

# Effects of Substituting Wheat Flour with Plantain Flour in Beef Sausage Production.

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## ABSTRACT

Wheat flour, which is one of the ingredients in sausage production, was substituted with plantain flour in beef sausage production. Five batches of beef sausages were investigated in which wheat flour was substituted with plantain flour in the following proportions; batch 1 control (0% plantain flour); batch 2 (25% plantain flour); batch 3 (50% plantain flour); batch 4 (75% plantain flour); batch 5 (100% plantain flour). Plantain (*Musa paradisiaca*) was purchased in a commercial market in Abeokuta, Ogun State, Nigeria. It was sliced and sun dried for several days until constant weight was attained.

All the results obtained were all significantly ( $p < 0.05$ ) different. Results revealed that for both cooking and refrigeration weight losses, batch 4 (75% plantain flour and 25% wheat flour) had the lowest percentage cooking and refrigeration weight loss of 10.23% and 0.67%, respectively after 24 hours of refrigeration.

For color, batches 2, 3, 4, and 5 had the highest score which was dislike slightly compare to batch 1 which recorded the lowest score which was disliked moderately. For overall acceptability, batch 5 had the highest score of being disliked slightly compared to batches 4 and 1. The higher the inclusion levels the lower the ether extract in beef sausage. Crude protein was highest for batch 5 having the values of 21.67% and lowest for batch 2 having the values of 15.73%.

It was recommended that up till 75% plantain inclusion is a good substitute for wheat flour in beef sausage production.

(Keywords: wheat flour, plantain flour, beef sausage, cook and refrigeration losses)

## INTRODUCTION

There is a wide range of non-meat products that are incorporated into sausages within the guidelines allowed under the United States Department of Agriculture (USDA) Meat Inspection Regulation. These products called binders or extenders include flours, seasonings, eggs, etc. These binders or fillers absorb large amounts of water causing the ground-up meat particles to adhere to each other.

Although wheat is the conventional flour used as fillers in sausage production so as to reduce the formulation cost (Belderok *et al.*, 2000), Ranken and Kill (1993) stressed that there are various other materials that have good water holding or meat binding properties, especially cereals such as rice, corn and wheat in which Potato, starch and farina that have very good water holding properties and are commonly used as fillers in canned luncheon meats and similar products. Thus the need to assess the effects of using alternative flour an unconventional, less expensive, less competitive and locally available as a substitute for wheat flour.

## MATERIALS AND METHODS

The experiment was carried out at the Meat Processing Laboratory of the Department of Animal Production and Health, University of Agriculture, Abeokuta. The equipment used was Kenwood Multipurpose Machine, water bath, artificial casing, bowls and plates.

### Preparation of Beef Sausage

Five batches of beef sausages (1kg per batch) were prepared using lean meat from the thigh muscles of cattle carcasses. Five hundred grams

of meat from each treatment sample was run through a 5mm plate in a Kenwood (Hampshire U.K.) mincing machine. Similar amounts of vegetable oil seed meal, seasoning, water and flour were added to each batch of beef sausage composed of;

Batch 1 - 0% Plantain flour and 100% Wheat flour,

Batch 2 – 25% Plantain flour and 75% Wheat flour;

Batch 3 – 50% Plantain flour and 50% Wheat flour;

Batch 4 – 75% Plantain flour and 25% Wheat flour;

Batch 5 – 100% Plantain flour and 0% Wheat flour inclusions.

The compositions of the sausage recipe are presented in Table 1.

#### **Determination of Cooking Loss of Beef Sausage**

Three replicates each per treatment sample were cooked immersed in a water bath for 20 minutes at 70°C and the losses were determined as follows (<http://www.ochef.com/418.htm>):

Cooking loss (g) =  
weight before cooking – weight after cooking

Cooking loss (%) =  
$$\frac{\text{weight before cooking} - \text{weight after cooking}}{\text{weight before cooking}} \times 100$$

#### **Determination of Refrigeration Loss of Beef Sausage**

The sausages prepared were weighed before and after refrigeration for 24 hours and the weight losses were determined as follows:

Refrigeration loss (g) =  
weight before refrigeration – weight after refrigeration

Refrigeration loss (%) =  
$$\frac{\text{weight before refrigeration} - \text{weight after refrigeration}}{\text{Weight before refrigeration}} \times 100$$

#### **Proximate Composition**

Carbohydrates, crude protein, crude fiber, ether extract, moisture content, and ash of the prepared batches of beef sausage and plantain flour were done using the procedure described by AOAC, 1995.

#### **Sensory Evaluation**

Sensory evaluation of samples of cooked beef sausage was assessed by ten (10) trained panelists. Some meat qualities estimated were color, juiciness, meaty flavor, tenderness, saltiness, overall flavor and overall acceptability. Bite size portions of 10g of meat samples were each served at room temperature to ten (10) trained panelists who awarded scores using a 9 point Hedonic scale of; 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, and 9=Like extremely (*Cross et al.*, 1975).

All data obtained were subjected to one way analysis of variance using SAS, 2000, while differences between means were determined by Duncan Multiple Range Test (Duncan, 1955) within the statistical package.

### **RESULTS AND DISCUSSION**

#### **Cook and Refrigerated Weight Loss of Beef Sausage**

Tables 2 and 3 show the significant effect ( $P < 0.05$ ) in both cooking and refrigerated weight losses in all measured parameter. Only, batches 1 and 3 had percentage cook loss higher than 10%, all other batches recorded values of less than 10%. Parameters for percentage refrigerated loss were all less than 10%. Batch 4 sausages recorded lowest weight losses of 6.98% and 0.67%, respectively, in both measured parameters.

Although, values obtained for cook and refrigerated loss can be considered as being averagely low indicating good quality sausage, as stated by Gerard, (1976). It was observed that increase in substitution of wheat by plantain flour was directly proportional to their carbohydrate content. This may be a contributing factor since

**Table 1:** Recipe (%) of Beef Sausage.

Ingredients (g)	Treatment				
	1	2	3	4	5
Beef	60	60	60	60	60
Wheat flour	20	15	10	5	0
Plantain flour	0	5	10	15	20
Vegetable oil	6	6	6	6	6
Seasoning	2	2	2	2	2
Water	12	12	12	12	12
Total	100	100	100	100	100

**Table 2:** Showing the Cooking Weight Loss of Wheat Flour Substituted with Plantain Flour at varying levels in Beef Sausage Production.

%Plantain Inclusion	Initial Weight (g)	Final Weight (g)	Weight Loss (g)	Weight Loss (%)
1	61.63 <sup>c</sup>	55.45 <sup>c</sup>	6.19 <sup>ab</sup>	10.02 <sup>ab</sup>
2	55.07 <sup>e</sup>	51.02 <sup>d</sup>	4.05 <sup>c</sup>	7.34 <sup>c</sup>
3	67.54 <sup>b</sup>	60.63 <sup>b</sup>	6.91 <sup>a</sup>	10.23 <sup>a</sup>
4	68.74 <sup>a</sup>	63.94 <sup>a</sup>	4.80 <sup>cb</sup>	6.98 <sup>c</sup>
5	60.24 <sup>d</sup>	55.43 <sup>c</sup>	4.81 <sup>cb</sup>	7.98 <sup>cb</sup>
±SEM	0.61	1.25	1.75	2.72

<sup>a,b,c,d</sup> Means along the same column with different superscripts are significantly different (P<0.05).

SEM: Standard Error of Means

KEY;

Batch 1 – 0% Plantain flour and 100% Wheat flour inclusions

Batch 2 – 25% Plantain flour and 75% Wheat flour inclusions

Batch 3 - 50% Plantain flour and 50% Wheat flour inclusions

Batch 4 - 75% Plantain flour and 25% Wheat flour inclusions

Batch 5 – 100% Plantain flour and 0% Wheat flour inclusions

**Table 3:** Showing the Effect of Refrigeration Weight Loss of Wheat Flour Substituted with Plantain Flour at varying levels in Beef Sausage Production.

%Plantain Inclusion	Initial Weight (g)	Final Weight (g)	Weight Loss (g)	Weight Loss (%)
1	60.72 <sup>a</sup>	59.68 <sup>a</sup>	1.03 <sup>ab</sup>	1.71 <sup>b</sup>
2	54.26 <sup>b</sup>	51.59 <sup>b</sup>	2.66 <sup>a</sup>	4.84 <sup>a</sup>
3	64.23 <sup>a</sup>	63.17 <sup>a</sup>	1.06 <sup>ab</sup>	1.66 <sup>b</sup>
4	60.16 <sup>a</sup>	59.75 <sup>a</sup>	0.40 <sup>b</sup>	0.67 <sup>b</sup>
5	62.57 <sup>a</sup>	61.96 <sup>a</sup>	0.61 <sup>b</sup>	0.98 <sup>b</sup>
±SEM	5.27	4.96	1.52	2.69

<sup>a,b</sup> Means along the same column with different superscripts are significantly different (P<0.05)

SEM: Standard Error Means

KEY;

Batch 1 – 0% Plantain flour and 100% Wheat flour inclusions

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Batch 3 - 50% Plantain flour and 50% Wheat flour inclusions

Batch 4 - 75% Plantain flour and 25% Wheat flour inclusions

Batch 5 – 100% Plantain flour and 0% Wheat flour inclusions

carbohydrates are known to be good absorbers of moisture. Also, the gelatinization of proteins which usually results in the formation of a matrix which entraps water and fat thereby reducing moisture loss during cooking and stabilizes sausage.

Sausage composition seems to be a contributing factor as equally observed by Sanwo *et al.* (2012) who substituted equal amount of wheat flour for rice flour and the author observed higher stability in 100% wheat flour substitution which was attributed to lower moisture content and higher crude protein and ether extract in the sausage.

The results of this studies also agrees with Choi, *et al.* (2008) who reported that meat products appeared to have improved water holding capacity and emulsion stability due to the added dietary fiber which is the plantain flour which has therefore lead to a higher cooking yield. Abiola and Soremi (1999) also reported that sausages with corn flour used as filler had a better water holding capacity due to lower results obtained for both cooking and refrigeration weight losses.

Table 4 shows significant differences ( $p < 0.05$ ) in all the evaluated parameters. For color, batches 2, 3, 4, and 5 had the highest score range of 4.26 – 4.56 which was dislike slightly compare to batch 1 which recorded the lowest score 3.95 which was disliked moderately. Juiciness was observed to be most preferred in the control batch 1 which is 100% wheat flour. Meaty flavor, tenderness, saltiness were disliked in all the prepared sausages. Overall flavor was also disliked

moderately within the range of (3.40-3.90) except in batch 5 which was scored 4.40, containing 100% plantain flour, was disliked slightly. The above results was equally observed by Veraverbeke *et al.* (2002) who reported that low juiciness can be due to the viscos elastic properties of wheat protein. For overall acceptability, batch 5 had the highest score of being disliked slightly compared with batch 4 and batch 1 which had the lowest score of being disliked moderately.

The higher the inclusion levels the lower the ether extract in beef sausage as shown in Table 5. Batch 2 has the highest ether extract content of 2.90% and batch 5 recorded the lowest content of 1.04%, which implies that flours have little fat. This was equally observed by Forrest *et al.* (1975) who reported that fillers contribute little to fats emulsification. The moisture content of the five batches of beef sausages was recorded between 43.93-49.55%. These values cannot be considered to be high because Forrest *et al.* (1975) reported that moisture content amounts to 45-65% of the finished weight of the meat products more than any other single component. Batch 5 recorded the highest moisture content of 49.55%, and the lowest was recorded on batch 2. For carbohydrate contents, batch 1 recorded the highest value with 85.90% and batch 5 recorded the lowest with 75.19%. The values recorded were comparable with one another, showing that both the plantain flour and wheat flour has high amount of carbohydrate. Batch 5 recorded the highest crude protein of 21.67% and the lowest was recorded in batch 1 which is the control.

**Table 4:** Sensory Properties of Beef Sausage Substituted with Wheat Flour and Plantain Flour at various levels.

%Plantain Inclusion	Color	Juiciness	Meaty Flavor	Tenderness	Saltiness	Overall Flavor	Overall Acceptability
1	3.95 <sup>c</sup>	4.20 <sup>a</sup>	2.40 <sup>a</sup>	3.86 <sup>a</sup>	2.40 <sup>a</sup>	3.90 <sup>b</sup>	3.95 <sup>b</sup>
2	4.30 <sup>ab</sup>	3.46 <sup>c</sup>	2.65 <sup>a</sup>	3.95 <sup>a</sup>	2.65 <sup>a</sup>	3.85 <sup>bc</sup>	4.15 <sup>a</sup>
3	4.26 <sup>b</sup>	3.90 <sup>ab</sup>	3.05 <sup>a</sup>	3.91 <sup>a</sup>	3.05 <sup>a</sup>	3.80 <sup>bc</sup>	4.15 <sup>a</sup>
4	4.56 <sup>a</sup>	3.90 <sup>ab</sup>	2.50 <sup>a</sup>	3.20 <sup>a</sup>	2.50 <sup>a</sup>	3.40 <sup>c</sup>	3.95 <sup>b</sup>
5	4.30 <sup>ab</sup>	3.76 <sup>bc</sup>	2.70 <sup>a</sup>	3.65 <sup>a</sup>	2.70 <sup>a</sup>	4.40 <sup>a</sup>	4.20 <sup>a</sup>
±SEM	0.38	0.42	0.33	0.38	1.04	0.66	0.12

<sup>a, b, c</sup> Means along the same column with different superscripts are significantly different ( $P < 0.05$ )

SEM: Standard Error of Means

KEY:

Batch 1 – 0% Plantain flour and 100% Wheat flour inclusions

Batch 2 – 25% Plantain flour and 75% Wheat flour inclusions

Batch 3 - 50% Plantain flour and 50% Wheat flour inclusions

Batch 4 - 75% Plantain flour and 25% Wheat flour inclusions

Batch 5 – 100% Plantain flour and 0% Wheat flour inclusions

**Table 5:** Showing the Effect of Substituting Wheat Flour with Plantain Flour at varying levels on Proximate Composition of Beef Sausage.

%Plantain Inclusion	%Crude Protein	%Ether Extract	% Ash	%Moisture Content	%Carbohydrate
1	10.95 <sup>e</sup>	2.04 <sup>b</sup>	1.11 <sup>e</sup>	44.60 <sup>d</sup>	85.90 <sup>a</sup>
2	15.73 <sup>d</sup>	2.90 <sup>a</sup>	2.40 <sup>a</sup>	43.93 <sup>e</sup>	78.97 <sup>c</sup>
3	15.83 <sup>c</sup>	1.83 <sup>c</sup>	1.63 <sup>c</sup>	46.10 <sup>c</sup>	80.71 <sup>b</sup>
4	19.69 <sup>b</sup>	1.10 <sup>d</sup>	1.30	48.71 <sup>b</sup>	77.90 <sup>d</sup>
5	21.67 <sup>a</sup>	1.04 <sup>e</sup>	2.10 <sup>b</sup>	49.55 <sup>a</sup>	75.19 <sup>e</sup>
±SEM	0.08	0.01	0.03	0.12	0.08

<sup>a, b, c, d, e</sup> Means along the same column with different superscripts are significantly different ( $P < 0.05$ )

SEM: Standard Error of Means

KEY;

Batch 1 – 0% Plantain flour and 100% Wheat flour inclusions

Batch 2 – 25% Plantain flour and 75% Wheat flour inclusions

Batch 3 - 50% Plantain flour and 50% Wheat flour inclusions

Batch 4 - 75% Plantain flour and 25% Wheat flour inclusions

Batch 5 – 100% Plantain flour and 0% Wheat flour inclusions

## CONCLUSION AND RECOMMENDATION

From the results obtained, if cooking weight loss is to be considered, substitution of wheat flour at 75% for plantain flour in beef sausage production is acceptable but if nutrient composition is to be considered, 100% rice flour inclusion (Batch 5) showed a better %Crude protein, Ash and Ether extract contents. All parameters for sensory evaluation were badly scored in all sausages. Therefore, substituting wheat flour with rice flour up to 75% in beef sausage production is acceptable, as this favors the product's resistance to diffusion thus favoring its storage stability.

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