Breakfast Meal from Breadfruit and Soybean Composite

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Abstract

Breadfruit, *Artocarpus altilis*, is a nutritious and high energy fruit which is low in protein. It is underutilized for food products due to its limited product diversity but has the potential to be formulated into certain desired products such as pastries, breakfast cereals and beverages that are highly consumed. Soybean, on the other hand, is one of the cheapest and most valuable sources of protein and can, therefore, be used to fortify low protein foods. This study investigated the quality and acceptability of breakfast meals produced from various breadfruit-soybean composite flours. Blends were formulated with a soybean substitution of 10%, 30%, 50%, 70%, and 90%. The proximate composition of the blends and the acceptability of the formulated products were determined. The results showed the blends to have crude protein content between 6.85-36.59%, crude fat content of 4.44-18.12%, carbohydrate content of 33.15-77.84%, ash content of 2.32-5.06%, and energy value of 378.72-442.04 Kcal/100g. The sensory analysis showed that the formulated products were acceptable with preference more tilted towards blends with higher soybean content.

Résumé

Artocarpus altilis ou châtaignier est un fruit nutritif avec une haute teneur en énergie mais avec un bas niveau de protéines. Le fruit est peu utilisé pour la fabrication d'une grande diversité de produits alimentaires, bien qu'il y ait lieu de l' incorporer dans quelques produits comme les pâtisseries, les céréales consommés au petit déjeuner et les boissons fortement consommées. Le soja d'autre part constitue l'une des sources meilleur marché de protéines et les plus importantes. Il peut donc être utilisé pour enrichir des aliments pauvres en protéines. Cette étude a évalué la qualité et l'acceptabilité des repas consommés au petit déjeuner et préparés à partir de divers mélanges de farines du châtaignier et de soja. Ces mélanges ont été faits en substituant le soja de 10%, 30%, 50%, 70%, et de 90%. La composition approximative des mélanges et l'acceptabilité des produits formulés ont été déterminées. Les résultats ont montré que ces mélanges avaient 6,85 - 36,59% de protéines brutes, 4,44-18,12% de graisse brutes, 33,15-77,84% d'hydrates de carbone, 2,32-5,06 de cendres et la valeur énergétique de 378.72-442.04 Kcal/100g. L'analyse organoleptique a prouvé que les produits formulés étaient acceptables avec une grande préférence pour les mélanges avec des teneurs plus élevées en soja.

Introduction

Most breakfast cereals produced in Ghana are made from maize which is deficient in lysine, an essential amino acid required for growth. Also, the seasonal nature of maize makes it expensive during some times of the year. Breadfruit, *Artocarpus altilis,* provides an alternative to maize and it has been used to feed malnourished children in Nigeria where an improvement was observed in their conditions without any adverse effects (Runsewe-Abiodun *et al*., 2001). The Breadfruit is a high carbohydrate source with a high energy value even though it is low in protein. One way of increasing the protein and mineral content of breadfruit is to fortify it with high protein and mineral sources such as meat, fish and legumes. Of all the protein sources, soybean serves as the most valuable and economic source (Osho and Dashiell, 1987). Waldroup and Smith (1989) reported that a great deal of research has been done in an attempt to partially replace traditional protein sources with soybean meal. However, the proportion of soybean protein directly consumed in human nutrition is still relatively small. Osho and Dashiell (1987) reported that soybean could play an important part in alleviating malnutrition in Africa.

Preliminary results from a survey indicates that the breadfruit - the seedless type and the one with seeds - is mostly used as snack with very little processing in Ghana. It is either cooked or roasted. Though it is used as snack, it is less regarded and therefore, its industry is not well developed. In most

of the regions, it serves as a source of income for children who gather it (Oduro and Ellis, 2004). Its potential could be enormous if the food utilization base is expanded. Breadfruit can indeed be processed into certain desired products such as pastries and breakfast cereals that are highly consumed. This study, thus, investigated the acceptability of breakfast meals produced from various breadfruit-soybean composite flours in order to encourage their utilization alongside other crops

Materials and Methods

The soybean (2kg) was obtained from Savannah Agricultural Research Institute (SARI), Nyankpala, and the breadfruit (10 fruits) was obtained from the campus of Kwame Nkrumah University of Science and Technology, Kumasi.

Preparation of breadfruit flour
Mature but unripe breadfruits were screened for insect infestation and physical defects. The fruits without any defects were peeled with a knife, cored, and the pulp sliced into chips which were dried in a solar dryer for three days. The dried breadfruit chips were then milled and sieved with a 75 micron mesh to obtain the flour.

Preparation of soybean flour
The soybeans were screened for stones, rot, and other physical defects. The beans without defects were then roasted under an open flame until they turned golden brown. The roasted beans was allowed to cool, milled and sieved with a 75 micron mesh to obtain the flour which was stored in a refrigerator prior to analysis.

Formulation of Blends
The soybean flour and breadfruit flour were mixed in different proportions to obtain five different blends which were used to prepare the breakfast meal. The composition of the different blends is shown in Table 1.

Table 1: Flour composition of blends

Blend	Breadfruit Flour (%)	Soybean Flour (%)
	0	100
	100	0
101	90	10
102	70	30
103	50	50
104	30	70
105	10	90
106	Control	-

Analyses
Proximate analysis was carried out on the soybean and breadfruit flours and the blends. The moisture content, percentage crude protein, crude fat, crude fiber and ash content were determined based on the Official methods of analysis (AOAC, 1990). Percentage carbohydrate was determined by difference (Kirk *et al*., 1981). The food energy level was determined by calculation using the Atwater factor.

Preparation of Ready-To-Serve Breakfast Meal
The composite flour was mixed with water, (about 500g flour to 250ml water) to form a condition composite flour. The conditioned flour was heat processed in an oven at 120 ºC for one hour after which it was allowed to cool and milled to obtain the ready-to-serve breakfast meal.

Sensory Evaluation
Sensory evaluation for the formulated breakfast meals was conducted by a thirty member untrained panel (mainly students) using a five point hedonic scale ranging from like very much (1), to dislike very much (5). The evaluated parameters were taste, color, flavor, mouth feel, after taste and overall acceptability. Rosamix (106), a breakfast cereal on the market was used as a control. It is made from groundnut, soybean, and maize. The samples were prepared for sensory by mixing 200g of the blends with 20g of sugar, 20g of whey milk, and 500ml of water and served to the panelists.

The data obtained was statistically analysed (correlations, variable clustering procedures and analysis of variance) using SAS program.

Results and Discussion

The results of the study is shown in Table 2. The moisture content of foods gives an indication of the shelf stability of the food. Nelson (1992) reported that moisture is used as a quality factor for prepared cereals which should have 3-8% moisture content. The moisture content of the blends ranged from 1.77% to 4.23%. Such low moisture content is required for convenient packaging and transport of products. The results showed that, the ash content of the blends increased with increasing addition of soybean flour. Sample 105 had the highest (5.06%) ash content while 101 had the lowest (2.32%). The high ash content is in accordance with the fact that fortified breakfast meals are a good source of micronutrient and macronutrient (Nicklas *et al*., 1993). The calcium and iron content of the soybean flour was greater than that of the breadfruit flour (Table 2). There was an

increase in the calcium and iron values of the blends as the soybean composition increased. The protein content of the various blends was high; increasing with increasing content of the soybean flour. Blend 101 had the lowest (6.85%) while 105 had the highest (36.59%), (Table 2). Nelson (1992) reported that in 1985, the FAO and WHO set the recommended intake level of the human adult at 0.75g/kg per day and this indicates that the blends would be appropriate for children whose weight ranges from 9.13kg to 48.79kg.The fat content of a food sample can affects its shelf stability. This is because fat can undergo oxidative deterioration, which leads to rancidification and spoilage. Hence a food sample with high fat content is more liable to spoilage than one with a lower fat content. The fat content of the blends increased with increasing content of the soybean flour; sample 101 had the lowest (4.4 %) while 105 had the highest (18.12) (Table 2). High intake of fat especially saturated fatty acid has been shown to increase the level of cholesterol in the blood but it can be altered by replacing a large part of the fat with fats containing high levels of unsaturated fats (Nelson, 1992). The crude fiber content of the blends increased with increasing amount of soybean flour, sample 105 had the highest (5.31%) while 101 had the lowest (4.32%) (Table 2). Adequate consumption of dietary fiber has been reported as being important for growth and the prevention of constipation (Nelson, 1992). The carbohydrate content of the blends decreased with increasing composition of soybean flour, 101 had the highest (77.84%) while 105 had the lowest (33.15%) (Table 2). It has been reported that cereals composed predominantly of carbohydrates are inexpensive sources of food energy (Nicklas *et al*., 1993). The blends, therefore, serves as an inexpensive source of carbohydrate and food energy. The energy values of the soybean and breadfruit flour were 463.34 and 369.86 Kcal/100g, respectively. There was, therefore, an increase in the energy value of the blends as the soybean composition increased.

Table 2: Nutritional composition of soybean, breadfruit, and composite flours

Sample	Moisture (%)	Ash (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)	Carbohy-drate (%)	Energy (Kcal/ 100g)	Fe mg/ 100g	Ca mg/100g
Soybean	0.94	5.05	40.46	22.02	5.70				
flour	(0.02)	(0.03)	(0.10)	(0.06)	(0.02)	(0.62)	463.34	42	426
Breadfruit	5.04	1.96	3.28	2.82	4.06				
flour	(0.05)	(0.03)	(0.02)	(0.04)	(0.05)	(0.86)	369.86	12	123
	4.23	2.32	6.85	4.44	4.32				
101	(0.026)	(0.148)	(0.148)	(0.163)	(0.045)	(1.61)	378.72	15.45	136.33
	3.84	3.51	15.54	7.32	4.52				
102	(0.113)	(0.665)	(0.170)	(0.049)	(0.021)	(0.92)	389.12	18.16	147.44
	2.58	3.80	20.99	11.24	4.98				
103	(0.127)	(0.021)	(0.219)	(0.156)	(0.021)	(0.06)	410.76	25.28	160.94
	2.05	4.33	30.21	14.99	5.12				
104	(0.092)	(0.156)	(0.028)	(0.064)	(0.028)	(0.13)	428.95	31.94	243.85
	1.77	5.06	36.59	18.12	5.31				
105	(0.035)	(0.035)	(0.085)	(0.134)	(0.028)	(0.26)	442.04	38.33	333.54
106	9.7	2.98	17.73	9	3.02	57.57	382.2		

Values are means of triplicate determinations, standard deviations are in parenthesis

The soybean flour had relatively high Fe and Ca content; thus, as the proportion of soybean increased in the blends, the level of these minerals increased.

Sensory Evaluation

The mean scores for taste showed that all the formulated blends were accepted (Table 3). Statistical analysis however indicated no significant ($p>0.05$) difference between the blends. Panelists' preference for taste was in the order 103, 102, 105, 104, and 101. Comparing the blends to the control, the blends were more preferred to the control. The results for mouth feel showed a significant ($p<0.05$) difference between the blends, though they were all accepted. The differences occurred between blends 101 and 102, 103 and 104, 105 and 106. There were also significant ($p<0.05$) differences between the blends, with respect to the aftertaste (Table 3). The 'aftertaste' mean scores show that the differences occurred between blend 101 and 103, 102 and 104, and 105 and 106. The differences observed can be attributed to the smell associated with the breadfruit flour. A significant difference was observed between blends with respect to product colour (Table 3). The difference observed was between products 101 and 106, and 102, 103, 104 and 105. Hence, for product colour, blends with low amount of soybean flour were more preferred. For product flavour, a significant difference was also observed between the blends. The difference occurred between products 101 and 105, 102, 103 and 104, and 106. For flavour the blends with low levels of breadfruit flour were more preferred relative to those with high levels of breadfruit flour.

Table 3: Preference Mean Scores for the Formulated breakfast Meal

Blend	Taste	After-taste	Mouth feel	Colour	Flavour
101	2.300	2.900	2.700	1.400	2.600
102	1.700	2.100	2.300	1.600	2.400
103	1.600	2.300	1.700	1.500	2.000
104	2.000	2.000	2.200	1.600	1.900
105	1.800	1.600	1.800	1.700	1.900
106	2.400	1.500	2.400	2.400	1.700
LSD (5%)	0.238	0.000	0.012	0.000	0.008

This can be attributed to the unpleasant characteristic smell associated with the breadfruit flour. The response for the overall acceptability (Figure 1) showed no significant ($p>0.05$) difference and had this order of preference 104 and 105, 102, 103, and 101. This implies that, for overall acceptance, with the exception of blend 102, preference was higher for those blends with higher levels of soybean flour relative to those with higher breadfruit flour. This may be as a result of the flavour the roasted soybean flour imparted to those blends.

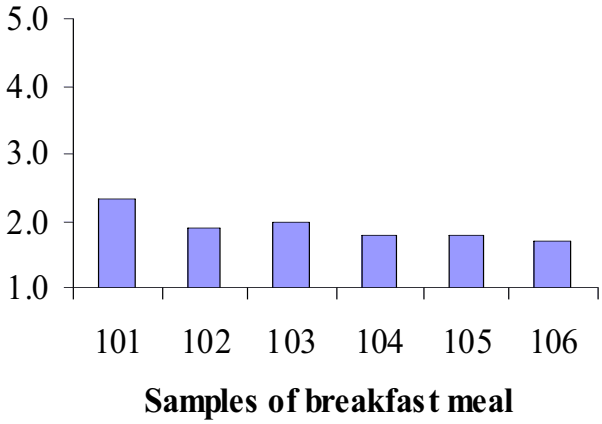

Figure 1: Mean score for the overall acceptability of breakfast meal

Correlation analysis of the nutritional data showed a negative relation between moisture and crude fiber, a positive relation between the ash, protein and the fat. These variables also had a positive relationship with carbohydrate as well as the energy. This is to be expected because carbohydrate content is determined by difference which is dependent on these variables. Energy levels are determined by the fat, protein and carbohydrate contents of the samples; thus, the relationship between these variables and energy.

Correlation between the sensory attributes indicated a positive relation between mouth feel and taste; also, between aftertaste and flavour.

Conclusion

The study shows that formulation of breakfast meal from soybean and breadfruit with varying characteristics can be produced, thus providing an alternate use for the breadfruit. Also, the addition of soybean flour in different proportion to breadfruit enhances the nutritional quality of the blends. It can be concluded from the sensory analyses that, the formulated products can compete with already existing breakfast meals on the market.

Acknowledgement

The authors would like to thank the African Forest Research Network (AFORNET) for providing financial support for this work.

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