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Investigation on the Effectiveness of Palm Ash Infusion and Water Soaking For the Reduction of Beany Flavor in Bambara Groundnut *(Vigna Subterranea)* Flour for Cake Production

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Abstract: *An investigation on the effectiveness of palm ash infusion and water soaking for the reduction of beany flavor in Bambara groundnut (Vigna subterranea) was studied. Bambara groundnuts were processed into six different flour samples. One sample was soaked in water and the other soaked in 2% sodium bicarbonate solution. The other four were soaked in palm ash infusions at different levels of concentrations ; 5%, 10%, 15%, and 20%. The nuts were dried, milled to flour samples and used in cake production. The functional properties of the resulting flour samples and the proximate composition of their cakes were analysed. The sensory attributes of the cakes were evaluated using 20 panelist familiar with cake products and a nine point hedonic scale.*

The data was subjected to one way analysis of variance using Fisher's Least Significant difference (LSD) at P<0.05. The Water absorption capacities ranged from 6.0%-8.0%, Gelation temperature ranged from 65.5°C-75.5°C, Wettability ranged from 0.23s-1.33s while the pH ranged from 6.95-8.94. Moisture content ranged from 0.49%-15.5%, ash content ranged from 1.65%-2.56%, protein content ranged from 0.49%-13.28%, crude fiber content ranged from 1.36%-3.68%, fat content ranged from 21.5%-28.54% and carbohydrate ranged from 40.74%-57.78%.

The sensory evaluation result indicated that all parameters such as appearance, mouthfeel, texture, aroma, flavor and general acceptability of the cake made from the water soaked Bambara groundnut were most preferred when compared to other treatments.

Keywords: *Bambara groundnut, Palm ash, Beany flavor,Functional properties,Proximate composition, sensory evaluation.*

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I. Introduction

Bambara groundnut(*Vigna subterranea*) known as 'Okpa' in the South Eastern zone of Nigeria is one of the grain legumes widely cultivated in Central and West Africa including Nigeria, particularly in Enugu and Ebonyi states of Nigeria. According to Mahazib *et al.* (2013), the high carbohydrate (65%) and relatively high protein (18%) content as well as sufficient fat content (6.5%) make Bambara groundnut a complete food. Bambara groundnut seeds have been found to be rich in essential amino acids such as Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine and Valine (Bamishaiye *et al.,* 2011).

In the Eastern part of Nigeria, the Bambara nuts are used to produce a moi-moi-like ready-to-eat food called 'Okpa'. This is a traditional delicacy and the major popular food product made with these nuts. This product retains the distinct Okpa beany-flavor which may not be acceptable in bakery products. Bambara groundnut is rich in protein which makes its flour suitable for baking. But, its limitation is its beany flavor and this beany flavor is usually unacceptable and can also render the baked product unacceptable.

Although regarded as a complete food, it is of little recognition and utilization in baking, thereby making it one of the untapped resources in this area. The objectives of this study is to investigate the effectiveness of palm-ash infusion in the reduction of the beany flavor of Bambara groundnut flour for cake production and to determine the functional, proximate and sensory acceptance of the cake samples produced from the resultant flours. Furthermore, this study will enhance the production of acceptable protein-richer baked products from Bambara groundnut and add varieties to the present market baked products while enhancing production and effective utilization of the Bambara groundnut, thus creating new marketing nitch.

II. Materials and Method

Source of Materials

The raw materials used in this study include Bambara groundnut (*Vigna subterranea*) and other ingredients such as sugar, baking powder, salt, eggs, sodium bicarbonate and baking fat were all obtained from Ihiagwa, market in Owerri West, Imo State. Palm ash was produced by burning waste palm bunch from Amaimo, Ikeduru L.G.A, Imo state. Other materials and facilities used in this project were obtained from the Department of Food Science and Technology Laboratory, Federal University of Technology, Owerri, Imo State.

Sample Preparation

Bambara groundnuts were sorted to remove unwanted materials and then divided into six portions, each weighed 300g. Four portions were soaked in 1litre of different concentrations of palm ash infusion: 5%, 10%, 15% and 20% of 1litre respectively. For the other two portions, one was soaked in 1litre of water without anything added and the last was soaked in 2% solution of sodium bicarbonate (NaHCO3). The soaking lasted for 24hrs after which the samples were dehulled and washed, spread and sundried for about 3hrs. The partially dried Bambara groundnuts were further oven dried at 65^{o}C for 50mins,milled in an attrition mill, and sifted using a 600µm aperture size sieve
(Fig 1). The six flour samples were packaged, sealed in a polythene bag and kept in a cool dry place until used.

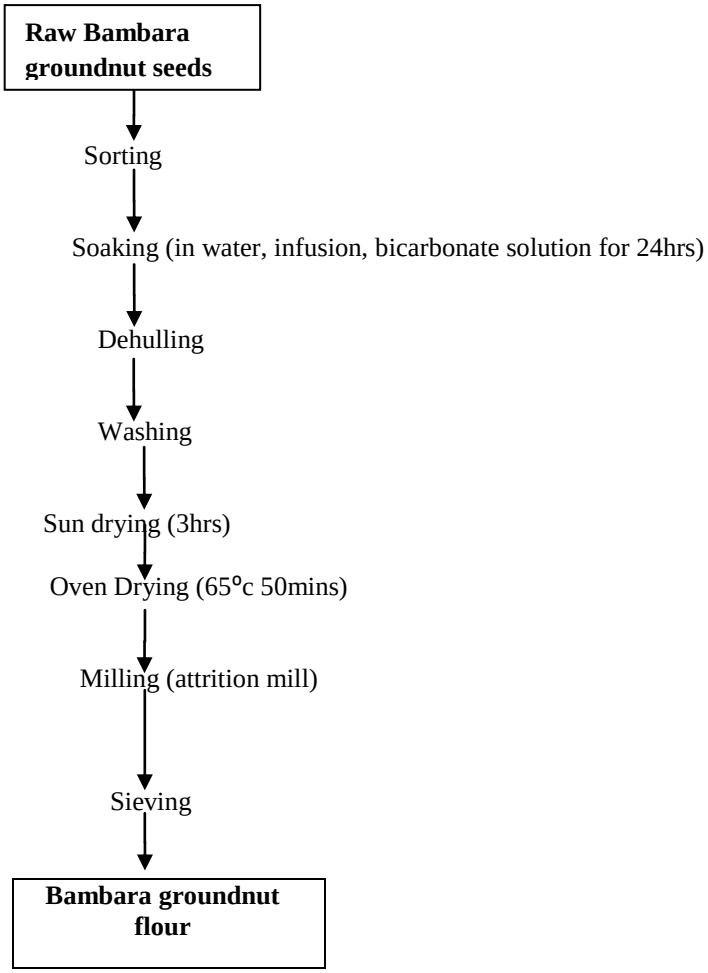

Fig 1: Flow chart for the production of Bambara groundnut flour

Functional Properties of the Flour Samples

Water absorption capacity

The method described by Onwuka (2005) was used. One gram of the flour was weighed into 15ml centrifuge tube and 10ml of water was added. This was placed on a platform tube rocker for 1 minute at room temperature. The sample was allowed to stand for 30 minutes and then centrifuged at 5,000rpm for 30 minutes. The volume of free water was read directly from the centrifuge tube.

$$WAC(\%) = Amount\ of\ water\ added - free\ water \times 100$$

$$\frac{}{Weight\ of\ sample}$$

Determination of Wettability

The method described by Onwuka (2005) was adopted. One gram(1g) of each of the flour samples was weighed out using analytical balance and were added into a 25ml graduated measuring cylinder with a diameter of 1cm, the finger was then placed over the open end of the cylinder, inverted and was clamped at a height of 10cm from the surface of 600ml beaker containing 500ml of distilled water. The finger was then removed and the test samples were allowed to be dumped. The wettability was recorded as the time required for the sample to become completely wet.

Gelation temperature

The method described by Onwuka (2005) was employed. A sample suspension of 10% (W/V) for each of the flour was prepared in 10ml of distilled water and the dispersion was transferred into a test tube. It was heated in boiling water till a gel was formed.

Gelation Capacity

The method described by Onwuka (2005) was used. A sample suspension of 10% (W/V) for each of the flour was prepared in 10ml of distilled water and the dispersion was transferred into a test tube. It was heated in boiling water till a gel was formed and rapidly cooled at 4°C for 2hrs. The least gelation is the concentration at which the sample did not fall or slip when the test tube was inverted

Sample formulation

The samples were formulated by preparing 125g (100%) of each of the flour samples including the control (soaked in$NaHCO_3$).

100% sample flour of Bambara groundnut soaked in $NaHCO_3$ (Control)
100% sample flour of Bambara groundnut soaked in water
100% sample flour of Bambara groundnut soaked in 5% palm ash infusion
100% sample flour of Bambara groundnut soaked in 10% palm ash infusion
100% sample flour of Bambara groundnut soaked in 15% palm ash infusion
100% sample flour of Bambara groundnut soaked in 20 % palm ash infusion

Production of Cake

The recipe used for the production of cake is shown on Table 3.1.The creaming method of cake production was used. Sixty grams (60g) portions of sugar were weighed along with 125g portions of baking fat and put into separate bowls and creamed by stirring until the sugar was completely dissolved in the baking fat to obtain a smooth, creamy consistency. For each sample, one egg was whisked thoroughly to incorporate air and was introduced into the cream in each of the six different bowls. All dry ingredients, 2g of baking powder and 125g of Bambara groundnut flour, were mixed together. The dry mixture was then added to the cream and stirred vigorously until properly mixed to obtain a homogenous batter.

The batter was poured in a greased pan and placed in a baking tray inside a heated oven. The baking operation was carried out at 213^{o}C for 45min, after which the products were brought out, cooled and packaged.

Table 1. Recipe for Bambara Groundnut Cake in Percentage and Grams

Ingredients All Bambara groundnut	Percentage (%)	Grams (g)
Flour samples	**100**	**125**
Sugar	**48**	**60**
Fat	**100**	**125**
Eggs	**48**	**60**
Baking powder	**1.6**	**2**

Proximate Analysis

Determination of Moisture Content

The method of AOAC (1990) was employed in determining the moisture content. Exactly 2g of the sample was put into a previously weighed can. The sample in the can was dried in the oven at 105^{o}C for 3hours. It was cooled in a desiccator and weighed. It was later returned to the oven for further drying after which it was left to cool and weighed. This was repeatedly done in hour intervals until a constant weight was obtained. The weight of moisture lost was calculated as a percentage of weight of sample analyzed as shown below:

% Moisture = $\frac{W2 - W3 \times 100}{}$

$$W2 - W1$$

Where W_1 = weight of empty moisture can
W_2 = weight of moisture can + sample before drying
W_3 = weight of moisture can + sample dried to constant weight.

Determination of Ash Content

This was done by furnace incineration using the method of AOAC (1990). Two grams (2g) of the processed sample was put into a previously weighed porcelain crucible. The sample was burnt to ash in a muffle furnace at 550°C. When it was completely ashed, it was cooled in a desiccator and weighed. The weight of the ash was expressed as percentage of the weight of sample analysed (as shown below).

$$\% \text{ Ash} = \frac{W2 - W1}{Weight\ of Sample} \times 100$$

Where W_1 = weight of empty crucible
W_2 = weight of crucible + ash

Determination of Crude Fibre Content

The AOAC (1990) method was used. Two grams (2g) of the processed sample was boiled in 150mls of 1.25% H_2SO_4 solution for 30minutes. The boiled sample was washed in several portions of hot water using a two fold Muslin cloth to trap the particles which were returned back to the flask and boiled again in 150mls of 1.25% NaOH for another 30minutes under the same condition.

After washing in several portions of hot water, the sample was allowed to drain dry before being transferred to a weighed crucible where it was dried in an oven at 105^0 C to a constant weight. It was burnt to ash in a muffle furnace at 550°C. The weight of fibre was calculated as a percentage of weight of sample analyzed as given by the expression below:

$$\% \text{ Crude fibre} = \frac{W2 - W1}{Weight\ of\ the\ sample} \times 100$$

Where W_2 = weight of crucible + sample after boiling, washing and drying.
W_3 = Weight of crucible + sample as ash.

Determination of Fat Content

The solvent extraction method of AOAC (1990) was used. Two grams (2g) of the processed sample was wrapped in a porous paper (Whatman filter paper) and put in a thimble. The thimble was placed in a soxhlet reflux flask and mounted in a weighed boiling flask containing 200ml of petroleum ether. The upper end of the reflux flask was connected to a water condenser.

The solvent (petroleum ether) was heated. It boiled, vaporized and condensed into the reflux flask. The sample in the thimble was covered with the solvent which extracted the fat. The sample remained in contact with the solvent until the reflux flask filled up and siphoned over, carrying its oil extract down to the boiling flask. This process was allowed to go on repeatedly for 4hours before the deffated sample was removed, the sample received and the oil extracted was left in the flask. The flask containing the oil extract was dried in the oven at 60°C for 30 minutes (to remove the residual solvent), cooled in a desiccator and weighed. By difference, the weight of fat extract was determined and expressed as a percentage of the weight of the analyzed sample and is given by the expression below:

$$\% \text{ Fat} = \frac{Weight\ of fat}{Weight of sample} \times 100$$

Determination of Protein Content

This was done by the Kjeldahl method with slight modification by onwuka (2005). The total Nitrogen (N_2) was determined and multiplied with the factor 6.25 to obtain the protein content. One gram (1.0g) of processed sample was put into10ml of concentrated H_2SO_4 in a digestion flask. A tablet of selenium catalyst was added to it before it was heated in a fume cupboard until a clear solution was obtained (i.e the digest) which was diluted to 100ml in a volumetric flask.

Ten (10) ml of the digest was mixed with equal volume of 45% NaOH solution in a Kjeldah distillation apparatus. The mixture was distilled into 10ml of 4% boric acid containing 3 drops of mixed indicator (bromocressol green/methy red) in a 150ml beaker. A total of 50mls of distillate was collected and titrated against 0.02N EDTA from green to a deep end point. The N_2 content and hence the protein content was calculated using the formula below:

% Protein = % N_2 x 6. 25

% Nitrogen = $\frac{(100 \times N \times 14 \times Vt) \times T \times B}{W \times Va \times 1000}$

Where, W = weight of sample

N = Normality of titrant (0.02 H_2S0_4)

Vt = Total digest of volume (100mls)

Va = Volume of digest analysed (10ml)

T = Titre value of sample

B = Titre value of Blank

Determination of Carbohydrate Content

The carbohydrate content was calculated by using the formula below:

$\%\ Carbohydrate = 100 - \%(\ Protein + Fat + Ash + Moisture\ + Crudefibre)$

Sensory Evaluation of the Cakes

The six different samples were evaluated by 15 untrained panelist selected at random. The panelist evaluated the samples based on the cake color, aroma, texture, mouth-feel, intensity of beany flavor and general acceptability. A nine point hedonic scale as described by Ihekoronye and Ngoddy,(1985) was used to carry out the analysis of variance (ANOVA) as follows;

9= like extremely; 8=like very much; 7=like moderately; 6=like slightly; 5=neither like nor dislike; 4=dislike slightly 3=dislike moderately; 2=dislike very much; 1=dislike extremely.

Statistical Analysis

The data generated was subjected to three-way analysis of variance using Micro soft excel 2007 software and means were separated using Fisher's Least Significant Difference (LSD) at P<0.05,

III. Results and Discussion

Table 2: Mean Values of the Functional Properties of Flour Samples from Bambara Groundnut Soaked in Different Media.

Samples soaked in	**Mean values**			
	Water Absorption (Ml)	**Gelatinization Temperature (°C)**	**Wettability(s)**	**pH**
2% $NaHCO_3$ solution	7.00±1.41^{a}	75.50±0.71^{a}	0.23±0.03^{a}	6.95±0.12^{a}
Water	7.50±0.71^{a}	69.00±4.24^{ab}	1.03±0.00^{b}	6.80±0.01^{a}
5% palm ash infusion	8.00±0.00^{a}	70.00±2.83^{ac}	1.33±0.31^{cb}	6.95±0.09^{a}
10% palm ash infusion	8.00±0.00^{a}	74.00±5.66^{ad}	0.87±0.42^{abce}	8.41±0.01^{b}
15% palm ash infusion	7.00±1.41^{a}	70.00±0.00^{ae}	0.86±0.39^{abce}	8.29±0.01^{cbd}
20% palm ash infusion	6.00±0.00^{a}	65.00±7.07^{bcde}	0.51±0.04^{abe}	8.54±0.06^{bd}
LSD	**2.12**	**10.40**	**0.66**	**0.16**

NB.: .....a,b,c… "Means" with the same alphabet as superscript in each column are not significantly different (P≥0.05)

Functional properties of flour samples obtained from Bambara groundnuts soaked in the different media

Water absorption capacity (WAC)

The water absorption capacity (WAC) values of the resulting flour samples ranged from 6.00% (nut of 20% palm ash infusion) to 8.00% (nuts of 5% and 10% palm ash infusion) (Table 2). There was no significant difference (P>0.05) between the water absorption values of all the samples. Also there was no trend followed by the values relating the effect of the different treatments. For instance, the flour sample from the nuts soaked in water had WAC value of 7.5% which decreased to 7.0% in the flour sample soaked in 2% sodium bicarbonate.

But soaking the nuts in 5% and 10% palm ash infusion resulted to a relative increase to 8.00% in the flour samples and further increase in the level of palm ash to 15% and 20% in the infusion media decreased the WAC of the resulting flour samples to 7.0% and 6.0% respectively. Mazahib *et al.* (2013) suggested that flours low in WAC may not readily absorb moisture, thus have longer shelf life.

Gelation Temperature

The gelatinization temperature of the flour samples from the treated Bambara groundnut ranged from 65.0° C to 75.5°C (Table 2) with the flour sample from nuts soaked in 2% sodium bicarbonate solution having the highest gelation temperature (75.5°C) and the flour sample from nuts soaked in 20% palm ash infusion having the lowest value (65.0°C). There was a significant difference ($P<0.05$) between the gelatinization temperature (65°C) of the sample treated with 2% $NaHCO_3$ solution, but only relative differences in the gelatinization temperatures of the other treated samples occurred. However, the results obtained in this study are \in line with the reports made by Adebowale *et al.* (2013).

Wettability

The values for the wettability of the resulting flour samples ranged from 0.23s (in the flour from nuts soaked in 2% $NaHCO_3$ to 1.33s in the flour from nuts soaked 5% palm ash infusion (Table 2). The least wettability value (0.23s) was observed in the flour sample produced from the Bambara groundnuts soaked in 2% $NaHCO_3$ solution. The highest wettabilty value (1.33s) was observed in the flour sample from the nuts soaked in 5% palm ash infusion. A decreasing trend in wettability as the level of palm ash in the infusion increased, specifically decreasing from 1.33s in the 5% infusion, through 0.87% and 0.86% in the 10% and 15% infusion respectively to 0.51s in 20% infusion flour samples. But for the flour from the sample soaked in $NaHCO_3$ solution whose wettability value (0.23) was significantly ($P<0.05$) different from the sample of the nuts soaked in 5% palm ash infusion, there was no significant difference among the other samples with regards to wettability. In other words, the flour from Bambara groundnut soaked in 2% sodium bicarbonate was the fastest in getting wet completely. Thus, Afokwa *et al.* (2007) reported that wettability increases with the degree of soaking.

pH of the flour samples

The pH of the flour samples from Bambara nuts soaked in 2% $NaHCO_3$ water and 5% palm ash were barely acidic or almost neutral (6.80-6.95) with no significant difference ($P>0.05$). Higher levels of palm ash (10%-20%) infusion resulted to flour samples with basic pH (8.29-8.54).

Table 3: Mean values of the Proximate Composition (%) of the Cake Samples made with Flours of Bambara Groundnuts Soaked in Different Media

Samples Soaked in	**Mean values**					
	MOISTURE	**TOTAL PROTEIN**	**ASH**	**FAT**	**CHO**	**CRUDE FIBER**
2% $NaHCO_3$ solution	14.00±1.41 ^{b}	10.36±0.07 ^{c}	1.65±0.01^{fbe}	26.00±1.41 ^{b}	44.07±0.04 ^{e}	3.53±0.03^{dc}
Water	15.50±0.71 ^{a}	9.27±0.07^{d}	1.77±0.00^{eb}	28.50±0.71 ^{a}	40.76±0.02 ^{f}	4.22±0.01 ^{a}
5% palm ash infusion	04.60±0.28 ^{c}	11.67±0.01^{b}	2.00±0.14^{db}	25.70±0.28^{cb}	51.78±0.01^{cb}	1.36±0.01 ^{f}
10% Palm ash infusion	05.60±0.14^{d}	8.93±0.04^{e}	2.36±0.01^{cb}	23.50±0.71^{db}	51.75±0.06^{cdb}	2.65±0.07^{e}
15% Palm ash infusion	06.45±0.07^{ed}	8.49±0.11^{f}	2.38±0.04 ^{b}	22.05±0.07^{ebd}	57.28±0.09 ^{a}	3.56±0.01 ^{c}
20% Palm ash infusion	07.65±0.07^{fe}	13.28±0.14^{a}	2.56±0.05 ^{a}	21.50±0.71^{fbde}	51.82±0.04^{b}	3.68±0.04 ^{b}
LSD	**1.16**	**0.15**	**0.15**	**1.89**	**0.12**	**0.09**

NB.: …..a,b,c… "Means" with the same alphabet as superscript in each column are not significantly different (P≥0.05)

Proximate Composition Of Cake Samples Made With Flours Of Bambara Groundnuts Soaked in Different Media.

The cake sample with the flour from Bambara groundnuts soaked in water had the highest moisture value (15.5%) followed by the sample from nuts soaked in 2% $NaHCO_3$ with the value of 14.0% (Table 3). The cake sample from nuts soaked in palm ash infusion had reduced moisture values which ranged from 4.60% to 7.65%. Though the moisture reduction in these samples seem drastic, decreasing from 15.5% in cakes from water soaked nuts to 4.6% in Bambara nut from 5% palm ash soaked nuts, the reduction showed a decreasing trend as the level of palm ash in the infusion increased from5% to 20%. Thus, the cake samples from palm ash soaked Bambara groundnuts moisture content gradually increased from 4.6% in 5% palm ash soaked nut-cake through 5.6% and 6.45% in 10% and 15% palm ash treated nut-cakes to 7.65% in 20% palm ash treated nut cake sample. There were significant differences ($P<0.05$) in the moisture content of the cake samples. Adebowale *et al.*(2013) reported that pretreatment affects the nutritional composition and moisture level of Bambara groundnuts.

The protein contents of the cake samples significantly ($P<0.05$) varied from each other, although no trend was established for the variations. For instance, while the cake sample from nuts soaked in water had 9.27% protein, the cake sample from nuts soaked in 2% $NaHCO_3$ solution had 10.36%, the cake sample from nuts soaked in 5% palm ash had 11.67% but the samples soaked in 15% and 20% palm ash had 8.49% and 13.28% respectively. . According to Bamishaiye *et al.* (2011), Bambara groundnut is a very high source of protein.

All cake samples from nuts soaked in palm ash infusion had higher levels of ash (≥2.0%) than those from nuts soaked in water (1.77%) or in $NaHCO_3$ (1.65%), though significant difference ($P<0.05$) in ash value existed only between cakes from nuts soaked in 20% palm ash and other samples. Thus, Nengi *et al.*(2001) reported that soaking mediums generally affects the nutritional composition of food materials.

Though the formula used for the cake samples had the same level of added baking fat, cakes from the nuts soaked in water had the highest level of fat (28.5%). The cake sample from nuts soaked in 2% sodium bicarbonate($NaHCO_3$) had 26.0% fat and all the cake samples from nut soaked in palm ash infusion had lower levels of fat which exhibited a decreasing trend of 25.7%- 21.5% as the level of palm ash in the infusion increased from 5% to 20%. According to De Kock (2013), Bambara groundnut contain appreciable quantities of fat.There were significant differences ($P<0.05$) between the fat content of the cake from water soaked nuts and the other cake samples. The cake samples from nuts soaked in 5%, 10% and 20% palm ash infusion are relatively significant in their carbohydrate contents. However, there were significant differences ($P<0.05$) in the levels of carbohydrate in the cake samples from nuts soaked in 2% sodium bicarbonate, water and 15% palm ash infusion. The cake sample from the nuts soaked in water had the lowest carbohydrate content (40.46%) while the sample from nuts soaked in 15% palm ash infusion had the highest carbohydrate content (57.28%). Hence, these results were in agreement with the report made by Adebowale and Lawal (2002).

The cake samples from nuts soaked in water had the highest (4.22%) crude fibre content and lowest in the cake sample from nuts soaked in 5% palm ash (1.36%). Though the crude fibre content reduced from 4.22% to 1.36% in the cake made from nuts soaked in 5% palm ash, it took a gradual increament as the level of palm ash in the infusion increased being 3.68% in the cake from 20% palm ash soaked nuts. Yao *et al.* (2015) reported that bambara nut which has undergone pretreatments such as soaking, heating, chemical treatments, etc., contains relative high amount of crude fibre.

Sensory Qualities of Cake Samples from Bambara Groundnut Soaked in Different Media.

The cake sample made with the flour from the nuts soaked in water had the most acceptable appearance (score 7.6 ≈ very much liked). The appearance of all cake samples (plates 1- 6) were moderately liked (scores ≈ 7) but statistically there was no significant difference in their appearance score, though relative differences were observed (Table 4).

Considering the numerical scores of the cake samples for the mouthfeel attribute, the cake from the 5% palm ash treated nut had the lowest score (5.5) and significantly different ($P<0.05$) from the others in that regard (mouthfeel) but in descriptive terms that cake sample (5% palm ash soaked nuts) were slightly liked (score ≈ 6.0) in mouthfeel as the samples treated with 10% (score 5.9), 15% (6.45), and 20% (score 6.2) palm ash infusions. The cake samples from nuts soaked in 2% $NaHCO_3$ solution and water were moderately liked (scores ≈ 7), though the sample from water soaked nut had a relatively higher numerical score (7.2) when compared to a score of 6.5 for the cake sample from 2% $NaHCO_3$ treated nuts.

Plate 1: Cake made from Bambara groundnut soaked in 2% Sodium bicarbonate ($NaHCO_3$) solution

Plate 2: Cake from water soaked Bambara groundnut

Plate 3: Cake from 5% palm ash infused Bambara groundnut

Plate 4: Cake from 10% palm ash infused Bambara groundnut

Plate 5: Cake from 15% palm ash infused Bambara groundnut.

Plate 6: Cake from 20% palm ash infused Bambara groundnut

Table 4. Mean Sensory Scores For Cake Samples From Bambara Groundnuts Soaked In Different Media.

Samples soaked in	Mean values					
	Appearance	**Mouth Feel**	**Flavour**	**Texture**	**Aroma**	**General Acceptability**
2% $NaHCO_3$ solution	6.80±1.58 [a]	6.50±1.88 [a]	5.70±2.27 [a]	6.70±1.65 [ab]	7.80±1.47 [a]	6.80±1.70 [b]
Water	7.60±1.31 [ad]	7.20±1.74 [a]	6.70±2.23 [a]	7.40±1.14 [a]	7.40±1.43 [ab]	8.00±1.02 [a]
5% palm ash infusion	7.20±1.47 [abd]	5.55±1.79 [c]	5.75±1.97 [abc]	5.35±1.93 [ed]	6.45±1.99 [bcd]	6.50±1.28 [cb]
10% palm ash infusion	6.55±1.15 [ab]	5.90±1.99 [b]	4.75±2.09 [ab]	5.45±1.91 [cd]	5.20±1.77 [e]	5.95±1.23 [ebc]
15% palm ash infusion	6.75±1.37 [abd]	6.45±1.89 [a]	4.70±2.11 [ab]	6.10±1.89 [b]	5.40±1.70 [d]	6.10±1.41 [bc]
20% palm ash infusion	6.70±1.59 [ab]	6.20±1.82 [a]	5.15±2.39 [abc]	5.50±1.79 [ce]	5.60±2.01 [c]	5.45±2.03 [fde]
LSD	**0.89**	**1.16**	**1.37**	**1.09**	**1.09**	**0.93**

NB.: The 'a, b, c, ... means' with the same alphabet as superscript in each column are not significantly different (P≥0.05)

The Hedonic scale

9= like extremely; 8=like very much; 7=like moderately; 6=like slightly; 5=neither like nor dislike; 4=dislike slightly; 3=dislike moderately; 2=dislike very much; 1=dislike extremely

The flavor of the cake sample made with the flour from nuts soaked in water was the most acceptable (score ≈ 7.0, moderately liked) among all the cake samples. The cake samples from Bambara groundnut soaked in 2% $NaHCO_3$ and 5% palm ash infusion had only slight likeness (score ≈ 6.0) for their flavor while all the cake samples from nuts soaked with higher levels of palm ash infusion (10-20%) had neither liked nor disliked (score ≈ 5) flavors. Basically there was no significant difference (P>0.05) in the flavor score of the cakes. A study carried out by Eltayeb *et al.*(2011) also suggested that Bambara groundnuts which are pretreated showed a distinct flavor, colour and as well as textural qualities.

The texture of the cake samples from Bambara nut soaked in water and $NaHCO_3$ were moderately liked (score ≈ 7.0), though there was no significant difference (P>0.05) in their flavor numerical scores, the score for the sample from water-soaked nut was relatively higher (7.4) when compared to the score (6.7) for the sample from $NaHCO_3$ soaked nuts. The cake samples from nuts soaked in 15% palm ash had only a slight likeness (score 6.1) in texture and that was the best among the palm ash treated nuts; texture wise.

With regards to aroma, the cake sample from nut soaked in 2% $NaHCO_3$ solution was very much liked (score ≈ 8) while the sample from nuts soaked in water was moderately liked (score 7.0) and the sample soaked in 5% palm ash infusion was only slightly liked (score = 6.0). This result implied that if aroma was the critical attribute for the acceptance of the cake samples then soaking of nuts in palm ash should not be encouraged or if it has to be done, the level of palm ash in the soaking infusion should not exceed 5%. Eltayeb *et al.*(2011) opined that the aroma of a food material is affected by the extent of pretreatments such as soaking, heating, chemical treatments, and so on.

In general acceptability rating, the cake sample from water-soaked Bambara groundnut was the most acceptable with a score of 8.0 (very much liked), followed by the samples from 2% $NaHCO_3$ and 5% palm ash soaked nut with scores of 6.8 and 6.5 (moderately liked) respectively. The cake samples from nuts soaked in 10% and 15% palm ash were just slightly liked (scores ≈6). These sensory results indicated that soaking in water was the best process to reduce the beany flavor of Bambara groundnut targeted for cake flour, in order to obtain a product with appreciable acceptance.

IV. Conclusion And Recommendation

Conclusion

In this study, soaking Bambara groundnut in cold water for twenty four (24) hours was the most effective technique for the reduction of beany flavor in Bambara groundnut flour intended for cake production. Soaking in 5% palm ash infusion or 2% $NaHCO_3$ solution are just fairly good alternative techniques, giving flours whose cakes had slightly liked flavor and moderately liked cake products. The flavor of cakes from the nuts soaked in palm ash infusion higher than 5% were all neither liked nor disliked. Thus, the use of such levels of palm ash infusion should be discouraged. The palm ash treatments reduced the fat contents of the cake samples and the higher the incorporation of palm ash in the infusion, the lower the fat content of the resulting cake sample. The application of palm ash infusion in the soaking of the nuts before dehulling, drying and milling drastically reduced moisture content in the resulting cakes even up to 70.3% reduction in 5% palm ash treated samples.

Recommendations

This study has shown that soaking Bambara groundnut in cold water was the best technique in the reduction of beany flavor in Bambara groundnut flour when compared to other treatments

Soaking the nuts in palm ash infusion was effective in reducing the fat content of the cake made with Bambara groundnut. Hence it is recommended that inclusion of palm ash in the infusion should not exceed 5% in order to produce cakes with good sensory attributes.

Storage stability studies should be carried out on the cake samples in order to ascertain their shelf stability.

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