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Using *Sierrathrissa leonensis* in Emulsion-Type Sausage

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Abstract

This study was conducted to produce emulsion-type sausages using *Sierrathrissa leonensis*. Boneless pork and *Sierrathrissa leonensis* were used as the meat ingredients, and portions of pork were replaced with *Sierrathrissa leonensis* at 0% (control), 50% and 100% to obtain three treatments, coded as T1, T2 and T3 respectively. Proximate composition, pH, moisture retention and cooking yield of the sausages were determined. Sensory evaluation was performed by thirty-nine untrained panelists in order to evaluate consumer acceptability of the products. A 9-point Hedonic scale was used to score sensory attributes (tenderness, juiciness, flavor, mouth feel, color, aftertaste and acceptability) of the sausages. There were significant ($p<0.05$) increases in moisture and ash contents in the products as the use level of *Sierrathrissa leonensis* increased from 0 to 100%. The moisture content increased from 74.50% (control) to 78.47% (T3) and ash increased from 1.50% (control) to 3.17% (T3). The crude fat content reduced significantly from 21.50% (control) to 8.67% (T3) with increasing usage of *Sierrathrissa leonensis*. Crude protein levels also decreased significantly from 15.71% (control) to 14.96% (T3), but there was no significant difference between T2 and T3. The pH significantly increased with increasing level of *Sierrathrissa leonensis* used in the products. Most of the sensory panelists preferred the control products, compared to sausages containing *Sierrathrissa leonensis*, because very high scores were obtained for the overall product acceptability and for most of the individual sensory attributes. Overall product acceptability significantly decreased ($p<0.05$) as the level of *Sierrathrissa leonensis* increased. However, increasing levels of *Sierrathrissa leonensis* decreased the costs of producing the sausages. It was concluded that *Sierrathrissa leonensis* has promising potential to replace portions of pork in emulsion-type sausages because sausages containing 50% *Sierrathrissa leonensis* were similarly rated in most of their eating qualities compared to the control. More so, sausages produced with *Sierrathrissa leonensis* had reduced costs of production and were lower in fat content.

Keywords: *Sierrathrissa leonensis*; Proximate composition; Emulsion; Sensory attribute

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Introduction

In Ghana and most West African countries, fish species like the West African Pygmy Herring (*Sierrathrissa leonensis*), have been assessed regionally as Least Concern [1,2]. Reported of an increasing awareness of fish as food, as due to its nutritional value, health benefits as well as affordability. Fish is of importance to the diet in the developing nations because in an about thirty low-income food-deficit countries in Africa and Asia, more than one-third of daily intake of animal proteins come from fish [3]. An increase in supply of fish protein for human consumption would depend on better utilization of the present catch [4]. And the underutilized species of fish are potential sources of inexpensive protein [5]. Reported that these species of fish and their products are more affordable and could therefore meet the needs of poor and vulnerable groups, particularly in rural and urban areas where limited economic resources prevent dietary diversity. A solution to the economic and logistic challenges in increasing fish consumption among these groups of people will be essential to make fish accessible and affordable. *Sierrathrissa leonensis* is a pelagic species; neither closes to the bottom nor to the shore [6]. This fish species is commonly called West African Pygmy Herring and locally called "one-man-thousand" or "woevi" in Ghana. Also, it is a plentiful low-value fish in Ghana, being underutilized mainly as fried fish and usually eaten with a locally made food called "a bolo" a steamed dish prepared from corn flour. Processing of this fish species is mostly by frying or drying. Utilization of fish is influenced by many interacting factors including: consumer preferences for a specific fish species, seasonal variation, fish processing and distribution and, probably to an increasing extent, nutritional value [7]. reported that value addition offers consumers with variety of protein sources and help meet the requirements in the Post-World Trade Organization period by successfully facing global competition. This can be done by developing processed fish products such as sausages which will add cooking convenience, consumer benefit

Table 1: Formulation of the sausages with and without *S. leonensis.*

Ingredient (g)	Treatment		
	T1 (control)	T2	T3
*S. leonensis*0.0		1000	2000
Pork	2000	1000	0
Curing salt	24	24	24
Phosphate	10	10	10
Corn starch	10	10	10
Ice	0.44	0.44	0.44
Mixed spices*	35	35	35
Total	2079.44	2079.44	2079.44

*Mixed spices consisted of the following in g/kg; chili pepper (5), ginger (5) and nutmeg (7.5).

and serving as a method of preservation for future usage: because consumers only have the option of choosing from preserved fish products like cured/salted fish, smoked/dried fish, canned fish and chilled/frozen fish [8]. Fish sausage which is a product from the processing of raw fish offers consumers a variety of fish product which can be served for breakfast, brunch, dinner or as a snack Pearson and [9]. Because there is not enough stability in such a product, some additives can be added to increase their stability. Sausage-type products made from fish emulsions are products in which fish flesh or whole fish is mixed with additives, stuffed into suitable casings and heat treated. The flesh of fish is usually used for sausage production because of its muscle protein as well as its unique characteristic gel forming which acts as an emulsifying agent [10]. Therefore, the preparation of fish sausage makes better use of fish by converting it into form of food accepted and appreciated by consumers [11]. The world's food protein shortage is a serious problem hence, several research approaches must be undertaken to alleviate the situation. The objective of this study was therefore to produce emulsion-type sausages using *Sierrathrissa leonensis* as a partial substitute to pork. Specifically, to evaluate the quality of the products by assessing their proximate composition, moisture retention, cooking yield, pH and sensory profile.

Materials and Methods

Experimental location and raw materials

The experiment was carried out at the meat science and processing unit, Department of Animal Science, KNUST. Frozen *S. Leonensis* was obtained from Kpong in the Eastern Region of Ghana whereas boneless pork and phosphate were acquired from the meat science and processing unit. Other non-meat ingredients used in the formulation were purchased from the Ayeduase market in Kumasi.

Emulsion-type production

Emulsion-type sausages were produced using 0%, 50% and 100% respectively of *S. leonensis* in place of pork. The types of sausages produced were respectively coded as T1 (control), T2 and T3 (Table 1). A Super Wolf MADO (MEW 513, Maschinferfabrik Domhan, and GmbH, Germany) grinder was used to grind the pork through a five-millimeter disc plate. *S. leonensis* and the minced pork were chopped using an MTK 561 MADO Grant tabletop cutter (Maschinferfabrik Domhan, GmbH, Germany) with ice to regulate the product's temperature during emulsification. The sausages were stuffed into hog casings and hand-linked to approximately 12cm lengths and scalded in 70°C water to an internal temperature of 65°C with the aid of a meat thermometer to prevent overcooking. The scalded sausages were then cooled under running tap water, packaged and labelled for storage in a freezer at -18°C for quality analysis and further studies.

Table 2: Proximate composition, acidity (pH), cooking yield and moisture retention of the products.

Treatment parameter (%)	T1	T2	T3	P-Value
Moisture	74.50^{a}	77.13^{b}	78.47^{c}	0
Ash	1.50^{a}	2.33^{b}	3.17^{c}	0
Crude fat	21.50^{c}	14.50^{b}	8.67^{a}	0
Crude protein	15.71^{b}	15.01^{a}	14.96^{a}	0
Acidity (pHr)	5.97^{a}	6.23^{b}	6.43^{c}	0
Cooking yield	ND	90.04	86.17	0.006
Moisture retention	ND	69.45	67.62	0.054

^{abc}: Means in the same row with different superscripts are significantly different ($p<0.05$); Control (T1) =100% Pork, (T2) =50% *S. leonensis* + 50% Pork and (T3) =100% *S. leonensis*; ND: Not Determined; pHr is pH of raw sausage batter.

Parameters measured

Physicochemical characteristics: Proximate analysis was determined using methods recommended by the [12]. Acidity (pH) was determined using procedure described by Hack-Youn et al. An equation proposed by Yang et al. was used to determine cooking yield and moisture retention was determined using the equation by [13]. All determinations were made in triplicate.

Sensory analysis: Sensory evaluation was performed by thirty-nine (39) untrained panelists made up of twenty-six (26) males and thirteen (13) females. Samples were evaluated by ten (10) panelists in one session to minimize communication. The panelists were recruited from the Animal Science Department of KNUST. Products from each treatment were taken out of the freezer and thawed at room temperature (26°C) under a ceiling fan. The treatments were put in baking pans that were labelled appropriately according to treatments and warmed in a hot-air oven (Wagtech, model: GP50SSF25001G, UK) at 70°C for 15minutes. Samples were turned every five (5) minutes during heating to ensure an even distribution of heat through all samples. The sausage samples were cut, wrapped in aluminum foil and placed on plates coded with three-digit random numbers in order to ensure uniform and independent sampling and to avoid biased assessment of the products. The panelists were asked to assess samples for tenderness, juiciness, flavor, mouth feel, color, aftertaste and overall acceptability using a 9-point hedonic scale. Water was provided to the panelists and instructed to rinse their mouth with the water before starting and between sample evaluations to avoid influence of the sensory attribute of one sample on the other.

Statistical analysis: Data collected was analyzed using the Statistical Package for Social Science (SPSS) (2015) version 21.0 using One-way Analysis of Variance (ANOVA) and Duncan's test of homogeneity was used to determine significant differences between treatment means at 5%.

Results and Discussion

Proximate composition of cooked sausages

Moisture content increased significantly ($p<0.05$) from 74.50 (T1) to 78.47 (T3) with increasing levels of *S. leonensis* (Table 2). The high level of moisture content observed in T3 (78.47) supports the findings of [14,15]. They reported that the moisture content of fish ranges between 70-80% and 66-81% respectively. The ash content also increased significantly ($p<0.05$) with increasing levels of *S. leonensis*.

Table 3: Sensory profile and cost of production of the sausages.

Treatment parameter	T1	T2	T3	P-Value	Sem
Tenderness	6.49[b]	5.31[a]	4.56[a]	0	0.193
Juiciness	6.67[b]	5.49[b]	4.51[a]	0	0.176
Flavour	6.33[b]	4.72[a]	3.92[a]	0	0.194
Mouth fee	6.79[c]	4.85[b]	3.59[a]	0	0.2
Colour	6.87[c]	4.31[b]	3.08[a]	0	0.214
Aftertaste	6.74[c]	4.82[b]	3.59[a]	0	0.199
Acceptability	6.90[c]	4.92[b]	3.26[a]	0	0.22
Cost (GH¢/kg)	13.87	10.44	6.84		

[abc]: Mean values in the same row with different superscripts are significantly different (p<0.05); Sensory scale: 1=Dislike extremely 9=Like extremely.

However, the observed value for T3 was higher than that reported by [14,15].who had earlier published that the ash content of fish ranges between 1-2% and 1.2-1.5% respectively. Nonetheless, the observed higher ash content in T3 could most probably be due to the fact that in this study *S. leonensis* was processed without separating the bones [16]. reported that processing such tiny fish species without separating the bones resulted in higher ash (mineral) contents compared to other fish species. It was observed that the control treatment (T1) had a significantly higher (p<0.05) fat content compared to the other two treatments with increasing levels of *S. leonensis*. Although low fat content was obtained in T3, the fat content for the treatment was within the normal range of values of fat in fish (0.1-24%) [15]. The differences observed in fat contents of the treatments might most probably be due to the different meat types, since pork is generally known to contain considerable amounts compared to fish meat, in this case, *S. leonensis*. This low-fat content in sausages produced with *S. leonensis*, according to [17]. Could result in improved shelf storage due to a reduction in the rate of auto-oxidation and rancid flavor development. The protein content of the control was significantly higher (p<0.05) than the sausages containing increasing levels of *S. leonensis* but T2 and T3 did not differ significantly from each other in terms of protein content [10,15]. Reported fish protein contents to range between 14-25% which agrees with the results in this study. Differences in fish protein contents can be attributed to differences in species, feed availability, sexual maturity and season of catching [18].

Acidity (pH), cooking yield and moisture retention

The results for cooking yield, moisture retention and pH (raw) of emulsion-type sausage with and without *S. leonensis* are shown in Table 2. The pH of the raw products increased significantly (p<0.05) from 5.97 (T1) to 6.43 (T3) with increasing levels of *S. leonensis* According to [19]. The pH of fish ranges between 6.35-6.73 which agrees with this study. However, bacteria can grow in fish between pH 6 and pH 8 and show less growth at extremes of pH [20]. which implies that T1 (control) could favor decreased microbial attack while treatments with increasing *S. leonensis* levels could create favorable conditions for microbial activities hence, subjected to proper heat treatment during processing. The cooking yield and moisture retentions for T1 could not be determined during this study due to circumstances beyond control.

Sensory profile and cost of production of the sausages

The results obtained for the sensory profile of sausages produced with and without *S. leonensis* are reported in Table 3. No significant differences (p<0.05) were found between T2 and T3 in terms of tenderness and flavor, however, significant differences (p<0.05) existed among T1, T2 and T3 for juiciness, mouth feel, color, aftertaste and overall acceptability. T1 (control) recorded higher (p<0.05) values in all the sensory parameters assessed, and values for treatment T2 were also higher (p<0.05) than for treatment T3. It could be deduced that most of the panelists generally preferred pork sausages to fish sausages. Every meat product has its typical flavor and taste and different animal species have different tastes relating the findings [21]. To this research, it could be justified why T1 (control) was more preferred compared to sausages containing different levels of *S. leonensis* probably due to strong "fishy flavor" which most probably was not pleasant to the panelists [22]. Reported similar findings with mackerel and catfish used in frankfurter-type sausages. Increasing inclusions of *S. leonensis* decreased the cost of production which could most probably be due to the fact that this fish species is relatively cheaper compared to pork [22]. Also observed that the cost of processing catfish and mackerel sausages were lower compared to pork sausages.

Conclusion

The results of the experiment suggest that Sierrahrissa leonensis has promising potential to replace portions of pork in emulsion-type sausages. Crude fat contents of the cooked sausages reduced with increasing amounts of *S. leonensis* used in the sausage formulations. Cost of production also reduced with increasing levels of *S. leonensis*. Hence, consumers with preference for low-fat emulsion-type sausages and low income earners are likely to patronize sausages produced with *S. leonensis* as partial substitute for pork. It is recommended that further work is done to improve on the sensory characteristics of the products containing *Sierrathrissa leonensis*.

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