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RESEARCH ARTICLE

# The shelf life of coarse beef sausage using dawadawa (*Parkia biglobosa*) pulp powder as an extender

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ABSTRACT

The shelf life and sensory characteristics of coarse beef sausage with dawadawa (*Parkia biglobosa*) pulp powder (DPP) as an extender were investigated. The sausages were formulated in four treatments with one serving as a control and the dawadawa pulp powder was added to the other three at various inclusion levels of 35g, 40g and 45g in T2, T3 and T4 respectively. The beef sausages were spiced and stuffed in natural casings and stored at a temperature of 4°C for 14 days. Weekly sensory characteristics of the products were evaluated for texture, taste, color, flavor, cohesiveness, juiciness and overall liking over a period of two weeks after storage. There were significant differences ($P < 0.001$) in the taste, flavor and overall liking of the product. All other parameters were not significantly different ($P > 0.05$). Microbial load analysis of the beef sausage was carried out weekly for the 14 days of storage. The highest microbial load count was obtained in T3 on day 7 with $5.18\times10^6$ cfu/g and the lowest count in T2 on day 14 with $1.63\times10^5$ cfu/g even though the difference was not significant. The dawadawa pulp powder did not reduce the microbial load of the beef sausage and hence the shelf life of the products was not extended.

**Keywords:** *Parkia biglobosa*, Shelf life, Extender, Storage, Total Bacterial Count.

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## INTRODUCTION

In the USA and other developed countries, meat composes a significant portion of the normal diet, contributing more than 15% to daily energy intake, 40% to daily protein intake and 20% to daily fat intake (Speedy, 2003). The demand for meat in developing countries continues to grow as the production and consumption of meat increases with available income (Walker et al., 2005). Meat is processed by the addition of ingredients and mechanical action to convert it into specific products which may include sausages, burgers etc. to meet desires of consumers (Teye and Boamah, 2012). Meat extenders are non-meat substances with substantial protein content (McMichael et al., 2007). Extenders were originally used to reduce cost but they were later used to add dietary fiber or to improve the texture (Yilmaz and Velioglu, 2009).

The African locust bean (*Parkia biglobosa*) is a tree legume found all over West Africa and tropical America. It is categorized under spermatophytes. *P. biglobosa* (Jacq.) (family Fabaceae) popularly called the African locust bean tree have been used traditionally as food and medicine and are of high commercial value in the West African region (Builders, 2014). It was stated

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that the African locust bean (dawadawa) is more than adequate to meet the FAO/WHO recommended daily allowance of protein of 0.591g/kg body weight for an average healthy individual (Gernah et al., 2007a). Nutritional and anti-nutritional composition of the African locust bean (*Parkia biglobosa*) fruit pulp were determined as follows, moisture content 8.41%, protein 6.56%, fat 1.80%, crude fiber 11.75%, ash 4.18%, carbohydrate 67.30%, total carotenoids 49.175ug/100g and ascorbic acid (Vitamin C) of 191.20mg/100g (Gernah et al., 2007b).

Shelf life is the recommended maximum time for which products can be stored, during which the defined quality of a specified proportion of the goods remains acceptable under expected or specified conditions of distribution, storage and display (Gyesley, 1991). Microbial growth, colour, lipid oxidation are factors important to shelf life and consequently to consumer acceptance of fresh meat (Zhao et al., 1994). Compared to a multitude of foodstuffs, meat represents one of the most perishable (Doulgeraki et al., 2012): first, for the presence of chemical and enzymatic activities, and second, because it constitutes a perfect *pabulum* for the growth of a wide variety of microorganisms, especially as a result of its nutrient composition, high water content and moderate pH (Dave and Ghaly, 2011). The impacts of dawadawa pulp as an extender in some meat products has been studied in lower inclusion levels and reported but not its shelf life after preparation. It is in this manner that this study was conducted, with its primary goal to determine the shelf life of dawadawa pulp powder as an extender in coarse beef sausage. Moreover, this investigation also determines the effects of the microbial interaction during the period of storage.

## MATERIALS AND METHODS

### Experimental site

The study was conducted at the Meat Processing Unit and the Spanish laboratory of the University for Development Studies (UDS), Nyankpala Campus in the Northern region of Ghana.

### Processing of coarse beef sausage

Four kilograms (4kg) of beef chuck was used for producing the sausage. The meat was thawed for about 45 minutes at room temperature, cut into smaller sizes and minced through a 5mm sieve table top mincer (Tallers Ramon, Spain). The minced meat was divided into four (4) treatments of 1.0kg each and spiced with 15g curing salt, 0.5g red pepper, 1.0g white pepper, 1.0g black pepper, and 2.0g adobo (commercial mixed spices). The spiced sausages were treated with 0g, 35g, 40g and 45g of P*. biglobosa* pulp powder labelled T1, T2, T3 and T4 respectively and stuffed into natural casing, using a hydraulic stuffer and manually linked into smaller sizes of about 10 cm (Teye et al., 2015). The products were bagged in transparent polythene bags and vacuum sealed using an electronic vacuum sealer and chilled at 4ºC for sensory and microbial analysis.

### Selection of taste panel

A total of six (6) panelists were selected and trained according to British Standard Institute (BSI, 1993) guidelines for panel training to form the sensory panel for the evaluation of the products.

### Products preparation for sensory evaluation

The products were grilled at 70°C in an electric oven (Turfbon, Blue Seal, UK) for 45 minutes, sliced into uniform sizes and wrapped with coded aluminum foils to keep them warm and maintain the flavor.

### Sensory analysis of the products

Sensory evaluation of the product was carried out on the 7$^{th}$ and 14$^{th}$ day during storage. The products were presented to each of the panelist, under conditions of controlled lighting, and examination to avoid the influencing of a panelist by another. Each panelist was provided with water and piece of bread to serve as neutralizers between the products and asked to indicate the eating qualities of the various products in accordance with the 5-point scale provided below (Teye et al., 2015).

- Texture: very smooth (1), smooth (2), intermediate (3), rough (4), very rough (5)
- Taste: very pleasant (1), pleasant (2), intermediate (3), bitter (4), sour (5)
- Juiciness: very juicy (1), juicy (2), intermediate (3), dry (4), very dry (5)
- Beef Flavour: very strong (1), strong (2), intermediate (3), weak (4), very weak (5)
- Color: red (1), light red (2), intermediate (3), dark red (4), very red (5)
- Pulp flavour: very strong (1), strong (2), intermediate (3), weak (4), very weak (5)
- Cohesiveness: very much together (1), together (2), intermediate (3), apart (4), very apart (5)
- Overall-liking: like very much (1), like (2), intermediate (3), dislike (4), dislike very much (5)

### Microbial analysis

The microbial quality and safety of the meat and meat products was assessed on the basis of Total Bacterial Counts (TBC) (Datta et al., 2012). 10g of Nutrient agar was suspended in 500ml distilled water and swirled. The mixture was heated with constant stirring to dissolve completely and sterilized at 121 ºC for 15 mins using an autoclave, allowed to cool and dispersed in sterile petri dishes. 0.056g agar of Buffered Peptone water was suspended in 560 ml of distilled water and stirred manually to completely dissolve. 100ml each of the prepared peptone water was poured into four (4) conical flasks respectively, one for each treatment. 10ml of the prepared peptone water was taken with a syringe into twenty universal bottles respectively, five (5) bottles per treatment. The mixtures were sterilized at 121 ºC for 15 minutes and allowed to cool.

### Meat sample preparation

Microbial load of the beef sausages during the 14 days of storage at 4ºC was assessed. The method used was a modification of those of (Ahmad et al., 2013; Sharma and Chattopadhyay, 2015). Approximately 10g each of the products was taken from each treatment into four sterile stomacher bags. Each of the 100ml peptone water in the conical flask was poured into each of the stomacher bags containing the beef sausage and manually homogenized. A 1-fold serial dilution was made from the mixture for $10^{-1}$ to $10^{-5}$ concentration and the dilutions was spread and plated unto the nutrient agar plates. The plates were incubated at 37ºC for 18 – 24 hours (Datta et al., 2012).

### Statistical analysis

The data obtained for the sensory evaluation and microbial load counts (CFU/g) which are represented as $\log_{10}$ CFU/g were analyzed by ANOVA using GenStat statistical package (GenStat Discovery 12$^{th}$ Edition) and descriptive statistics respectively.

## RESULTS

### Sensory characteristics of the coarse beef sausage

The sensory characteristics of the coarse beef sausage prepared with and without dawadawa pulp powder are represented in Table 1. There was no significant difference (P > 0.5) in texture, flavour, juiciness, cohesiveness, and color of the treatment.

However, the taste, pulp flavor in the treatments and overall liking were significantly different ($P < 0.05$) by the 14th day of storage.

**Table 1: Results of Sensory Evaluation of the Coarse Beef Sausage after 14th day of storage**

| Parameters | T1 | T2 | T3 | T4 | SED | P-Value |
|---|---|---|---|---|---|---|
| Texture | 2.67 | 2.58 | 2.58 | 2.58 | 0.285 | 0.988 |
| Taste | $1.58^{b}$ | $3.25^{a}$ | $3.33^{a}$ | $3.08^{a}$ | 0.421 | 0.001 |
| Juiciness | 2.50 | 2.75 | 2.83 | 2.67 | 0.367 | 0.825 |
| Beef flavor | 2.67 | 2.25 | 2.42 | 2.42 | 0.306 | 0.600 |
| Color | 3.25 | 2.75 | 2.75 | 2.58 | 0.346 | 0.259 |
| Pulp flavor | $3.25^{a}$ | $2.42^{b}$ | $2.17^{b}$ | $2.25^{b}$ | 0.343 | 0.011 |
| Cohesiveness | 2.25 | 2.08 | 2.42 | 2.17 | 0.300 | 0.718 |
| Overall-liking | $1.83^{b}$ | $3.08^{a}$ | $3.00^{a}$ | $2.92^{a}$ | 0.367 | 0.004 |

*Means on the same row with same superscripts are not significantly different (P > 0.05). SED: - Standard error of difference, P < 0.05. T = Treatment*

**Table 2: Total bacterial count of the products (TBC)**

| TREATMENT | DAYS | BACTERIAL COUNTS |
|---|---|---|
| T1 | 1 | $7.03\times10^{5}$ |
| | 7 | $1.01\times10^{6}$ |
| | 14 | $7.26\times10^{5}$ |
| T2 | 1 | $8.27\times10^{5}$ |
| | 7 | $7.30\times10^{5}$ |
| | 14 | $1.63\times10^{5}$ |
| T3 | 1 | $6.76\times10^{5}$ |
| | 7 | $5.18\times10^{6}$ |
| | 14 | $1.14\times10^{6}$ |
| T4 | 1 | $8.28\times10^{5}$ |
| | 7 | $5.57\times10^{5}$ |
| | 14 | $2.37\times10^{6}$ |
| **SED** | | 1392108.9 |
| **P-Value** | | 0.096 |

*SED: - Standard error of difference, P > 0.05. T = Treatment*

**Microbial analysis of the products**

The results obtained from the microbial analysis are represented as $\log_{10}$ CFU/g (Table 2). The total bacterial counts by the 14th day of storage were $7.26\times10^{5}$, $1.63\times10^{5}$, $1.14\times10^{6}$ and $2.37\times10^{6}$ for T1, T2, T3 and T4 respectively. There was no significant difference in the microbial analysis of the products ($P > 0.05$).

## DISCUSSION

### Sensory characteristics of the coarse beef sausage

Tenderness and flavor depend on textural characteristics, composition of meat and many other factors (Dinh, 2008). To a consumer color is a very important criterion which depends on the concentrations of myoglobin and the degree of its oxidation as well as the meat structure (De Huidobro et al., 2005). Color is probably one of the most important visual factors in purchasing decisions concerning meat and meat products (Hunt et al., 1991; Wulf and Wise, 1999). The color of the beef sausages gradually changed during the storage days which could be attributed to the temperature at which the products were stored (Nychas et al., 2008). Flavor is the most important factor in our food choices (Pearson and Gillett, 1999), it is designed to deliver performance and bold taste with flexibility which creates the sensation the consumer has during eating. In this study the addition of DPP at increasing levels to the beef sausages instigated sensorial changes in the characteristics of the product. The flavor of the product was not affected during the 14 days of storage (Table 1). According to Teye et al. (2015) there was a significant difference at lower levels of inclusion (20g, 25g, and 30g) of the DPP on the flavor of the products. One of the essential properties of a food ingredient is to cause desired sensorial changes in a food product. Each of the factors exhibited a statistically significant positive effect on the quality perception of the products. There were significant changes in taste, pulp flavor and overall-liking of the sausages and this variability may be as a result of the higher inclusion level of the dawadawa pulp powder (DPP) (Table 1). However, palatability was achieved in the control product and the treated products on the day of preparation. Measuring the degree to which a substance presents one basic taste can be achieved in a subjective way by comparing its taste to a reference substance. An increase in sourness of the treated products was observed on the $7^{th}$ and $14^{th}$ day. The overall acceptability was compromised which could be attributed to the presence of sugar in the DPP which might have caused the sourness of the sausages due to fermentation.

### Microbial analysis

Sausages have limited shelf life even though they are subjected to high temperatures during the production process (Bingol and Bostan, 2007). The highest microbial counts attained in this study were $5.18\times10^6$cfu/g (T3, day 7), $2.37\times10^6$cfu/g (T4, day 14), $1.14\times10^6$cfu/g (T3, day 14) and $1.01\times10^6$cfu/g (T1, day 7) respectively Table 2. The point of spoilage is normally defined as the maximum acceptable bacterial level, the unaccepted odor/flavor, or the appearance for consumption (Borch et al., 1996). The least microbial count attained was $2.33\times10^5$cfu|g (T4, day 14) and $1.63\times10^5$cfu/g (T2, day 14). At this limit the product may also be considered as good for consumption. The treated product exhibited no signs of spoilage after 14 days of storage in a refrigerator. Food and Agriculture Organization (2014) stated that the total viable counts of bacteria (TVC) on fresh meat or meat products set a limit to its shelf life (FAO, 2014).

The products were noted for its odor and this can be compared to Food and Agriculture Organization (FAO) limit at which meat and meat products produces odor at a TVC of $10^6$cfu/cm$^2$ (Charlebois et al., 2014). Antimicrobial effects of dawadawa pulp powder in beef sausage and its spoilage microorganisms may have had a negative effect on the product. Bello and Okwore indicated in their study that dawadawa pulp powder oil inhibited the growth of some test bacteria (*M. luteus, E. coli* and *B. subtilis*). They concluded that the test bacteria showed various degree of resistance to commercial antibiotics, while showing appreciable susceptibilities to the pulp powder oils (Bello and Olawore, 2012). Though the dawadawa pulp powder did not have any effect on the microbial load of the product, it is still acceptable for consumption based on the standard at which meat is considered spoilt which is $10^8$cfu/cm$^2$ (Charlebois et al., 2014).

## CONCLUSION

The texture, flavor, color, cohesiveness, and juiciness of coarse beef sausages using dawadawa pulp powder as an extender at higher inclusion levels 35g, 40g and 45g were not affected. The results indicate that, *Parkia biglobosa* pulp powder as an extender in coarse beef sausage had no adverse effect on the most sensorial characteristics at increased levels of 35g, 40g and 45g. The study also indicates that the products can be stored up to 14 days without any sign of deterioration. It is recommended that further studies should be conducted to determine the pH at which microorganisms may thrive at a more lower storage temperature and same inclusion levels of the *P. biglobosa* pulp powder.

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