Effect of Blending on the Composition and Acceptability of Blends of Unripe Banana and Pigeon Pea Flours

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Effect of Blending on the Composition and Acceptability of Blends of Unripe Banana and Pigeon Pea Flours

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ABSTRACT

Proximate composition, amino acid profile, trace minerals, functional properties and organoleptic evaluation of blends of unripe banana and pigeon pea flours were studied. The proximate composition of the blends showed that addition of pigeon pea significantly ($p < 0.05$) increased the protein from 2.40 – 14.48 $\pm^{0.11}$. Similarly, the ash, fat and crude fibre increased while carbohydrate content significantly decreased from 79.86 – 55.00 $\pm^{0.47}$. The amino acid profile showed that addition of pigeon pea up to 37.5% levels resulted in increase in all amino acids evaluated. The blend amino acid status was adequate for adult nutrition when compared to the FAO recommendations. However the blend was found deficient in lysine, leucine, iso-leucine and phenylalanine when compared with the FAO recommendations for infants. Increased levels of pigeon pea in the blend also resulted in significant increases in potassium, phosphorus, sodium, magnesium and calcium. Similarly, increased levels of pigeon pea in the blend significantly increased the gelation concentration and foaming capacities while the bulk density, water absorption and oil absorption capacities significantly ($p > 0.05$) decreased. The results showed that blending of pigeon pea with unripe plantain would produce meals of balanced nutrient densities for adults.

Keywords: Pigeon pea, unripe banana, blending, nutrients, acceptability.

Introduction

According to Ifeoma *et al.* (2010), most traditional African weaning foods are inadequate in energy and protein which has been a major cause of protein energy malnutrition in pre-school children. The situation has been worsened in recent years by the economic downturn with a substantial proportion of the population living below the poverty line. Weaning food should be given to the baby at about the age of four to six months since they grow faster at about this age and need extra food in addition to breast milk (Sani *et al.* 1999).

This weaning period (from around 4 – 6 months until 2 years of age) is a critical period of a child's life when it is mostly at risk from malnutrition and disease.

Emphasis has been placed on the use of nutritious 'locally' produced foods such as beans, lentils and edible fish varieties to enrich the starchy foods. Locally produced beans *(Phaseolus vulgaris)* have particularly been targeted because they are inexpensive, readily available and contain high amount of protein with high level of lysine which can complement the low lysine in cereals. However, there are several other legumes whose utilization is still very low though their potential is high. Among them is pigeon pea.

Pigeon Pea (*Cajanus cajan*) is a member of the papilonoidaceae (*leguminaceace*), a deep rooted drought resistant perennial shrub grown throughout the world under different climatic and cultural conditions (Troedson *et al*, 1990; Akinola, *et al.*, 1975). In Nigeria, the plant has been listed as one of the under-utilized legumes with broad potentials (Badifu, 1992). Although India remains the major

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producer of pigeon pea, the resurgence of interest in the crop in other parts of the world including Nigeria is as a result of unfolding nutritional, medicinal, economic and agronomic usefulness of the crop (Nyalor *et al.*, 2004).

Several clinical studies have shown the potential of pigeon pea seed based meal in the dietary management of diabetes mellitus and cardiovascular disease (Ekeke and Shode, 1990). According to these authors, the oil also contains anti-sickling agent. This claim was further supported by the work of Iwu *et al.* (2002) in which seed extract of *Cajanus cajan* was observed to reverse sickling of the erythrocytes. In Nigeria, the seed flour of the plant has recently been exploited for biscuit making (Eneche, 1999). According to Amaefule and Obioha (2001), pigeon pea is limited presently in its use because it takes longer to cook and is not as palatable as cowpea. Nutritionally however, it contains about 17 – 30% protein which recommends it for weaning and complementation purposes (Onu and Okongwu, 2006).

Banana is an important crop in the tropical and subtropical regions of the world (Gallant *et al.*, 1995). The fruit is either consumed ripe, due to it, high sugar content, or unripe in several indigenous dishes requiring high starch content. In Mexico and other Latin American countries, banana is mainly consumed ripe. For this reason, large quantities of the fruit are lost during commercialization as a consequence of deficient post-harvest handling. New economical strategies are now considered for banana use, such as the production of banana flour when the fruit is unripe. Several studies have suggested that consumption of unripe bananas confers beneficial effect on human health, a fact often associated with its high resistance starch (RS) content, which ranges between 47% and 57% (Gallant *et al.*, 1995). Recently, the preparation of unripe banana flour was described, with 73.4% total starch content, 17.5% resistant starch content and dietary fibre level of 14.5% (Jurez Garcia *et al.*, 2006). Additionally, unripe banana flour might be an important source of polyphenols; compounds that are regarded as natural antioxidants, hence conferring a functional food status on banana.

It is therefore envisaged that blending unripe banana and pigeon pea flours will produce meals of balanced nutrient densities for both infant and adult nutrition. This work was undertaken to evaluate the nutrient composition of blends of unripe banana and pigeon pea flours. It also assessed the physicochemical, functional and organoleptic quality of the blends.

Materials and Methods

Green unripe but fully matured banana bunches and pigeon pea *(Cajanus cajan)* seeds used for this study were bought from the Minna Central Market, Niger state, Nigeria.

Processing of the samples

Unripe banana (1.2 kg) was cleaned and banana flour was produced from unripe banana fruit according to the method reported by Adeniji *et al.* (2008). Banana fingers were washed, peeled and sliced to about 5 mm thickness using a kitchen knife. The sliced banana was steam blanched with sodium bisulphate ($NaHSO_3$) for 5 min. The pulp was drained and dried for 7 days after which it was milled into flour using an attrition mill. The flour was screened through a 2 mm sieve mesh.

The pigeon pea seeds (1 kg) were sorted and then soaked in cold water for 48 h and then washed according to the traditional processing method. Water was drained off and the seeds were dried about 48 h. The dried seeds were later milled using an attrition mill and sieved to pass through a 2 mm sieve mesh. The sieved flour samples were blended with unripe banana according to Anuonye (2006) (Figure 1).

Proximate analysis

The moisture, the crude protein, the fat, the ash, the fibre and carbohydrate contents were determined as described by AOAC (2000). The minerals (calcium and magnesium) were evaluated using an Atomic Absorption Spectrophotometer AAS (Buck 210 vgp Germany) while sodium and potassium were determined using a flame photometer as described in AOAC (2000).

The amino acid profile of the blends was determined using a using sequential multi-analyser technicon (TSM-1 model DNA 0209) auto analyser according to the methods of Sparkman *et al.* (1958). The amino acid determination was on the sample that had the best overall acceptability.

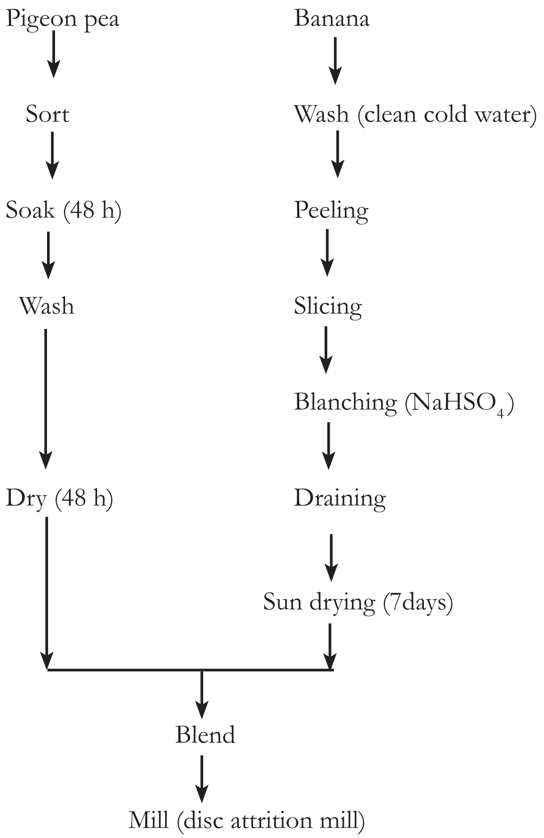

Fig. 1: Flow chart for the preparation of blends of unripe banana and pigeon pea

Functional properties

The water absorption capacity (WAC) was determined using the method of Sosulski *et al.* (1976).

Water and oil absorption capacities, the bulk density and foaming capacity were determined by the methods of Okezie and Bello (1988) while emulsion capacity was evaluated following the reports of Yatsumatsu *et al.* (1997). The method of Coffman (1979) was used to determine the least gelation concentration.

Sensory evaluation of the blends

Unripe banana and pigeon blends were made into semi-solid gels by adding boiling water at 100^{o}C and stirring till the pasty mixture became firm. The colour, texture, taste, appearance and overall acceptability were rated by twenty trained judges as described by Ihekoronye and Ngoddy (1985). The samples were evaluated on a 9-point hedonic scale where 1 represented disliked extremely and 9 liked extremely. The assessment was carried out at the testing booth of the National Cereals Research Institute, Baddeggi, Niger State, Nigeria. The panel members consisted of research scientist's technical staff, housewives, students and labourers familiar with the crops. Samples were presented in white plastic cups. The order of presentation of the samples was randomized. Clean tap water was provided for the judges to rinse their mouths in-between evaluations.

Results and Discussion

The results showed that the proximate compositions of the formulae were influenced by addition of pigeon pea flour (Table 1). Protein, fat energy, etc. increased significantly ($p < 0.05$). These increases were expected as several authors (Anuonye) 2006; Iwe, 2003 and Obatolu, 2002 have reported the improvement of proximate parameters with substitution of legumes.

The fat content of the blends also increased significantly ($p < 0.05$) when compared to sole unripe banana flour. This was also expected as a general trend in literature following complementation. A significant decrease in carbohydrate content was observed following addition of pigeon pea flour. The decrease which is due to increase in the protein and fat contents is indicative of modification in the sample's nutritional composition.

Amino acid profile of unripe banana and pigeon pea

The amino acid profile of mixtures of unripe banana and pigeon pea (62.5: 37.5%) is presented in Table 2. The results obtained showed that the pigeon pea amino acid profile was significantly ($p < 0.05$) different from those of unripe banana and the mixtures from it. This was expected since pigeon pea is a legume. The results showed that mixing pigeon pea flour with unripe banana flour improved significantly ($p < 0.05$) the amino acid profile of the blend. The composition of the resulting blend met the FAO standard (1970) for infant and adult nutrition with the exception of lysine, leucine and isoleucine, phenylalanine and histidine. The results were however at variance with the earlier report of Singh *et al.* (1981). The differences may be due to the pigeon pea varieties used as influenced by environmental and other agronomic factors.

Table 1: Proximate composition of unripe banana/pigeon pea blends

Samples	Parameters Evaluated					
	Pr (%)	**Fat (%)**	**Fibre (%)**	**Ash (%)**	**Moisture (%)**	**Cho (%)**
A	2.40 ± 0.30^{e}	0.34 ± 0.00^{e}	6.00 ± 0.40^{e}	4.40 ± 0.10^{e}	6.00 ± 0.01^{e}	79.86 ± 1.37^{e}
B	6.60 ± 0.31^{d}	0.68 ± 0.02^{d}	6.80 ± 0.42^{d}	5.40 ± 0.03^{d}	7.90 ± 0.14^{d}	$72.82 \pm 0.1.10^{d}$
C	11.00 ± 0.34^{c}	1.10 ± 0.00^{c}	7.80 ± 0.48^{c}	6.80 ± 0.10^{c}	9.90 ± 0.02^{c}	$63.40 \pm 0.0.72^{c}$
D	11.80 ± 0.34^{b}	1.20 ± 0.03^{b}	8.048 ± 0.48^{b}	7.00 ± 0.11^{b}	10.40 ± 0.21^{b}	61.60 ± 0.60^{c}
E	14.80 ± 0.34^{a}	1.50 ± 0.04^{a}	8.80 ± 0.50^{a}	8.00 ± 0.15^{a}	11.90 ± 0.24^{a}	55.00 ± 0.47^{c}

Values are means of three determinations

Values with the same superscript in the same column are not significantly ($p < 0.05$) different.

A = 100:0% (unripe banana/pigeon pea flour)
B = 87.5 = 12.5% (unripe banana/pigeon pea flour)
C = 75:25%(unripe banana/pigeon pea flour)
D = 62.5:37.5% (unripe banana/pigeon pea flour)
E = 50:50% (unripe banana/pigeon pea flour)

Functional properties of the blends

The result of the functionality of the mixtures of unripe banana and pigeon pea flours is shown in (Table 3).

Increased levels of pigeon pea substitution led to decreases in the water and oil absorption capacities of the blends. This might be due to preponderance of hydrophilic chains in the protein moieties of the mixtures resulting in reduced water affinity.

Similar observation, were reported by Okezie and Bello (1988). The gelation strength could be as a result of high soluble protein which gives a great intermolecular contact during heating, hence a good material for infant food formulation.

The values obtained were similar to those reported for mucuna bean protein isolate (14% to 20%) by Udensi *et al.* (2001).

However, there were significant differences ($p < 0.05$) in least gelation concentration among flour samples. This variation might be related to the protein and carbohydrate type and levels in the samples. Sathe and Salunkhe (1981) showed that gelation is not only a function of quantity of protein but the type of protein as well as its non-protein component. The results indicated possible interactions of starch with protein leading to increase in gelation. A similar observation was reported by Pawar and Ingle (1988) and Wilton *et al.* (1997). According to Udensi *et al.* (2001), gelation influences the texture of foods such as *moin-moin*, *agidi* and soup and convalescent gruels.

Table 2: Amino acid profile of unripe banana/pigeon pea flours/blend compared to FAO recommendation (1970)

	Samples evaluated				
Amino acid	**Unripe banana**	**Pigeon pea**	**Blend (65.5: 37.5)**	**FAO (Child)**	**FAO (Adult)**
Lysine	1.40	6.87	3.09	5.50	2.40
Histidine	0.60	3.35	1.32	5.50	2.00
Arginine	1.70	6.47	2.98	–	–
Aspartic acid	2.47	8.90	5.59	–	–
Threonine	0.94	3.22	1.19	4.00	0.70
Serine	2.37	2.91	2.37	–	–
Glutamic acid	5.09	15.17	8.93	–	–
Proline	2.34	3.40	2.34	–	–
Glycine	1.51	3.65	2.14	–	–
Alanine	2.30	4.32	2.90	–	–
Cystine	0.26	1.26	0.66	5.50	5.50
Valine	1.70	5.49	2.59	1.00	2.00
Methionine	0.36	1.38	0.73	5.50	2.40
Isoleucine	0.80	3.70	0.88	4.00	2.00
Leucine	0.36	7.50	5.55	7.00	2.80
Tyrosine	2.25	2.25	2.09	5.50	5.50
Phenylalanine	0.42	8.45	6.76	5.50	5.50

Table 3: Functional properties of unripe banana/pigeon pea flours and blends

Samples	Functional parameters measured				
	BD(g/cm3)	**FC (%)**	**WAC(g/sample)**	**OAC(g/sample %)**	**EC (m/oil/g %)**
A	0.68 ± 0.00^{a}	0.00 ± 0.00^{a}	6.96 ± 0.15^{e}	2.14 ± 0.03^{a}	20.25 ± 0.95^{a}
B	0.63 ± 0.00^{a}	0.50 ± 0.00^{b}	5.95 ± 0.01^{d}	1.67 ± 0.01^{d}	19.50 ± 0.98^{b}
C	0.65 ± 0.00^{a}	1.00 ± 0.00^{c}	4.72 ± 0.23^{c}	1.75 ± 0.01^{c}	18.63 ± 0.23^{c}
D	0.60 ± 0.00^{a}	1.50 ± 0.03^{d}	3.60 ± 0.11^{b}	1.82 ± 0.01^{b}	17.48 ± 0.11^{d}
E	0.60 ± 0.00^{a}	2.00 ± 0.02^{e}	2.60 ± 0.00^{a}	1.89 ± 0.01^{b}	16.40 ± 0.08^{e}

Values are means of three determination

Values with the same superscript in the same column are not significantly($p < 0.05$) different

KEY:

A = 100:0%(unripe banana/pigeon pea flour)

B = 87.5 = 12.5% (unripe banana/pigeon pea flour)

C = 75: 25% (unripe banana/pigeon pea flour)

D = 62.5: 37.5% (unripe banana/pigeon pea flour)

E = 50: 50% (unripe banana/pigeon pea flour)

Table 4: Gellation concentration profile of unripe banana and pigeon pea flour blends

Conc. Levels (%)	Samples				
	A	**B**	**C**	**D**	**E**
2	–	–	–	–	–
4	–	–	–	–	Gelled
6	–	–	–	Gelled	Gelled
8	–	–	Gelled	”	”
10	–	Gelled	”	”	”
12	Gelled	”	”	”	”
14	”	”	”	”	”
16	”	”	”	”	”
18	”	”	”	”	”
20	”	”	”	”	”

Values are means of three determination

Values with the same superscript in the same column are not significantly ($p < 0.05$) different

A = 100:0% (unripe banana/pigeon pea flour)

B = 87.5: 12.5% (unripe banana/pigeon pea flour)

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D = 62.5: 37.5% (unripe banana/pigeon pea flour)

E = 50: 50% (unripe banana/pigeon pea flour)

Sensory evaluation of formulations

The result obtained in Table 5 showed that the organoleptic ratings of the fortified blends were higher in terms of colour and taste. The 63.5: 37.5% formulation was more preferred to other samples confirming the earlier report of Anuonye *et al.* (2007). that legumes could be substituted in meals up to 37.5%. The results showed that acceptability increased with increase in pigeon pea substitution. Even at 50% levels of substitution the results did not show a development of objectionable taste and aroma as panelist ratings were over 50% and about 80% overall acceptability.

Table 5: Mean sensory scores of samples

Samples	**Parameters measured**				
	Appearance	**Taste**	**Aroma**	**Colour**	**Overall acceptability**
A	3.40[d]	3.70[c]	4.10[b]	5.70[b]	5.90c
B	4.40[c]	4.70[b]	4.30[b]	5.90[b]	6.60[b]
C	4.80[c]	6.40[a]	4.40[b]	5.90[b]	6.70
D	6.70[a]	6.80[a]	5.90[a]	7.30[a]	7.80[a]
E	5.70[b]	6.30[a]	6.10[a]	5.90[b]	

Values are means of three determinations

Values with the same superscript in the same column are not significantly ($p < 0.05$) different

A = 100: 0% (unripe banana/pigeon pea flour)

B = 87.5 = 12.5% (unripe banana/pigeon pea flour)

C = 75: 25% (unripe banana/pigeon pea flour)

D = 62.5: 37.5% (unripe banana/pigeon pea flour)

E = 50: 50% (unripe banana/pigeon pea flour)

Conclusion

Pigeon pea flour added to unripe banana flour improved the physiochemical properties, functional and nutritional quality of the blend. It also improved the appearance and acceptability of the blends. It is concluded that acceptable convenient meal for infants and adults could be developed from mixtures of unripe banana and pigeon pea. Blends of 62.5/37.5% gave the test colour appeal. It is recommended that unripe banana should be blended with 37.5% pigeon pea flour for optimum acceptability. The amino acids of the blends did not meet the FAO recommendations for infant nutrition. Investigation of the effect of processing on nutritional status is the subject of an ongoing research.

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