



Nutritional and sensory properties of smoked pork sausage produced with pig stomach as filler-meat

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ABSTRACT

The nutritional and sensory characteristics of processed meat are of major concern to consumers across the globe. This study evaluated nutritional and sensory properties of pork sausages using pig stomach as filler meat. Pig stomach replaced lean pork at 0% (control), 25%, 50%, 75% and 100%, respectively to obtain treatments coded as T₀, T₂₅, T₅₀, T₇₅ and T₁₀₀, respectively. The sausages were assessed for acidity, water holding capacity, cooking loss, proximate composition and sensory attributes. There were no significant differences ($p > 0.05$) in flavour of sausages in particular; and all other sensory attributes of sausages produced with or without pig stomachs. Treatments T₀, T₂₅ and T₅₀ were very similar in most of the sensory properties. Both pH and water holding capacity reduced with increasing levels of pig stomach used, and there were significant differences ($p < 0.05$) between treatments. The results obtained suggest that pig stomach could be used at 50% in smoked pork sausages without adverse effects on nutritional and sensory properties.

Keywords: Nutritional property, Pig stomach, Sausage, Water holding capacity, Sensory attribute

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Introduction

Meat is the flesh of animals used as food and it is mostly made up of skeletal muscle tissues and fat, all of which can be described as edible tissues or organs including liver, stomachs, kidneys, hearts and lungs (Lawrie and Ledward, 2006). According to Scott and Sockett (1998), meat was typically processed to preserve it, but the act has since evolved to the provision of highly nutritious meat products to serve consumers readily rather than for future use. Some methods of meat preservation include canning, freezing and smoking. Processing increases the life span of meat by preventing the action of spoilage microorganisms. Fresh meat can be processed into several products including 'khebab', meatloaf, bacon, hams and sausages of different kinds. The manufacture of some of these meat products may require the use of meat extenders or fillers. Meat extenders are mostly non-meat ingredients which when used in meat formulation may result in increases in protein contents and, more importantly reduce the costs of production

appreciably (FAO, 2010). Filler-meats are edible portions of different meat animal carcasses, which are lowly priced and may be utilized in further processing of value-added products. According to the FAO (2010), examples of filler-meats used as extenders in meat processing include pork skin, chicken gizzard, kidney, tongues, intestines, hearts and stomachs of different meat animals. These form significant portions of slaughter animals and according to Ockerman and Basu (2004), they could amount to 10% in pigs to as high as 30% in cattle. Therefore, when such significant portions of animal by-products are not effectively utilized, substantial economic losses could be recorded along the animal slaughter and processing value-chains. Toldra *et al.* (2012) reported that in order to increase the economic returns from different edible meat by-products, various processed meat products including liver pate, liver sausage, and blood sausage have been developed for human consumption. However, it is important to note



that the utilization of different meat by-products would depend on several factors including culture, religion, incomes and personal preferences, in addition to information on their nutritional benefits. Seong *et al.* (2014) characterized the yields and nutritional compositions of some edible pork by-products and concluded that economic benefits could be derived from their utilization in other meat products. Pig stomachs are traditional delicacies in some countries across the world, where they are either processed solely or with other meat and non-meat ingredients such as vegetables for human consumption. The objective of this study was to provide evidence for the suitability or otherwise of pig stomach as filler-meat in the production of smoked pork sausages. The specific objectives included determination of pH and water holding capacity, cooking loss, proximate composition and sensory attributes of the sausages produced with and without pig stomach.

Materials and Methods

Location of experiment and smoked pork sausage production

This experiment was conducted at the Meat Science and Processing Unit of the Department of Animal Science, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi. Pork shoulders and stomachs from the same carcasses were obtained from the Kumasi Abattoir Company Limited. The shoulders were deboned and trimmed of all visible adipose tissues. Pig

stomachs were also trimmed of visible fats, dipped in hot water at 40°C in order to remove the mucosa lining and washed thoroughly after which both boneless shoulder and stomachs were frozen at -18°C overnight prior to sausage formulations. All spices used were obtained from the Kumasi Central Market. After frozen storage both boneless pork shoulder and pig stomachs were cut into smaller pieces and comminuted separately with a mincing machine (MADO Superwolf, Germany) with a sieve size of 15 mm. Minced pork was allotted to five different treatments: T₀, T₂₅, T₅₀, T₇₅ and T₁₀₀ in which minced pig stomach replaced minced pork at 0%, 25%, 50%, 75% and 100%, respectively. A spice-mix comprising of garlic, chilli pepper and black pepper was added to each treatment and hand-mixed for 10 minutes each to obtain a uniform meat-spice mix. Each resultant mixture was finally minced separately using a 5 mm sieve, stuffed into natural hog casings and hand-linked at equal lengths of 10 cm. Saw-dust obtained from *Triplochiton scleroxylon* was used to generate smoke in a traditional smoke chamber for cold-smoking the sausages for 3.5 h after which they were cooled for 55 min under a ceiling fan. Three different batches were produced per treatment, and each batch weighed 3 kg. All treatments were packaged in polythene bags, labelled appropriately and frozen at -18°C for further studies. Table 1 is the ingredient formulation used in smoked pork sausages produced with and without pig stomach.

Table 1. Ingredients (%) used in smoked pork sausages with and without pig stomach.

Treatment	Pork	Pig stomach	Water	Mix-spice	Salt	Total
T ₀	86.16	0.00	10.00	2.88	0.96	100.00
T ₂₅	62.12	14.04	10.00	2.88	0.96	100.00
T ₅₀	38.08	38.08	10.00	2.88	0.96	100.00
T ₇₅	14.04	62.12	10.00	2.88	0.96	100.00
T ₁₀₀	0.00	86.16	10.00	2.88	0.96	100.00

Mix-spice = black pepper, red pepper, and garlic in ratios of 1:2:1, T₀=0% pork stomach, T₂₅=25% pig stomach, T₅₀= 50% pig stomach, T₇₅=75% pig stomach, T₁₀₀=100% pig stomach respectively in place of minced pork.

Parameters measured

Acidity (pH), water holding capacity (WHC), cooking loss (%) and costs of production

The procedure described by Van Lack *et al.* (2001) was employed to measure pH of raw sausages using a micro pH-meter (Suntex pH Meter SP-701, Taiwan), after calibration with buffer solutions of pH 7.00 and pH 4.01 as recommended by manufacturer. Water holding capacity was determined as described by Lee *et al.* (2008). Cooking loss was calculated as difference in weight of raw and cooked sausages expressed as a percentage of raw weight. The costs of producing smoked pork sausages with

and without pig stomachs were computed based on retail prices of ingredients used per kg of sausage manufactured.

Proximate compositions

Proximate analysis of cooked sausages was performed 24 hours after production according to procedures prescribed by AOAC (2012) for moisture, crude ash, fat and protein. All the evaluations were performed in triplicate.

Sensory attributes

Three pieces of frozen sausages were randomly selected from each treatment and thawed overnight at 2°C. Thawed sausages were cut into

equally sized pieces of 3 cm lengths and cooked in a microwave oven for 2 min. Panelist were sited in a single session and all treatment type samples were served to each member at the same time on disposable plates for testing. The sausages served were coded with three-digit random numbers and a panel of 35 members were tasked to evaluate the following sausage attributes: appearance, tenderness, flavor, mouthfeel, aftertaste and overall acceptance, using a 9-point hedonic scale (Akwetey *et al.*, 2014). Each plate contained all treatments at the same time, and panel members were asked to rinse their mouths with water before starting and between sample evaluations in order to prevent carry-on effects of sensory attributes from sample to sample.

Statistical analysis

The design of the study was 5 (treatment) x 3 (replication) in completely randomized design and each experiment was repeated 3 times, resulting in 45 experimental units. Data generated were subjected to one-way analysis of variance (ANOVA) using SPSS version 20.1 for windows. Significant differences between treatment means were determined using Duncan's test of homogeneity at 5%.

Table 2. Acidity (pH), water holding capacity, cooking loss and costs of producing smoked pork sausages with and without pig stomach.

Parameter	Type of smoked pork sausage					P - value	SE
	T ₀	T ₂₅	T ₅₀	T ₇₅	T ₁₀₀		
pH	6.04 ^a	6.21 ^{ab}	6.11 ^{ab}	5.36 ^b	5.41 ^b	0.04	0.182
WHC	56.53 ^a	55.63 ^{ab}	55.52 ^{ab}	49.17 ^b	45.29 ^{bc}	0.03	2.216
CL	13.88 ^b	14.11 ^{ab}	13.73 ^b	18.42 ^{ab}	19.43 ^a	<.001	1.241
CoP	14.30	13.41	12.51	10.73	9.40		

abc Means in same row with different superscripts are significantly different (p<0.05), T₀=0% pig stomach, T₂₅=25% pig stomach, T₅₀= 50% pig stomach, T₇₅=75% pig stomach, T₁₀₀=100% pig stomach respectively in place of minced pork. WHC = water holding capacity, CL= % cooking loss, CoP= cost of production (GHS/kg).

The results obtained for costs (GHS/kg) of producing smoked pork sausage reduced from GHS 14.30 (T₀) to GHS 9.40 (T₁₀₀), which translated into making substantial savings of 6.22%, 12.52%, 24.97% and 34.27%, respectively for replacing minced pork with 25%, 50%, 75% and 100% pig stomach in the formulation of smoked pork sausages. These savings can possibly further translate into improved profit margins, all things been equal, under competitive market situations for pork sausage processors.

Proximate components of smoked pork sausages with and without pig stomach

The percentage compositions of moisture, protein, fat and ash in the smoked pork sausages are shown in Table 3. The levels of moisture

Results and Discussion

Acidity (pH), water holding capacity, cooking loss (%) and costs of production

Table 2 shows results obtained for pH, WHC, cooking loss and costs of producing smoked pork sausages with and without using pig stomach as filler-meat. It was observed that the pH and water holding capacity declined significantly (p<0.05) with increasing levels of pig stomach. However, the differences recorded for pH and WHC for T₀, T₂₅ and T₅₀ were similar. The cooking losses increased significantly (p<0.05) with increasing use of pig stomachs, but again losses reported for treatments T₀, T₂₅, T₅₀ and T₇₅ showed no significant differences (p>0.05). Similar findings have been reported by Akwetey *et al.* (2014) which is a manifestation of the direct relationship between pH and water holding capacity and their effects on either reducing or increasing cooking loss in meats. Higher meat pH generally results in increased WHC, which in turn enables cooked products to resist weight losses that may accompany heat-denaturation of proteins during cooking.

recorded were ranged between 49.83% (T₁₀₀) and 55.61% (T₂₅), protein contents were between 20.34% (T₁₀₀) and 23.30% (T₅₀), fat levels were ranged from 13.98% (T₀) to 17.57% (T₇₅) while ash contents were between 1.13% and 1.38% for treatments T₁₀₀ and T₅₀, respectively. Whereas there were no significant differences (p>0.05) observed in the contents of ash recorded, significant differences (p<0.05) existed between moisture, protein and fat contents of the sausages. However, the observed differences were not statistically different in treatments T₀, T₂₅ and T₅₀. Similar findings were reported by Akwetey and Dompney (2013) when chicken gizzard was used to replace portions of pork in the production of smoked pork sausages.

Table 3. Proximate composition of smoked pork sausages with and without pig stomach.

Type of sausage	Proximate composition			
	Moisture	Crude protein	Crude fat	Crude Ash
T ₀	54.00 ^{ab}	23.30 ^a	13.98 ^c	1.37
T ₂₅	55.61 ^{ab}	23.09 ^a	14.57 ^{bc}	1.33
T ₅₀	54.00 ^{ab}	22.68 ^{ab}	15.01 ^{bc}	1.38
T ₇₅	51.03 ^{bc}	22.69 ^{ab}	17.57 ^a	1.29
T ₁₀₀	49.83 ^c	20.34 ^{ab}	16.99 ^a	1.13
<i>P</i> - value	<.001	<.001	<.001	0.11
SE	1.065	0.533	0.702	0.045

*abc*Means in same column with different superscripts are significantly different ($p < 0.05$), T₀=0% pig stomach, T₂₅=25% pig stomach, T₅₀= 50% pig stomach, T₇₅=75% pig stomach, T₁₀₀=100% pig stomach respectively in place of minced pork.

Sensory attributes

Results obtained after sensory evaluation of smoked pork sausages produced using pig stomach in place of some portions of lean pork are reported in Table 4. A total of 35 consumer panelists evaluated the sausages based on appearance, pork flavour, juiciness, tenderness, mouth feel, aftertaste and acceptability using a scale of 1 to 9 for dislike extremely to like

extremely. Quite high mean scores were recorded for all the sensory attributes evaluated and there were no significant differences ($p > 0.05$) in the observed values. Appearance scores ranged from 6.32 (T₇₅) to 6.87 (T₂₅), pork flavour was scored between 5.21 (T₀) and 6.33 (T₁₀₀), juiciness was 5.09 (T₀) to 5.84 (T₇₅), tenderness 5.50 (T₀) to 6.34 (T₇₅), mouth feel 5.51 (T₇₅) to 6.00 (T₀), after-taste 5.52 (T₂₅) to 6.11 (T₀) and acceptability ranged from 6.68 (T₀) to 7.97 (T₅₀).

Table 4. Sensory attributes and consumer acceptability of smoked pork sausages with and without pork stomach.

Attribute	Type of sausage					<i>P</i> - value	SE
	T ₀	T ₂₅	T ₅₀	T ₇₅	T ₁₀₀		
Appearance	6.84	6.87	6.84	6.32	6.48	0.07	0.113
Flavour	5.21	5.56	5.40	5.41	6.33	0.056	1.015
Juiciness	5.09	5.32	5.72	5.84	5.64	0.14	0.138
Tenderness	5.50	5.64	6.04	6.34	5.54	0.18	0.163
Mouth feel	6.00	5.56	5.63	5.51	5.66	0.07	0.086
After-taste	6.11	5.52	5.58	5.63	5.76	0.12	0.105
Acceptability	6.68	7.86	7.97	6.88	6.72	0.21	0.059

*abc*Means in same row with different superscripts are significantly different ($P < 0.05$), T₀=0% pig stomach, T₂₅=25% pig stomach, T₅₀= 50% pig stomach, T₇₅=75% pig stomach, T₁₀₀=100% pig stomach respectively in place of minced pork. Sensory scale: 1= dislike extremely to 9= like extremely.

In particular, the acceptability scores for pork sausages produced with 25% and 50% substitution with pig stomach were very encouraging. This is because the respective scores translated to 87% and 88% of consumers' willingness to purchase these products when available, compared to 74% who may buy the sausages produced without any inclusion of pig stomach. This suggests that a mix of minced pork and pig stomach could potentially provide better consumer sensory acceptability effects in smoked pork sausages.

Conclusions and Recommendations

The use of pig stomach did not affect sensory attributes in smoked pork sausages. However, consumers were more likely to purchase the

sausages produced with 25% -50% pig stomachs. Producing smoked pork sausages with pig stomachs resulted in substantial reductions in the cost/kg of sausage. The proximate compositions of sausages produced without pork stomach was not different from those containing 50% pork stomach. Thus, pig stomach could be used as substitute for lean pork in the production of smoked pork sausages up to 50% on weight basis without any adverse effects on nutritional and sensory characteristics. Further study is recommended to assess to use of pig stomachs and other pork by-products in the manufacture of value added meat products in order to reduce the costs of ingredients without affecting nutritional and sensory attributes of such products.

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