African Journal of Biotechnology Vol. 6 (6), pp. 799-802, 19 March 2007
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2007 Academic Journals

Full Length Research Paper

Effects of cowpea fortification and the level of ripeness of plantain on the nutritive value of plantain based snack foods

Ann Nancy Etsey, Esther Sakyi-Dawson, Samuel Sefa-Dedeh, Emmanuel Ohene Afoakwa, Kwaku Tano-Debrah and George Amponsah Annor *

Department of Nutrition and Food Science, University of Ghana, P. O. Box LG 134, Legon-Accra, Ghana.

Accepted 7 March, 2006

To investigate effects of cowpea addition and level of ripeness of plantain on the nutritional and sensory characteristics of *Kaklo* and *Ofam* in Ghana, A 2X4 factorial experiment with firm and soft ripe plantain and cowpea fortification of 0, 10, 20 and 30% was designed. The proximate composition and acceptability of products using a 7-point hedonic scale were evaluated. With the addition of 30% cowpea, the protein content of the *Kaklo* from the firm ripe and soft ripe plantain increased from 2.92% to 7.32% and 3.65% to 8.05% respectively, whilst the protein of the *Ofam* from the firm and soft ripe plantain also increased from 3.80% to 8.45% and 3.75% to 8.15% respectively. The 10% fortified *Kaklo* and O*fam* were the most acceptable. The cowpea addition significantly affected the nutritional value of the *Kaklo* and O*fam*. To obtain an acceptable cowpea fortified plantain-based snack, the fortification should be done at 10%.

Key words: Cowpea, fortification, level of ripeness, plantain-based snacks.

INTRODUCTION

The use of cowpea in fortifying plantain mix is important for the following reasons; they make substantial contribution to the energy needs, they are used as a major dietary protein source (FOA, 1996) and a source of vitamins and minerals in the plantain product.

Plantain (*Musa paradisica*) forms part of the staple foods in Ghanaian market. The ripe plantain, apart from it being boiled and eaten as a main meal, it can also be used in preparing a great number of snacks, which could be baked, fried in oil or drum dried to get flaked products. Example of baked product is *Ofam*, which is a mix of pounded over ripe plantain with a binder in the firm of wheat flour, maize dough, rice, flour, etc, mixed together with ginger, pepper, onions, salt and palm oil. Examples of fried products include *Kelewele*, *Tatale* and *Kaklo*. Both *Tatale* and *Kaklo* uses the same recipes as *Ofam* but is fried with vegetable oil. *Tatale* is shallow fried whereas *Kaklo* is deep fried. These snacks are sold at the roadside as convenient foods.

*Corresponding author. E-mail: gannor@ug.edu.gh. Tel: +233243509215.

Snacking is a passion and snack foods are sold everywhere; from prisons to big supermarkets and may be eaten at every mealtime as well as in-between meals. (Hollingsworth, 1995). A snack should be balanced nutritionally, should provide quick energy, should be easy to eat, and should be of great taste. One requirement transcends all others, and is that, a snack should be perceived as healthy.

In spite of all the benefits derived from the use of plantain, the protein content of plantain is 2.20% (FOA/WHO, 1973). Since plantain is a staple food crop in Ghana, enhancing its nutritional value will be of great importance in promoting better nutrition through the food we eat. The objective of this study is therefore to investigate the influence of the addition of cowpea and the level of ripeness of plantain on the nutritional and sensory characteristics of *Kaklo* and *Ofam* which are popular plantain snacks in Ghana.

MATERIALS AND METHODS

Materials

Cowpea (*Vigna unguiculata*) and unripe mature plantain (*Musa*

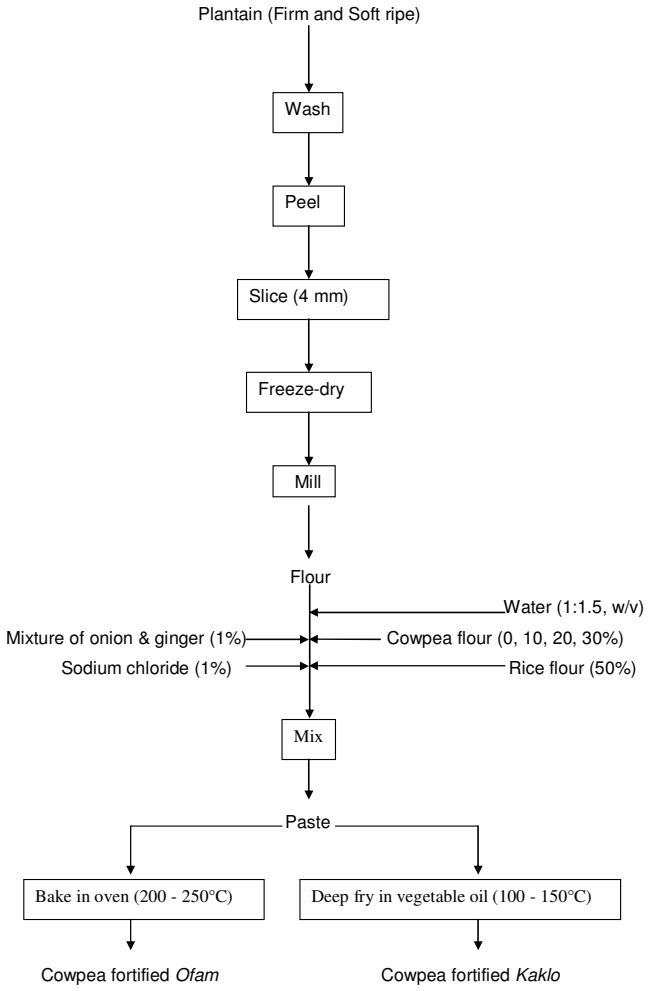

Figure 1. Preparation of cowpea fortified *Kaklo* and *Ofam*.

paradisica, var*. apentupa*) were obtained from a local market in Accra, Ghana and used for the study. Vegetable oil, onions, ginger, rice flour, and salts were also purchased from the market.

Cowpea flour preparation

Cowpea flour was prepared by soaking in water for 5 min and at room temperature (27°C), oven dried at 55°C for 5 h and dehulled using the disc attrition mill (Agrico Model 2A, New Delhi). The hulls were separated from the cotyledons using the Amalco seed blower. The cotyledons were then milled into flour using the hammer mill (Christy and Morris ltd, England) with a mesh number 4. The cowpea flour was then bagged in polyethylene bags and kept in cold storage (4°C).The cowpea flours was used to fortify the plantain snack food at 10, 20 and 30%.

Preparation of cowpea fortified *Kaklo* and *Ofam*

The method used in the preparation of the cowpea fortified *Kaklo* and *Ofam* is outlined by the flow diagram shown in Figure 1. The products were then dried at 55°C for 16 h and milled with a hammer mill and bagged in polyethylene bags and kept in cold storage (4°C).

Determination of level of ripeness of plantain

The plantains obtain from the market were kept at room temperature (27°C) in a jute sack to initiate ripening. The TA.XT2 Texture analyser was used to determine the force needed to cut through the plantain of the plantain samples at 108 and 132 h, respectively, and grouped into firm and soft ripe.

Proximate composition

The moisture, crude protein (N x 6.25), fat, fibre, and ash contents were determined by Association of Official Analytical Chemists Approved methods (AOAC, 1990).

Sensory analysis

Twenty-four untrained panellists were randomly selected and asked to indicate their degree of acceptability of the product by scoring on a 7-point hedonic scale. The quality attributes scored were taste, texture, colour, flavour and overall acceptability. 1 was ranked “like extremely” whilst 7 was “dislike extremely”.

Statistical analyses

The data obtained from the analyses were statistically analyzed using Statgraphics (Graphics Software System, STCC, Inc. U.S.A). Comparisons between sample treatments and the indices were done using analysis of variance (ANOVA) with a probability $p \leq 0.05$.

RESULTS AND DISCUSSION

Determination of level of ripeness

It was observed that the peak forces needed to cut through the plantain samples decreased with increasing level of ripeness. Firm ripe had an average peak force of 1403.42 g/s whist the soft ripe had 1187.88 g/s.The decrease in the peak forces may be due to an increase in the moisture content in the pulp due to respiratory breakdown of starch and osmotic movement of water from the peel to the pulp during ripening (Loesecke, 1950). Hence minimum force was needed to cut through a slice of very soft ripe plantain as compared to firm ripe. It was observed that the level of ripeness had significant effects ($p \leq 0.05$) on the average peak force of the samples.

Proximate composition

The proximate composition of the cowpea fortified *Kaklo* and Ofam from the firm and soft ripe plantain is Tables 1 and 2. The protein content of the *Kaklo* from the firm ripe plantain increased from 2.92 to 7.32% with addition of 30% cowpea, while that of the *Kaklo* from soft ripe plantain increased from 3.65 to 8.05%. The protein content of the *Ofam* from the firm ripe plantain increased from 3.80 to 8.45% with addition of 30% cowpea, the *Ofam* from soft ripe plantain increased from 3.65 to 8.05%. This increase in protein contents of the products was significant ($p \leq 0.05$). The significant increase in the protein contents of the products can be attributed to the relatively

Table 1. Proximate Composition of fortified and unfortified *Kaklo*.

Level of ripeness of plantain	Cowpea fortification (%)	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)
Firm Ripe	0	5.40	2.92	0.71	2.45	1.33
	10	6.22	6.01	0.93	2.52	2.16
	20	6.17	6.97	0.41	2.56	3.60
	30	5.80	7.32	2.01	2.98	4.02
Soft Ripe	0	5.90	3.65	0.78	3.05	1.98
	10	6.95	6.72	1.05	2.96	2.96
	20	6.69	7.95	0.56	2.95	4.26
	30	6.40	8.05	2.52	4.08	4.95

Table 2. Proximate Composition of fortified and unfortified *Ofam*.

Level of ripeness of plantain	Cowpea fortification (%)	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)
Firm Ripe	0	6.01	3.80	0.85	3.15	1.58
	10	7.05	6.83	1.15	2.98	2.82
	20	6.95	8.05	0.63	2.96	4.15
	30	6.65	8.45	2.75	4.15	4.77
Soft Ripe	0	5.96	3.75	0.79	3.08	2.08
	10	6.99	6.75	1.07	2.99	2.96
	20	6.79	7.99	0.58	2.97	4.26
	30	6.50	8.15	2.53	4.18	4.98

Table 3. Rank Sums for sensory qualities of *Kaklo*.

Level of ripeness of plantain	Cowpea fortification (%)	Rank sums				
		Colour	Flavour	Sweetness	Softness	Overall acceptability
Firm Ripe	10	77 [a]	85 [a]	70 [a]	60 [a]	66
	20	94 [a]	74 [a]	75 [a]	65 [a]	80 [b]
	30	91 [a]	95 [a]	99 [a]	75 [a]	100 [c]
Soft Ripe	10	88 [a]	87 [a]	70 [a]	74 [a]	73 [a]
	20	79 [a]	94 [a]	108 [b]	129 [b]	105 [b]
	30	85 [a]	85 [a]	102 [b]	125 [b]	124 [c]

Rank sums followed by the same letter are not significantly different at $p<0.05$.

high protein content of cowpeas. In addition to the high protein content of cowpeas, it has also been reported by Rachie (1972) that cowpea has a net protein utilization of 53.3%, making cowpeas one of the best sources of plant protein, which can be used as a replacement to expensive sources of proteins like meat and poultry. Fortification of plantain based snacks will therefore go a long way to help alleviate malnutrition in Ghana, since plantain is a staple food and consumed throughout the year by a large proportion of the population at risk. It was also observed that there were increases in the protein contents of the products with respect to the two levels of ripeness of the plantains. The protein contents of the products of the soft ripe plantain had relatively higher protein content than that of the firm ripe plantain.

The *Kaklo from* the soft ripe plantain had its protein content increased from 3.65 to 8.05% with the addition of 30% cowpea. The ash and fibre contents of the *Ofam* from the firm ripe plantain increased from 3.15 to 4.15% and 1.58 to 4.77%, respectively, with the addition of 30% cowpea. The *Ofam* from the soft ripe plantain had its protein content increased from 3.75 to 8.15%with the addition of 30% of cowpea.

Sensory analysis

The rank sums for hedonic rankings for the *Kaklo* and *Ofam* from the firm and soft ripe plantains are shown in Tables 3 and 4. Even though there were no significant di-

Table 4. Rank Sums for sensory qualities of *Ofam*.

Level of ripeness of plantain	Cowpea fortification (%)	Rank sums				
		Colour	Flavour	Sweetness	Softness	Overall acceptability
Firm Ripe	10	73[a]	81[a]	66[a]	77[a]	58[a]
	20	83[a]	88[a]	86[a]	76[a]	77[b]
	30	98[a]	86[a]	86[a]	109[a]	120[c]
Soft Ripe	10	74[a]	70[a]	89[a]	64[b]	54[a]
	20	86[a]	94[a]	79[a]	101[c]	71[b]
	30	101[a]	94[a]	103[a]	107[c]	128[c]

Rank sums followed by the same letter are not significantly different at $p<0.05$.

ferences in the colour and flavour of the cowpea fortified, *Kaklo from* both firm and soft ripe plantain, the colour of the 10% cowpea fortified *Kaklo* from the firm ripe plantain was preferred. The flavour of the 30% cowpea fortified *Kaklo* from the firm ripe plantain was the least preferred, probably because of the strong beany flavour. Significant differences ($p\leq0.05$) were observed in the sweetness and softness of the 20% and 30% cowpea fortified *Kaklo* from the rest of the samples. The sweetness and softness of the 20% cowpea fortified *Kaklo* from the soft ripe plantain was the least preferred. The 10% cowpea fortified *Kaklo* from the firm ripe plantain was the most acceptable followed by the 10% cowpea fortified *Kaklo* from the firm ripe. This is an indication that to get an acceptable cowpea fortified *Kaklo*, the level of fortification should be 10%. The colour and sweetness of the 10% cowpea fortified *Ofam* were the most preferred. The differences observed in the colour, flavour, and the softness of the cowpea fortified *Ofam* from both firm and soft plantain were not significant. The colour and sweetness of the 30% cowpea fortified *Ofam* from the soft ripe plantain were the least preferred. The softness of the 10% cowpea fortified *Ofam* from the soft ripe plantain was the most preferred followed by the 10% cowpea fortified Ofam from the firm ripe plantain. Significant differences were observed in the softness of the cowpea fortified *Ofam* products from the firm ripe and soft ripe plantain. The 10% cowpea fortified *Ofam* from the soft ripe plantain was the most acceptable with the 30% cowpea fortified *Ofam* from the soft ripe plantain the least acceptable.

Conclusion

The addition of cowpea was able to increase the protein content of the plantain based snacks. This gives an indication that cowpea can be effectively used in improving the nutritional value of plantain based snacks. The level of ripeness of the plantain also influenced the nutritional and sensory characteristics of the plantain based snack foods. The fortification of *Kaklo* and *Ofam* with 10% cowpea resulted in very acceptable products. It can therefore be concluded that to obtain an acceptable cowpea fortified plantain-based snack, the fortification should be done at 10%.

ACKNOWLEDGEMENT

This study was funded through the Bean-Cowpea Collaborative Research Support Program by the United States Agency for International Development - Grant No. GOG-G-00-02-00012-00

REFERENCES

AOAC (1990). "Official methods of analysis", 15th Ed. Association of Official Analytical Chemists, Washington DC.
FAO (1996). Food Balance Sheet Average. (1992-1994).
FAO/WHO (1973). FAO Nutritional Meeting Report Series S2. WHO Technical Report Series S2, Energy and Protein Requirements.
Hollingsworth P (1995), Snack Foods: Food Technol. J. pp. 58-65.
Loesecke HW (1950). Banana Chemistry, Physiol. Technol., New York, Interscience Publishers.
Rachie KO (1972). Improvement of Food Legumes in Tropical Africa. Proceedings of a Symposium sponsored by PAG, 3-5 July. FAO, Rome Italy.