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Quality evaluation of composite bread produced from wheat, defatted soy and banana flours

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Abstract: The physicochemical and sensory evaluation of the bread produced from the composite flour of wheat, defatted soy and banana was determined. Five bread samples were produced from the proportion of wheat/defatted/banana composite flours as 90%:5%:5% (B), 80%:10%:10% (C), 70%:15%:15% (D), 60%:20%:20% (E) and 100% wheat was the control sample (A). The crude protein, crude fibre, moisture and ash contents of the composite breads increased significantly ($P<0.05$) with increase in the proportion of defatted soy and banana flours. The carbohydrate and fat contents were observed to decrease significantly ($P<0.05$) with corresponding increase in the percentage of the composite flours from 5-20% for both defatted soy flour and banana flour. The result of the physical properties showed that there was no significant difference ($P>0.05$) in texture and taste but the mean sensory scores decreased with increased addition of defatted soy and banana flours to the wheat flour. There was decrease in crust colour, crumb colour and aroma as the substitution of flours increased with significant decrease at 10-20% substitution level. The loaf weight however increased significantly ($P<0.05$) with increased defatted soy and banana flours. There was no significant difference ($P>0.05$) in the overall acceptability of the bread for all the samples. The mean sensory scores however showed that consumers preferred the bread from 100% wheat but bread from the composite flours of 20% substitution for both defatted soy and banana flours were all well accepted.

Keywords: Defatted Soy Flour, Banana Flour, Proximate Analysis, Composite Flour

1. Introduction

Bread is one of the most important staple foods and the second most widely consumed non-indigenous food products after rice in Nigeria [1]. It is consumed by people in every socioeconomic class and is acceptable to both adults and children. The word bread is used to describe the whole range of different bread varieties which may vary in weight, shape, crust hardness, crumb cell structure, softness, colour and eating quality [2].Wheat is the conventional flour used in the production of bread in Nigeria. It is however expensive because it is not grown in Nigeria due to unfavourable climatic conditions. It thus has to be imported from other countries using huge foreign exchange. Moreover cases of increased number of people with celiac disease have been recorded [3,4]. In the last few years, there is an increased trend towards healthy eating which has resulted in the development of many novel functional foods including use of other locally available crops for bread production. Partial or total substitution of wheat flour with the other cereals in non-wheat producing countries like Nigeria is on record.[5,6,7,8,9]. The information on the use of composite flours of wheat, defatted soy and banana is scanty in literature especially in North central Nigeria. The use of local agricultural crops such as soya beans and bananas in bread production would diversify their use; enhance value addition and nutrients of the bread.

Banana (musa acuminate colla) fruit belongs to the family of Musaceae. Commercially, it is one of the widely cultivated crops in the tropical and sub-tropical zones [10]. There are several cultivars of bananas which vary in color (yellow to brown), size (4-9 inches) and weight (70-150g). The fruit has an excellent source of nutrients comprising of vitamin B6 (28%), vitamin C (15%) and potassium (12%), Vitamin A, and negligible quantity of sodium and high fibre which when incorporated into wheat flour for bread production can enhance healthy bowels, cardiovascular health, protection from strokes, ulcers, improve blood pressure, may boost mood and reduce water retention because of low sodium [11].

Soybean (Glycine max L) has been the primary source of proteins for use as a functional ingredient in food system [12]. Its protein content is about 32.40 – 50.20% [13]. This high protein contents are particularly important supplements for improving the nutritional value of baked products. It is widely used in human and animal nutrition because of its

favorable agronomic characteristics, relative low price, high quality and quantity of its protein oil [14] and important functional properties for development of different products for humans [15].

The incorporation of defatted soy and banana flours in wheat flour for the production of bread would increase the protein, micro and macro nutrient contents of the bread, diversify the use of the crops, encourage farmers to produce local crops which would boost their economic power, add value to the local crops, reduce total dependence on imported wheat flour and save foreign exchange for Nigeria. Apart from being readily available and cheap, both banana and soya bean were chosen for their high nutrients that are complementary to each other. The aim of the research is therefore to produce bread from composite flours of wheat, banana and defatted soy flours and to determine its physicochemical as well as the sensory properties of the bread.

2. Materials and Methods

2.1. Source of Materials

Wheat flour and soybean were purchased from a local market in Makurdi while mature green banana were purchased from a local market in Okpoga, all in Benue state. All other materials and chemicals were of analytical grade and were obtained from the Food Processing laboratory of the Department of Food Science and Technology, University of Agriculture, Makudi, Nigeria.

2.2. Preparation of Raw Materials

2.2.1. Banana Flour Preparation

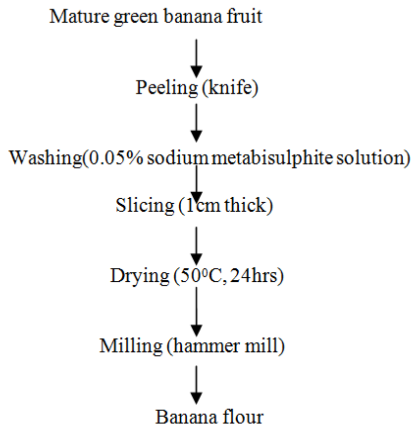

Fig 1. *Flow chart for the production of banana flour [16]*

Banana flour was produced according to the procedure of [16] with little modification for prevention of enzymatic browning (Fig.1). Fresh mature green bananas were peeled under water treated with 0.05% sodium metabisulphite and then sliced at average thickness of 1cm using sharp knife. The slices were then dried at 50°C for 24h in air draft oven. The dried chips were then milled in a hammer mill to obtain banana flour.

2.2.2. Defatted Soybean Flour Preparation

Defatted soybean flour was prepared according to the method described by [17] as shown in Fig 2.

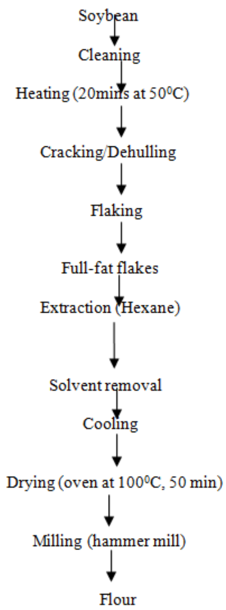

Fig 2. *Flow chart for the production of defatted soy flour [16]*

2.3. Blend Formulation of Wheat, Banana and Defatted Soy Flour

Five flour blends, each containing wheat, banana and defatted soy flours were prepared by mixing flours in the proportions of 90:5:5 (B), 80:10:10 (C), 70:15:15 (D), 60:20:20 (E), using machine food processor, (Kenwood KM 201, England). The control sample was 100% wheat flour (A). The five flour samples were packaged in black low density polyethylene bags and stored at room temperature until use for analysis and bread production.

2.4. Baking Process

The five blends of composite flour were baked into bread using the straight dough method [18]. The wheat flour and composite flours were mixed with 5 g salt, 40 g shortening, 20 g yeast and 60g sugar in 500 ml water followed by stirring using a Kenwood mixer (Model A 907 D) for 5 min to obtain a dough. The dough was kneaded for 40 minutes. The kneaded dough was then transferred into baking pans greased with plasticized fat and covered with greased bread wrapper. The dough was allowed to ferment for 90 minutes at room temperature in the baking pans. The fermented dough was then allowed to undergo proofing at 40^0C for 90 minutes and then baked at 250^0C for 30 minutes. The breads were cooled to room temperature and used for analysis.

2.5. Analyses

2.5.1. Proximate Composition

Proximate composition of the whole wheat and the composite bread samples were determined using the AOAC [19] . The moisture content (MC) was determined by drying samples in an oven at 105°C for 24 hours to obtain %MC. Crude protein percentage was determined using the Kjeldahl method with the Kjeltec 8400 analyzer unit (FOSS, Sweden) and the percentage nitrogen (%N) obtained was used to calculate the percentage crude protein (% CP) using the relationship: % CP = % N X 6.25. Ether extract percentage was determined using Soxhlet system HT-extraction technique of AOAC[19]. The percentage ash (%) was determined by incinerating the samples in a muffle furnace at 550°C for 4hrs. The ash was cooled in a desiccator and weighed. Crude fibre percentage (% CF) was determined by dilute acid and alkali hydrolysis of AOAC [19]. Carbohydrate was calculated by difference .

2.5.2. Determination of Physical Properties of Dough and Bread Loaves

Dough development in terms of increase in volume as affected by fermentation and proofing was determined as follows: a portion of the dough was placed inside a 500ml graduated beaker and placed on level surface (laboratory table). Initial and final volumes at the beginning and end of fermentation and proofing were determined. Fermentation and proofing rates were calculated by dividing the average volume increase due to fermentation and proofing by the time taken for fermentation and proofing respectively [18]. Bread characteristics were evaluated by measuring the loaf weight, loaf volume and specific loaf volume. Loaf weight was measured 30 minutes after the loaves were removed from the oven using a weighing balance whereas loaf volume was measured using the rapeseed displacement method as modified by [20] as follows: A box of fixed dimensions (23.00 x 14.30 x 17.21 cm) of internal volume 5660.37 cm3 was put in a tray, half filled with corn, shaken vigorously 4 times, then filled till slightly overfilled so that overspill fell into the tray. The box was shaken again twice, and then a straight edge was used to press across the top of the box once to give a level surface. The seeds were decanted from the box into a receptacle and weighed. The procedure was repeated three times and the mean value for seed weight was noted (C g). A weighed loaf was placed in the box and weighed seeds (3500 g) were used to fill the box and leveled off as before. The overspill was weighed and from the weight obtained the weight of seeds around the loaf and volume of seed displaced by the loaf were calculated using the following equations by AACC [21]

Seeds displaced by loaf (L) = C g + overspill weight – 3500 g.

Volume of loaf (V)=L ×5660.37 cm^3/C

The specific loaf volume was determined by dividing the loaf volume by its corresponding loaf weight (cm^3/g) as described by [22].

2.5.3. Sensory Evaluation of the Bread Samples

The sensory evaluation of the breads including the one made from 100% wheat flour and the composite flours were evaluated for texture, taste, aroma, crust colour, crumb colour and general acceptability of the product by a twelve man panel on a 9 point hedonic scale (1 = extremely disliked, 9 = extremely liked) as described by [10].

2.6. Statistical Analysis

The data collected were subjected to analysis of variance (ANOVA) (Steele and Torrie, 1980). Where significant differences existed, Turkey's test was used in separating the means using SPSS 19 version 2011.

2.7. Results and Discussion

2.7.1. Proximate Composition

Table 1. *Proximate composition of bread samples (%)*

Parameters	Samples					
	A	B	C	D	E	LSD
Ash	1.51^d±0.01	1.54^d±0.01	1.62^c±0.01	2.19^b±0.01	2.52^a±0.01	0.04
Fats	15.33^a±0.01	11.95^b±0.01	10.17^c±0.09	10.04^d±0.08	8.81^e±0.01	0.11
Fibre	1.39^e±0.01	1.64^d±0.01	1.87^c±0.01	2.38^b±0.01	2.61^a±0.01	0.03
Protein	10.05^e±0.07	12.65^d±0.07	14.15^c±0.07	15.89^b±0.01	17.11^a±0.13	0.04
Moisture	19.51^d±2.00	20.04^c±0.01	20.70^b±0.01	20.85^b±0.07	21.47^a±0.02	0.55
Carbohydrates	52.21^a±0.04	52.18^a±0.03	51.49^b±0.01	48.65^c±0.04	47.48^d±0.04	0.44

*Values in the same row with different superscript are significantly different at P<0.05 using turkeys test across rows
*Values are means ± standard deviation of duplicate determinations
*LSD = Least significant difference ± standard deviation of duplicate determinations
A= 100% wheat flour
B= 90% wheat flour+5%banana flour+ 5% defatted soy flour
C= 80% wheat flour+ 10%banana flour+10% defatted soy flour
D=70% wheat flour+ 15%banana flour+ 15% defatted soy flour
E=60% wheat flour+ 20% banana flour+20% defatted soy flour

The proximate composition of the bread samples is shown in Table 1. The ash, fibre, moisture and protein contents of the bread samples increased significantly (P<0.05) with increased substitution of banana and defatted soy flours from 5-20% of each flour. The ash content varied from 1.51- 2.52 %, the fibre varied from 1.39-2.61% while the protein and moisture ranged from 10.05-17.11% and 19.51-21.47% respectively. The fat and carbohydrates contents on the other hand decreased significantly with increased banana and defatted soy flours substitution. The increased ash and fibre contents could be attributed to the banana flour which is rich in minerals and fibre [24] . Banana is reported to be a rich source of potassium which is an important component of the body cells and fluids that helps to control heart rate and blood pressure thus; it counteracts the negative effects of sodium. The higher protein contents in the composite flours could have come from the defatted soy flour which is known to contain high protein contents.[24] The increased moisture content could be due to increased hydrophilic molecules provided by the defatted soy flour and banana flour. The decrease in fat content could be attributed to the addition of the defatted soy flour and low fat content of banana flour while the lower content of carbohydrate in composite flours could be due to the defatted soy flour that contributed high proteins and low carbohydrate. The increased protein content is an indication that supplementation of wheat flour with defatted soy and banana flours greatly improved the protein and nutritional quality of the bread. Thus the enriched bread would be used to solve malnutrition problems. Soy flour and banana is reported to contain all the essential amino acids. [10] High fibre is reported by [25] to enhance the gastrointestinal tract (GIT) health. It helps normal bowel movements thereby reducing constipation problems.

2.7.2. Physical Properties of Dough and Bread Loaves

Table 2. *Physical properties of dough and bread*

Parameters	Samples					
	A	B	C	D	E	LSD
ADVAF (35mins)	65.50^a±0.70	65.00^a±0.71	64.50^a±0.71	63.20^a±0.71	59.50^b±0.71	1.61
FermentationRate (cm^3/min)	1.87^a±0.10	1.83^a±0.02	1.79^a±0.10	1.76^a±0.03	1.66^b±0.02	0.08
ADVAP (90mins)	93.50^a±0.70	91.50^a±0.70	89.50^a±0.70	87.50^a±0.70	83.50^b±0.70	2.70
Proofing rate (cm^3/min)	1.04^a±0.05	0.98^a±0.01	1.01^a±0.05	0.95^a±0.01	0.84^b±0.10	0.08
Loaf weight(g)	199.50^d±0.70	201.00^d±1.41	204.00^c±1.41	208.00^b±1.41	213.00^a±1.41	2.17
Loaf volume(cm^3)	391.00^a±1.41	390.00^a±1.41	386.50^b±0.50	382.50^c±1.41	376.00^d±1.41	1.76
Specific loaf volume (cm^3/g)	1.96^a±0.07	1.94^a±0.07	1.89^a±0.04	1.84^a±0.03	1.77^b±0.01	0.06

*Values in the same row with different superscript are significantly different at P<0.05
*Values are means ± standard deviation of duplicate determinations
*LSD = Least significant difference.
ADVAF= Average dough volume after fermentation
ADVAP= Average dough volume after proofing
A= 100% wheat flour
B= 90% wheat flour+5%banana flour+ 5% defatted soy flour
C= 80% wheat flour+ 10%banana flour+10% defatted soy flour
D=70% wheat flour+ 15%banana flour+ 15% defatted soy flour
E=60% wheat flour+ 20% banana flour+20% defatted soy flour

The results of the physical properties of the dough and the bread are presented in Table 2. The average dough volume decreased as the concentration of defatted soy and banana composite flours increased with respect to proofing and fermentation period but the decrease was only significant at 20% level of substitution. The values decreased from 63.5cm3 for the control sample to 59.5cm^3 as the proportion of defatted soy and banana flours increased after 35min of fermentation and the rate of fermentation decreased from 1.87 – 1.66cm^3/min with increased defatted and banana composite flours. A similar trend was observed in the dough during proofing. The average dough volume varied between 93.5-83.5cm^3 after 90min of proofing. The proofing rate however decreased from 1.04- 0.84 cm^3/min. The result is in line with that of [26,27].

The loaf volume and specific loaf volume was observed to decrease significantly (P<0.05) as the proportion of defatted soy flour and banana flour increased from 5%- 20% . This could be due to reduction of the quantity of gluten in the dough with addition of composite flour resulting to less retention of carbon dioxide gas and a dense texture [28]. The gluten causes the dough to extend and trap the carbon dioxide produced by yeast during fermentation making the dough to be elastic and retain high volume. The loaf weight however increased significantly ($p<0.05$) with increased defatted soy and banana flours. The values ranged from 199.5g for the control sample to 213g at 20% substitution of both defatted and banana flour. The increase in loaf weight could be attributed to increased moisture absorption and decreased air entrapment, resulting in heavy dough and thus heavy loaves [26] . The bulky bread is also desirable by hungry consumers for its filling and satisfying characteristics [29].

2.7.3. Sensory Scores of Bread Loaves

Table 3. *Sensory properties of bread samples*

Parameters	samples					
	A	B	C	D	E	LSD
Texture	7.75^{a}	7.72^{a}	7.68^{a}	7.65^{a}	7.60^{a}	0.06
Taste	7.83^{a}	7.80^{a}	7.77^{a}	7.75^{a}	7.70^{a}	0.09
Crumb colour	7.43^{a}	7.42^{a}	7.39^{a}	7.30^{b}	7.18^{c}	0.04
Crust colour	8.92^{a}	8.33^{b}	8.08^{c}	7.83^{d}	7.60^{d}	0.72
Aroma	7.75^{a}	7.63^{b}	7.60^{c}	7.56^{c}	7.50^{c}	0.08
Overal acceptability	7.67^{a}	7.62^{a}	7.61^{a}	7.52^{a}	7.49^{a}	0.12

*Values in the same row with different superscript are significantly different at $P<0.05$
*Values are means ± standard deviation of duplicate determinations
*LSD = Least significant difference.
A= 100% wheat flour
B= 90% wheat flour+5%banana flour+ 5% defatted soy flour
C= 80% wheat flour+ 10%banana flour+10% defatted soy flour
D=70% wheat flour+ 15%banana flour+ 15% defatted soy flour
E=60% wheat flour+ 20% banana flour+20% defatted soy flour

3. Conclusion

This study has shown that bread of acceptable quality can be produced from composite flours of wheat, defatted soy and banana. The bread samples produced have increased nutrients of fibre, protein and ash contents which are all desirable for good health and wellbeing. The supplementation of up to 20% defatted soy flour and banana flour were well accepted therefore nutritious and acceptable bread can be produced. This would save a lot of foreign exchange used on wheat importation, reduced the cost of bread production and provide nutritious bread to combat malnutrition problems and enhanced food security.

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