice or pasta, an incorrect assumption since potato has negligible fat and a low energy density similar to legumes [15]. The insignificant difference in the fat content of the products indicated that consumers would not be at risk health wise when sweet potato puree is included in frankfurter sausages formulation.

Less moisture makes meat dryer in the mouth while high moisture content in meat makes it more juicy [16]. Statistically, there was a trend in products per the percentage inclusion of puree which shows the correlation in the moisture content. The inclusion level of 15% was found to have higher values to 10% inclusion level. However, high moisture content enhances microbial growth and *vice versa* [17].

Ash or mineral content is the portion of the food or any organic material that remains after it is burned at very high temperatures. Ash content of a product indicates the level of mineral available if consumed. Earlier workers [18] recorded ash content of meat which values are in the same range as this study.

It was observed that sausages frankfurter, had similar pH as the control except the 15% test products. Lower pH of meat products creates an acidic medium, making it inappropriate for bacterial growth and reproduction [19]. Generally high acidic foods are less prone to bacterial spoilage. This implies that the inclusion of sweet potato puree up to 15% would have effect on the shelf life of frankfurter sausages.

Peroxide value of sweet potato frankfurter sausages

The sweet potato products had lower peroxide values than the control frankfurter sausage which was significantly higher from day one to the 14th day (Fig. 2). Carotenoids are found largely in orange and red sweet potatoes [20]. Products with sweet potato puree were not different from each other because of the antioxidant content which is known to halt or slow oxidation of lipids. In addition to the coloured flavonoids, sweet potatoes with skins contain a variety of colourless phytochemicals with antioxidant potential, most notably vitamin C [21]. These could be the major cause of stabilization of the peroxide values of the test products.

Mineral content of sweet potato frankfurter sausages

The iron content was significantly higher in the sweet potato product than the control frankfurter sausage with FP2 15% being the highest. Iron deficiency may affect three billion people worldwide [22]. This shows sweet potato sausage can provide some iron needed by human. Therefore, it would be predicted that sweet potato-based

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complementary foods (sweet potato sausage), with cereal-based infant foods, would have better iron bioavailability [23].

Significant amount of Zinc was recorded in the test products though the control was significantly higher than the test products. Courtney [24] found that genotypic variation of iron and zinc concentration exists in sweet potato storage roots. Health problems caused by zinc deficiency include anorexia, dwarfism, and weak immune system [25]. Higher ($P<0.001$) selenium content was recorded in the control compared to the test products though all had appreciable amount of selenium. Selenium works with vitamin E to protect cells from damage that may lead to cancer, heart related disease and other health problems [26]. Selenium also has a role, besides vitamin E, in muscle function by improving endurance, recovery and slowing the ageing process [27, 28].

CONCLUSION

The inclusion of sweet potato puree as an extender did not negatively affect the sensory characteristics of both beef sausages. It improved on the tenderness and texture of both beef sausages. The beef sausages were not influenced negatively. Lipid per oxidation process was slowed by the sweet potato puree inclusion in the sausages. The three sweet potato varieties appeared to be rich sources of micro minerals (zinc, iron and selenium).

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Table 1: Sensory characteristics of sweet potato frankfurter sausages on day 1

Parameters	TO 0%	WFP1 10%	WFP2 15%	OFP1 10%	OFP2 15%	PFP1 10%	PFP2 15%	S.e.d	P value
Colour	6.45	6.36	6.64	7.18	6.45	6.00	5.91	0.74	0.69
Aroma	5.73	7.09	6.00	6.36	6.27	7.27	6.73	0.78	0.39
Flavour liking	6.42	6.92	6.17	6.33	6.75	6.75	6.08	0.59	0.73
Tenderness	7.18	6.18	7.36	6.36	6.91	6.27	7.09	0.87	0.72
Texture	6.73	6.09	6.45	6.73	6.27	6.64	6.00	0.90	0.97
Taste	5.55	6.18	7.09	6.64	7.18	6.82	5.82	0.78	0.27
Overall liking	5.27^{a}	7.45^{b}	7.09^{ab}	7.27^{ab}	7.27^{ab}	7.36^{ab}	7.36^{ab}	0.71	0.04

Sed = standard error of difference. Means on the same row with the same superscript are not significantly different (P>0.05)

Table 2: Sensory characteristics of sweet potato frankfurter sausages on day 7

Parameters	TO 0%	WFP1 10%	WFP2 15%	OFP1 10%	OFP2 15%	PFP1 10%	PFP2 15%	S.e.d	P value
Colour	5.92	6.08	7.25	6.17	6.58	5.58	5.17	0.73	0.13
Aroma	6.83	6.92	7.00	6.50	6.75	6.67	6.17	0.61	0.85
Flavour liking	6.42	6.92	6.17	6.33	6.75	6.75	6.08	0.58	0.73
Tenderness	6.17	5.75	6.33	5.33	5.17	5.00	5.67	0.85	0.65
Texture	4.92	5.33	6.25	5.75	6.25	5.25	5.83	0.73	0.44
Taste	6.67	7.17	6.75	6.33	7.42	6.83	6.83	0.55	0.58
Overall liking	7.08	7.08	6.92	6.42	7.17	6.92	6.33	0.62	0.74

S.e.d = standard error of difference. Means on the same row with the same superscript are not significantly different (P>0.05)

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Table 3: Sensory characteristics of sweet potato frankfurter sausages on day 14

Parameters	TO 0%	WFP1 10%	WFP2 15%	OFP1 10%	OFP2 15%	PFP1 10%	PFP2 15%	S.e.d	P value
Colour	5.55	5.82	6.91	6.27	5.73	5.00	5.09	0.77	0.19
Aroma	6.00	6.00	6.27	6.27	5.82	5.91	5.45	0.71	0.93
Flavour liking	6.18	6.27	6.18	6.18	6.09	5.18	5.18	0.68	0.40
Tenderness	6.00	5.64	5.09	4.73	4.82	4.91	6.09	0.77	0.35
Texture	4.91	5.45	4.82	5.27	5.18	5.00	5.45	0.74	0.96
Taste	6.18	6.64	6.00	6.45	5.73	5.91	5.45	0.64	0.56
Overall liking	6.27	6.82	6.00	6.45	6.18	6.09	5.82	0.70	0.85

S.e.d = standard error of difference. Means on the same row with the same superscript are not significantly different (P>0.05)

Table 4: Mineral composition of sweet potato frankfurter sausages

Parameters	Iron	Zinc	Selenium
TO	0.197^{f}	0.067^{a}	0.573^{a}
WFP1 10%	0.238^{d}	0.025^{e}	0.086^{b}
WFP2 15%	0.302^{b}	0.031^{c}	0.071^{c}
OFP1 10%	0.211^{e}	0.021^{f}	0.055^{d}
OFP2 15%	0.289^{c}	0.019^{g}	0.057^{d}
PFP1 10%	0.159^{g}	0.027^{d}	BDL
PFP2 15%	0.321^{a}	0.038^{b}	0.056^{d}
Pooled standard error of means	0.0	0.0	0.0
P value	0.01	0.01	0.01

Means (± standard error) Means in the same column with different superscript are significantly different (P<0.01). BDL- Below detection limit

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Table 5: Proximate composition of sweet potato frankfurter sausage

Parameter	TO	WFP1 10%	WFP2 15%	OFP1 10%	OFP2 15%	PFP1 10%	PFP2 15%	P value
Moisture	56.15 ± 0.14^{e}	60.30 ± 0.14^{d}	61.30 ± 0.14^{c}	61.05 ± 0.14^{cd}	63.20 ± 0.14^{b}	63.25 ± 0.14^{b}	66.45 ± 0.14^{a}	0.0
Protein	20.78± 0.10^{a}	19.69±0.10^{b}	18.52± 0.10^{c}	19.76±0.10^{b}	18.81± 0.10^{c}	19.91±0.10^{b}	18.89^{c}±0.10^{c}	0.0
Fat	16.88 ± 0.54	17.50 ± 0.54	17.19 ± 0.54	16.88 ± 0.54	16.88 ± 0.54	16.88 ± 0.54	15.62 ± 0.54	0.4
Ash	6.72 ±0.06^{a}	6.80± 0.06^{a}	5.15± 0.06^{c}	5.79± 0.06^{b}	6.92± 0.06^{a}	6.78± 0.06^{a}	5.84± 0.06^{b}	0.0

Means (± standard error) Means in the same row with the same superscript are not significantly different (P < 0.05)

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