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# Whole Unfermented African Locust Bean (WUALBF) Flour (*Parkia biglobosa*) as Non-Conventional Extender in Frankfurter-type Sausage

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## Abstract

*Frankfurter-type sausages were produced using Whole Unfermented African Locust Bean Flour (WUALBF) to substitute Ground Beef (GB) in the product formulation at 0%, 5%, 10%, 15% and 20% respectively. Dried African Locust bean seeds (Parkia biglobosa) were obtained from the Crops Research Institute of the Council for Scientific and Industrial Research, Kumasi, Ghana. They were cooked overnight to soften the testa, which was carefully removed by pressing between palms and separated by swirling in water bath through a colander of 25mm sieve diameter. The resultant beans were sun dried, milled into flour for incorporation into the sausage formulations. Protein, fibre and cooking yield increased significantly ($P<0.05$) with increasing use of WUALBF while moisture, ash, fat and cooking loss reduced significantly ($P>0.05$). Sensory evaluation revealed very high score ($P<0.05$) for formulations with 5% WUALBF for taste, flavor, mouth-feel and Overall Acceptability (OA). The use of WUALBF had no significant effect ($P>0.05$) on appearance, tenderness, juiciness and pH of the product. Production cost reduced by 6.5%, 12.92%, 24.32% and 29.60% respectively when using 5%, 10%, 15% and 20% WUALBF in Frankfurter-type sausages. The results suggest that WUALBF has promising potential as a non-conventional extender in Frankfurter-type Sausage.*

**Key words**: Whole locust bean, sausage, cost, sensory attributes, extender

## Introduction

The high cost of meat in processed products have led to increasing price of meat products to the extent that most consumers in many developing countries across the globe are unable to purchase and consume processed meat products. They are therefore deprived the benefit of consuming high quality nutrients that processed meat provide. Non-meat proteins from a variety of plant sources have therefore, been used as binders and extenders in comminuted meat products to either emulsify fat or retain moisture and improve textural properties (Akwetey *et al.*, 2012 and Teye *et al.*, 2012). The use of plant protein products in food as functional ingredients to improve the stability and texture as well as the nutritional quality of the product or for economic reasons is much extended (Messina, 1999). Therefore, research attention has been directed toward increasing utilization of plant protein sources in meat products; such research includes the use of pigeon pea (Akintayo *et al.*, 1999), peanut (McWatters *et al.*, 1976) and sunflower (Hufman *et al.*, 1975).

African locust bean (*Parkia Biglobosa)* is a leguminous plant with an outstanding protein quality and its protein and amino acid composition has been reported by several researchers (Cook *et al.*, 2000, Lockeett *et al.*, 2000, Alabi *et al.*, 2003, Elemo *et al.*, 2011).

*Parkia biglobosa* is well known for its high commercial value as food and have high medicinal properties. The most popular form of consumption of African locust beans is in its traditional fermented tasty food condiment called *Dawadawa* which is used as a flavor intensifier for soups and stews and adds protein to a protein-poor diet (Campbell-Platt 1980, Odunfa, 1986, Dike and Odunfa, 2003). The suitability of locust bean in meat products will be dependent on its functional properties such as water and oil absorption capacities and thermally induced gelatin ability. Though, extensive works have been done on utilization of some plant proteins for food, there is insufficient information on the use of Whole Unfermented African Locust Bean Flour (WUALBF) as extender in Frankfurter-type Sausage production.

The objective of this study was therefore to evaluate the effects of substituting GB with WUALBF to produce acceptable low-cost Frankfurter-type sausage that will have comparable eating quality without any compromise on nutritional benefits just as the currently highly priced "all-meat" sausage.

## Materials and methods

### *Materials*

Dried African Locust bean seeds (*Parkia biglobosa*) were obtained from the Crops Research Institute of the Council for Scientific and Industrial Research, Kumasi, Ghana. Beef, lard, curing salt and food grade sodium tri-polyphosphate were obtained from the Meat Science and Processing Unit of the Department of Animal Science, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana. All other additives were purchased from the Kumasi Central Market in Ghana. The dried African Locust beans were cooked overnight to soften the testa, after which the testa were carefully removed by pressing between palms and later separated swirling in water bath through a colander of 25mm sieve diameter. The resultant beans were sun dried, milled into flour for incorporation into the sausage formulations.

### Sausage preparation

The experimental product formulation is shown in Table 1. The frozen beef and pork fat were thawed prior to chopping into smaller chunks. All tendons, ligaments, connective tissues and excess fat were removed from the meat. Beef and pork fat were ground using a Super Wolf (MADO MEW 513, Maschinferfabrik Domhan, GmbH, Germany) grinder through 3mm and 5mm sieve plates respectively and kept at 2°C overnight. Ground beef, pork fat, spices and WUALBF were chopped using a table-top MTK561 meat cutter (MAsGarant, Germany). The chopping temperature was maintained at 15°C for 10 minutes to obtain a meat "emulsion" of desirable consistency. The minced beef was partitioned into 5 groups representing treatments 1, 2, 3, 4 and 5 respectively. The powdered WUALBF were weighed and added at 5%, 10%, 15% and 20% replacement of GB across the respective treatments in a Completely Randomized Design (CRD). Each treatment was replicated three times. Treatment 1 served as control. After chopping for 10 min, meat batter was filled in collagen reconstituted casing (diameter 2.5 cm) and hand-linked at 10 cm interval. Sausage was cooked in a temperature- controlled water-bath maintained at 80°C for 30min and allowed to cool to room temperature. The cooked sausages were stored at 2°C. The treatments were coded as $P_1$, $P_2$, $P_3$, $P_4$ and $P_5$ respectively. The sausage samples were hung on labeled wooden sticks and smoked for 3 hours in a smoke chamber at temperatures ranging from 71 to 76°C. The products were cooked in water immediately after smoking until they attained internal temperatures of 72°C; the core temperature of the samples was measured using a meat piercing thermometer (Troy, OH, USA). The samples were well labeled, vacuum packaged separately and stored at –18°C for further analysis.

**Table 1 Formulation of experimental products**

| Ingredients (%) | Frankfurter-type Sausage | | | | |
|---|---|---|---|---|---|
| | $P_1$ | $P_2$ | $P_3$ | $P_4$ | $P_5$ |
| Ground beef | 70.00 | 65.00 | 60.00 | 55.00 | 50.00 |
| Pork fat | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| Water/Ice | 16.00 | 16.00 | 16.00 | 16.00 | 16.00 |
| Curing salt | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| Sodium tripolyphosphate | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Spices* | 2.45 | 2.45 | 2.45 | 2.45 | 2.45 |
| Locust Bean Flour | 0.00 | 5.00 | 10.00 | 15.00 | 20.00 |

***White pepper, garlic powder, hot pepper and powdered nutmeg**

### *Chemical composition, pH and cooking loss of sausage*

The chemical compositions of sausages were determined using procedures described by AOAC (1990) for moisture, protein, fiber, fat and ash determinations. The analyses were made in triplicate for all the treatments. A pH meter fitted with glass electrode (FC200, HI9024C, Hanna Instruments, Singapore) was used to measure pH (raw) of each treatment "emulsion" and the ultimate $pH_u$ (cooked) of each product after overnight storage at 2°C. The weight of each treatment was taken before cooking and after overnight chilling at 2°C and cooking losses were calculated as percentage of (weight before cooking – weight after cooking)/weight before cooking.

### *Cooking yield and production cost*

The weights of individual treatments were taken after casing (W1) and after cooking (W2) to an internal temperature of 72 °C. The percentage cooking yield of products were calculated as; (W2 / W1) × 100. While production cost was based on the prevailing market retail price of ingredients used and expressed per percentage yield of respective treatments thus;

$$\frac{\text{Cost of formulating 1Kg (100\% yield) of each treatment x \% yield of respective treatment}}{100}$$

### *Sensory evaluation*

Fifty consumer panelists made up of Staff and Students of KNUST evaluated the samples for appearance, juiciness, texture, flavor and acceptability using a 9-point Hedonic scale (9 like extremely, 5 neither like nor dislike and 1 dislike extremely). The products were sliced to approximately equal sizes of 2.0cm and wrapped in kitchen foil and warmed in an oven at 180°C for 5 min before serving. Water was offered to rinse the mouth in-between tasting the sausages. Panelists sat in such a manner that ensured independence throughout the entire duration of product evaluation. All products were blind coded with 3-digit random numbers and the orders of serving all sausage samples were randomized, the room was well illuminated with white fluorescent lights and there were no noises or unpleasant odors that could detract the attention of panelists.

***Statistical analysis***

The data generated from the study were subjected to one- way analysis of variance (ANOVA) in a Completely Randomized Design (CRD) and significant differences (P = 0.05) between means were determined by Scheffé multiple comparison test using SPSS (2006) 16.0.1 for Windows.

**Results and discussion**

The percentage composition for moisture, protein, crude fiber, fat and ash of Frankfurter-type sausage are reported in Table 2. Substituting GB with WUALBF improved the protein content at all levels of use. The protein was significantly different with increasing levels of WUALBF in the formulation especially at 15% and 20% inclusion levels. The high protein content of the formulation with WUALBF could probably be due to the high protein content of the test ingredient. *Parkia biglobosa* is a known source of high quality protein containing 33.64g/100g protein in raw unfermented flour and 35.3g/100g protein in fermented flour (Ijarotimi and Keshinro, 2012). Several researchers have reported that the use of leguminous proteins in meat batters leads to increase in their protein and water content (Lecomte *et al.*, 1993). The component increase in protein contents represented 2.02%, 3.40%, 12.97% and18.26% respectively when sausages were produced with 5%, 10%, 15% and 20% respectively (Table 2). Moisture content of the control ($P_1$) was higher than the treatments with WUALBF most probably because the WUALBF was added in dry form to the formulation thereby increasing the dry matter of the product. Although, the moisture content of the product reduced with increasing level of WUALBF in the formulation, the cooking loss result showed that the product with WUALBF was able to retain most of its moisture upon cooking. This is an indication that WUALBF had the ability to absorb and retain water probably due to its high water absorption capacity (Ijarotimi and Keshinro, 2012), and its content of carbohydrate which are relatively hydrophilic (Voutsinas and Nakai, 1983).

**Table 2: Proximate composition of Frankfurter-type sausage with or without WUALBF**

| Parameters (%) | Frankfurter-type Sausage | | | | | |
|---|---|---|---|---|---|---|
| | $P_1$ | $P_2$ | $P_3$ | $P_4$ | $P_5$ | SSE |
| Crude Protein | $31.76^{c}$ | $32.40^{c}$ | $32.84^{c}$ | $35.88^{b}$ | $37.56^{a}$ | 1.022 |
| Crude Fibre | $0.00^{d}$ | $0.19^{c}$ | $1.40^{b}$ | $1.44^{ab}$ | $1.89^{a}$ | 0.014 |
| Ash | $5.50^{a}$ | $4.22^{b}$ | $4.00^{b}$ | $2.50^{c}$ | $1.50^{d}$ | 0.140 |
| Fat | $25.00^{a}$ | $22.00^{b}$ | $20.86^{b}$ | $20.20^{b}$ | $16.13^{c}$ | 0.472 |
| Moisture | $35.30^{a}$ | $32.65^{b}$ | $31.55^{b}$ | $30.40^{b}$ | $28.14^{c}$ | 1.124 |

$^{(abcde)}$Means in the same row with different superscripts are significantly different (P<0.05)
$P_1$, $P_2$, P3, P4 and $P_5$ represent Frankfurter-type sausage with 0, 5, 10, 15 and 20 % respectively of WUALBF in place of ground beef. SEM, standard error of mean

The crude fibre increased significantly as the WUALBF levels in the formulation increased and it ranged from 0.00% in $P_1$ (Control) to 1.44% in $P_5$ (20% WUALBF). The increase in the dietary fibre is essential for good bowel movement and helps in preventing obesity and cancer of the colon (Constantine *et al.*, 2008) and other ailment of the gastro intestinal tract of man. The ash content reduced significantly from 5.50% ($P_1$) to 1.50% ($P_5$) this is a pointer that the test ingredient is low in mineral content than beef and an indication that products formulated using WUALBF must be fortified with mineral supplement. The decrease in fat content with the use of WUALBF from 25% in the control to 16.13% in product containing 20% WUALBF is an advantage for people who want to consume low fat sausages. The overall reduction in fat represented 12%, 16.56%, 19.20% and 35.48% over the treatment without WUALBF.

The cooking yield, cooking loss and production costs for using WUALBF as partial substitute to ground beef in Frankfurter-type sausage are shown in Table 3. Substituting GB with WUALBF improved product yields of the product at all levels of use. These yields were significantly different (P<0.05) with increasing level of WUALBF in the sausage formulations compared to the control except in $P_2$ (5% replacement) which was similar to the control. The yield of both $P_4$ and $P_5$ were similar and significantly (P<0.05) higher than the yield for $P_3$. The presence of WUALBF in the product formulations resulted in increased moisture adsorption during production. Consequently, this resulted in higher water holding capacity of the products as the WUALBF level increased with attendant lower cooking loss and thus the observed higher yield in the treatments with WUALBF. This could be due to the high hydrophobic carbohydrate and starch content of WUALBF. Abdoulaye *et al.*(2014), reported high carbohydrate and total starch for *Parkia biglobosa* seed and starch which has been noted to contribute greatly to the textural properties of various foods and has many industrial applications as a thickener, colloidal stabilizer, gelling agent, and water retention agent among others (Singh *et al.,* 2003). These findings are in agreement with that of Annor-Frempong *et al.* (1996), who reported that the carbohydrate in cassava aided moisture retention in pork sausages leading to increased cooking yields. There were significant reducing trends in the cooking loss as the level of WUALBF inclusion in the product formulations increased from 22.15% ($P_1$) to 9.57% but no significant differences (P>0.05) were observed for sausages containing 0% and 5% and those with 10% and 15% WUALBF respectively. The formulation with the highest WUALBF had the least cooking loss most probably because of the high water binding ability of the carbohydrate fraction of the *Parkia biglobosa* seed that increased as the *Parkia biglobosa* inclusion in the formulations increased. Dzudie *et al.* (2002), observed a similar trend when beef patties were extended with common bean flour.

Economic analysis of ingredients and total production cost showed that the adoption and use of WUALBF in Frankfurter-type sausage formulations will most probably reduce the cost of production. The production cost of the products per Kg was 23.68, 22.14, 20.62, 17.92 and 16.67 Ghana Cedi for formulations with 0%, 5%, 10%, 15% and 20% inclusion levels of WUALBF respectively. Thus 6.5%, 12.92%, 24.32% and 29.60% of production costs per kg were saved respectively using WUALBF in Frankfurter-type sausage formulations. The 6.5 to 29.6% reduction in formulation cost per kg will translate into enormous savings on large scale production and could lead to reduction in product price hence the affordability of the product by low income earners which are the majority in the study area.

**Table 3: Effect of using WUALBF on pH, cooking loss, product yield and production cost of Frankfurter-type sausage**

| Parameter | Frankfurter-type Sausage | | | | | |
|---|---|---|---|---|---|---|
| | $P_1$ | $P_2$ | $P_3$ | $P_4$ | $P_5$ | SSE |
| pH (raw) | 5.87 | 5.89 | 5.98 | 5.98 | 6.07 | 0.044 |
| pH (cooked) | 5.77 | 5.80 | 5.87 | 5.88 | 5.93 | 0.054 |
| Product yield (%) | $77.96^{c}$ | $79.50^{c}$ | $81.19^{b}$ | $88.61^{a}$ | $90.13^{a}$ | 1.701 |
| Production cost (GH¢/Kg) | $23.68^{a}$ | $22.14^{ab}$ | $20.62^{b}$ | $17.92^{c}$ | $16.67^{c}$ | 1.236 |
| Change in production cost (%) | | (6.50) | (12.92) | (24.32) | (29.60) | |

(abcde)Means in the same row with different superscripts are significantly different (P<0.05)
$P_1$, $P_2$, P3, P4 and $P_5$ represent Frankfurter-type sausage with 0, 5, 10, 15 and 20 % respectively of WUALBF in place of ground beef. SEM, standard error of mean

The pH of the emulsion and the cooked products increased (P>0.05) with increasing use of WUALBF (Table 3) while there was a slight decrease in pH of the cooked products over their respective emulsions. The pH of the cooked sausage was between 5.77 ($P_1$) and 5.93 ($P_5$), the use of tri-polyphosphate tends to stabilize the product pH. However, Dzudie *et al.*, 2002 observed significant increase in pH with increased addition of common bean flour in beef sausages. Results of the sensory attributes of meat loaf as assessed by the consumer panelists are reported in Table 4.

**Table 4: Sensory attributes of cooked Frankfurter-type sausage with or without WUALBF**

| Attribute | Frankfurter-type Sausage | | | | | |
|---|---|---|---|---|---|---|
| | $P_1$ (Control) | $P_2$ | $P_3$ | $P_4$ | $P_5$ | SSE |
| Appearance | 6.20 | 6.20 | 6.10 | 5.95 | 5.40 | 0.183 |
| Taste | $6.60^{b}$ | $7.35^{a}$ | $5.80^{c}$ | $5.65^{c}$ | $4.74^{d}$ | 0.166 |
| Flavor | $6.90^{a}$ | $6.80^{a}$ | $5.75^{b}$ | $5.15^{c}$ | $5.05^{c}$ | 0.185 |
| Tenderness | 6.45 | 6.90 | 6.10 | 6.15 | 6.15 | 0.164 |
| Juiciness | 5.80 | 6.30 | 5.70 | 5.55 | 5.45 | 0.419 |
| Mouth-feel | $6.50^{a}$ | $6.60^{a}$ | $5.90^{b}$ | $4.90^{c}$ | $4.65^{c}$ | 0.188 |
| Overall acceptability | $6.74^{b}$ | $7.35^{a}$ | $5.80^{c}$ | $5.65^{c}$ | $4.74^{d}$ | 0.205 |

(abc)Means in the same row with different superscripts are significantly different (P<0.05)
9 = Like Extremely; 5 = Neither Like or Dislike; 1 = Dislike Extremely
$P_1$, $P_2$, P3, P4 and $P_5$ represent Frankfurter-type sausage with 0, 5, 10, 15 and 20 % respectively of WUALBF in place of ground beef. SEM, standard error of mean

There were no significant differences in the color of the sausage although, there was a progressive reduction in the color score as the level of WUALBF in the formulation increased. The tenderness score ranged from 6.9 ($P_2$) to 6.1($P_3$) with no clear cut pattern also the inclusion of WUALBF did not affect the juiciness of the product although, for juiciness and tenderness, the formulation with 5% WUALBF inclusion has the highest score. This suggests that the repeatability of purchase might not be different for each of the formulations. There were no significant differences (P<0.05) in the flavor and mouth feel score up to 5% level of WUALBF in place of GB in frankfurter-type sausage ($P_1$=$P_2$). But using WUALBF at 10%, 15% and 20% resulted in significantly lower score for the two parameters. The reduction in flavor score was not expected as *Parkia biglobosa* is noted as a flavor intensifier (Dike and Odunfa, 2003) however, it was the unfermented African locust bean flour that was used in the present study. The formulation with 5% inclusion of

WUALBF ($P_2$) was the most preferred in terms of taste (7.35); this was followed by the control formulations with a mean score of 6.60. This could be due to the high sugar content of *Parkia biglobosa* which apart from imparting sweetness could also act as preservative. There was a noticeable reduction (P<0.05) in taste score of products with 10%, 15% and 20% WUALBF. The mean score for OA ranged from 7.35 ($P_2$) to 4.74 ($P_5$) but beyond 5% inclusion level of WUALBF, the OA reduced significantly. Product with 5% WUALBF ($P_2$) compared favorably with control ($P_1$) in color, flavor and mouth-feel but has higher ratings for taste and overall acceptability.

## Conclusion

The use of WUALBF in Frankfurter-type sausage reduced the cooking loss to improve product yield. Also, the protein of the product increased with increasing levels of WUALBF in the formulations. Sensory evaluation score revealed very high score (P<0.05) for formulations with 5% WUALBF for taste, flavor, mouth-feel and OA while the production cost reduced appreciably with the use of WUALBF in the formulations.

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