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PROXIMATE COMPOSITION AND FUNCTIONAL PROPERTIES OF RAW AND PROCESSED (STEEPED, BOILED AND ROASTED) PLANTAIN (MUSA PARADISIACA) FLOUR.

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ABSTRACT

Moisture content, proximate composition and some functional properties (Water binding and Oil absorption capacities, pH and amylose content) of raw, steeped, boiled and roasted plantain (Musa paradisiacal) flours were analyzed. Results showed that properties like protein, pH and crude fibre content decreased remarkably with steeping time. For instance, protein content decreased from 1.43 to 1.17 percent while crude fibre content decreased from 0.48 to 0.35 percent. A decrease of 33.3 percent in crude fibre was observed due to boiling. Over a 100 percent increase was observed in the water binding capacity of the boiled sampled. Water binding capacity was affected in the order boiled > roasted > steeped > control. No significant change was observed for oil absorption capacity of the processed samples when compared with increase observed in water binding capacity.

Key Words: Plantain, proximate composition, functional properties and processing

INTRODUCTION

Plantain is possibly the most outstanding example of a neglected food crop because the proportion of research resources allocated to it falls far below its relative importance in the diet. One of the reasons for the neglect of plantain by researchers is its close relationship to banana which has received more attention earlier and the common but erroneous believe that plantains and bananas are similar in physiological patterns; Wilson, (1986). In recent times there has been reports on the nutritive properties of plantain, however information is lacking on the effects of the different processing methods on the proximate composition and functional properties of plantain.

Plantains are known to have an advantage over other starchy staple foods like yam, cassava or cocoyam where labour is an important factor of production as a result of its high energy returns per unit of labour. Therefore they are sources of the cheapest carbohydrate foods in terms of cost per hectare, per tonne and per calorie (Obazt, 19%).

Nutritionally, plantain is a good source of carbohydrate and is also rich in pro-vitamin *A* (carotene). Gastro intestinal disorders like diarrhea and vomiting can be treated with plantain. Plantain is also used as a carbohydrate source for diabetic patients. Water extracts of the roasted peel of plantain is used by the Efiks in Cross River S[illegible] of Nigeria in place of 'akang' as a tenderizer of fluted pumpkin leaves during the cooking of the popular 'Otong' *(Okro/pumpkin* soup). Roasted peel and stalk of plantain are also used for washing pots, pans and cutlery. Plantain leaves are used by some communities as wrappers for food. In the Cross River State of Nigeria the Efiks use plantain leaves as wrappers for 'ekoki' (grated corn meal) and 'ayan ekpang' (grated cocoyam meal).

Processing holds a key role in the transformation of food crops into forms with diverse nutritional value thus widening the appeal of a particular food crop to the consumer. It also enhances product utilization to the processor.

The aim of the present study was to investigate the effect of different processing methods (Steeping, boiling and roasting) with processing time on the moisture content; proximate composition and functional properties of plantain flours.

MATERIALS AND METHODS

Collection of samples for analysis

Unripe plantain was obtained from a farm in Akpabuyo Local government Area in Cross River State. The plantain fingers were hand peeled, washed in distilled water and cut into chips of approximately 2.5 to 3.0mm thickness.

The chips were divided into four portions for processing.

Food processing techniques:

Raw (control sample)

The first portion was dried at 60°C for 24 hrs in an oven. The dry sample was ground into

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Table 1
Proximate composition and functional properties of processed plantain flour.

Processing Method	Raw flour (control)	Roasted	Steeped			Boiled		
Duration (mins)	-	120	360	720	1440	5	10	30
Moisture (%)	10.4± 0.25	9.8±0.15	10.4±0.50	10.7±0.059	10.1±0.82	10.6±0.22	10.3±0.10	10.3±0.10
Ash (%)	1.71±0.00	1.69±0.00	1.68±0.01	1.67±0.01	1.68±0.03	1.66±0.00	1.66±0.00	1.68±0.00
Fat (%)	0.13±0.21	0.66±0.03	0.24±0.39	0.61±0.01	0.38±0.18	0.33±0.00	0.34±0.02	0.40±0.00
Crude fibe (%)	0.48±0.32	0.36±0.12	0.35±0.07	0.35±0.10	0.38±0.10	0.22±0.03	0.25±0.05	0.26±0.10
Protein (%)	1.43±0.68	1.35±0.21	1.18±0.15	1.17±0.10	1.17±0.8	1.16±0.00	1.22±0.01	1.40±0.00
Carbohydrate (%)	85.86±1.44	85.54±0.61	86.75±1.12	8.50±0.81	86.28±1.21	86.03±0.25	85.87±0.81	85.46±0.20
PH	7.2±0.21	5.9±0.02	6.0 ±0.11	5.8±0.03	5.8±0.01	5.7±0.02	5.6±0.01	5.9±0.04
Water binding capacity	117.8±0.09	163.5±0.07	131.1±0.11	125.6±0.10	137.3±0.05	266.5±0.13	268.7±0.21	252.4±0.08
Oil absorption capacity	1.4±0.00	1.4±0.08	1.4±0. 01	1.4 ±0.01	1.4±0.00	1.6±0.01	1.6±0.01	1.6±0.02
Amylose (%)	25.5±0.03	25.7±0.01	26.8±0.00	27.5±0.02	27.9±0.01	25.3±0.00	23.4±0.00	22.9±0.00

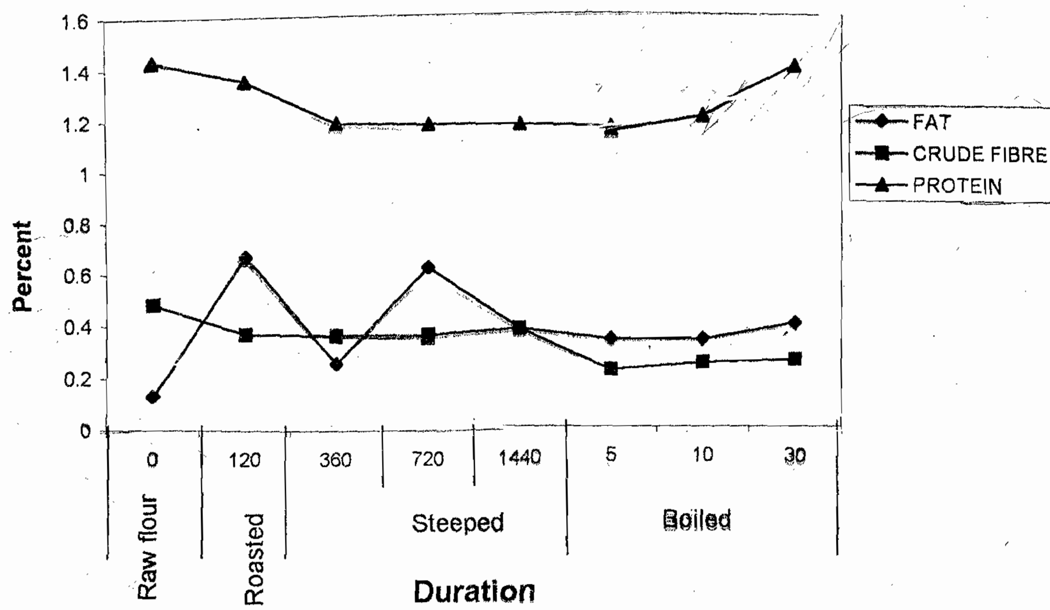

Fig. 1: Effect of processing (roasting, steeping and boiling) on fat, protein and crude fibre contents of plantain flours

flour using a Kenwood portable mill, sifted through a 300 micronsieve and stored in a labeled airtight container at room temperature.

Steeping

The second portion of chips were steeped in water at room temperature for 6hrs, l2hrs and 24hrs. At the end of each steep the chips were drip dried, oven dried at 60^{0}C for 24 hrs, ground and stored in a labelled airtight container.

Boiling

The third portion was divided into three lots and each lot was placed in boiling water. The samples were withdrawn at 5 mins, 10 mins and 30 mins intervals. Each was drained, oven dried, ground and stored in labelled airtight containers.

Roasting

The last batch was placed in an oven at 165^{0}C and roasted for 2hrs, cooled, milled and stored in a labelled container.

Proximate composition analysis

Ash, crude fat; crude protein, crude fibre and carbohydrate contents of the samples were determined by the recommended methods of the Association of official Analytical Chemist (A. O. A. C.) 1984.

Moisture content

The samples (2g each) were weighed in a crucible and dried to a constant weight at a temperature of 60^{0}C in a hot air circulating oven. This temperature was used because overheating does not occur at that point and the temperature is high enough to put a check on enzymic and respiratory actions. The crucible and its contents were cooled to room temperature in a desiccators and the loss in weight represented the moisture content.

$$\% \text{ moisture} = \frac{\text{Loss in weight on drying} \times 100}{\text{initial sample weight}}$$

Water binding capacity.

Water binding capacity was determined by the method of Beuchat (Beuchat; 1977). A 2.5g of samples were added to 37.5 of distilled water in a centrifuge tube. This was agitated on a wrist — action shaker for one hour and centrifuged for 10 minutes at approximately 7,500 rpm. The water was decanted and allowed to drain for 10 mins. The centrifuge tube was then weighed with its content and the amount of water held by the sample was calculated by difference.

% Water binding capacity =

$$\text{Grams bound water} \times \frac{100}{25}$$

Amylose content

Amylose content was determined by Milton Roy's Spectro photometric method. A 0.1g sample was weighed in duplicate into two 100

cm^3 volumetric flasks. 1 cm^3 of 35% ethanol and 9 cm^3 of 1N NaOH were added to each flask. The mixture was heated for 10 mins in a boiling water bath to gelatanize the starch, cooled and made up to mark. The solution (5 cm^3) was placed in a 100 cm^3 volumetric flask and 1 cm of 1N acetic acid added to acidify the solution followed by 2 cm^3 of iodine solution. The solution was made up to mark with distilled water. After 20 mins absorbance was determined at 620nm.

% Amylose = F x Absorbance x 20%

F = Conversion Factor = 3.06

Oil absorption capacity

Oil absorption capacity was determined by the method of Sosulski, Humbert, Bui and Joxmes (1976). One gram of the sample was added to 10 cm^3 of refined corn oil in a weighed 25cm^3 centrifuge tube. The tube was agitated for 2 mins and centrifuged at 4,000 rpm for 20 mins. The volume of free oil decanted was recorded and the tube with content was weighed. Fat absorption capacity expressed as cm^3 oil bound by 100g dry flour.

RESULTS AND DISCUSSION

Moisture content

The percentage moisture of the fresh (unprocessed) sample was 40.0, while the roasted steeped and boiled samples ranged between 9.8 to 10.7 with the roasted sample having the lowest value of 9.8 as shown in Table 1.

Proximate analysis

Crude protein

The percentage crude protein in boiled samples ranged from 1.16 to 1.40 with the 5 mins boiled sample having the lowest value of 1.16 while the 30mins boiled sample had the highest value of 1.40 as shown in Table 1. Roasting and steeping led to reductions in percentage crude protein. Decreases from 1.43 to 1.35 and 1.43 to 1.17 were observed for roasted and steeped samples respectively. Figure 1 shows a decrease in protein content with increased time of soaking. This according to Henshaw and Lawal (1992), Okoka and Potter, (1979) is due to protein solubilities. Percentage protein was observed to increase with boiling time, this does not however indicate that more protein is produced but rather that heat denatured the proteins resulting in reduced protein solubility and increased solubility of other constituents like amylose (Figure 1) leading to a concomitant percentage increase of constituents like protein. Abbey and Ibeh (1988), Henshaw and Lawal (1992) while studying the functional properties of raw and heat processed cowpea flour reported a reduction in protein solubility of heat processed cowpea flour. Padilla Alvarcz and Alfaro (1996) while studying functional properties of barinus nut flour, observed that heat denaturation improves water

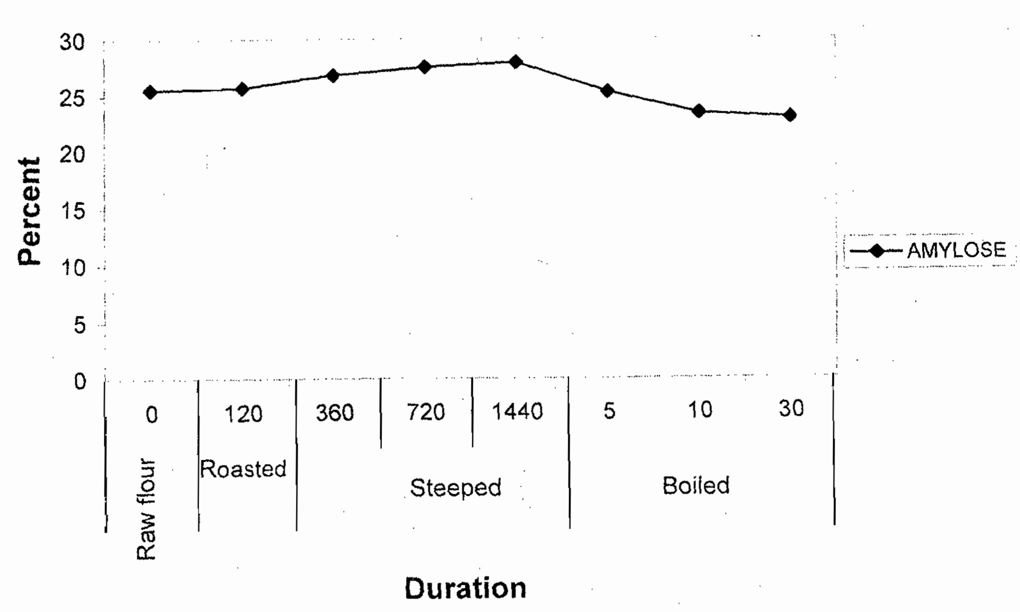

Fig. 2: Effect of processing (roasting, steeping and boiling) on % amylose of plantain flours.

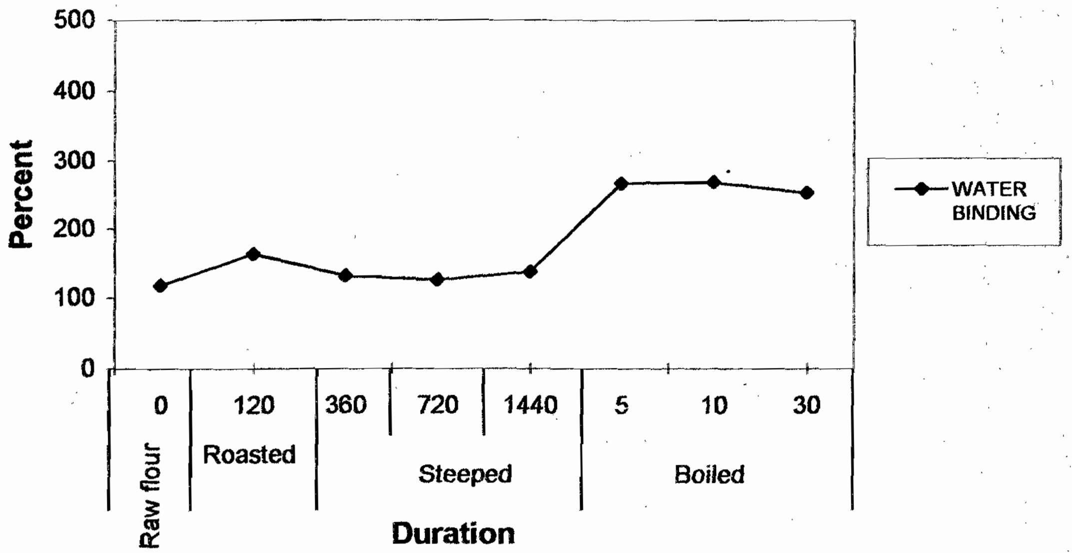

Fig. 3: Effect of processing (roasting, steeping and boiling) on water binding capacities of plantain flours.

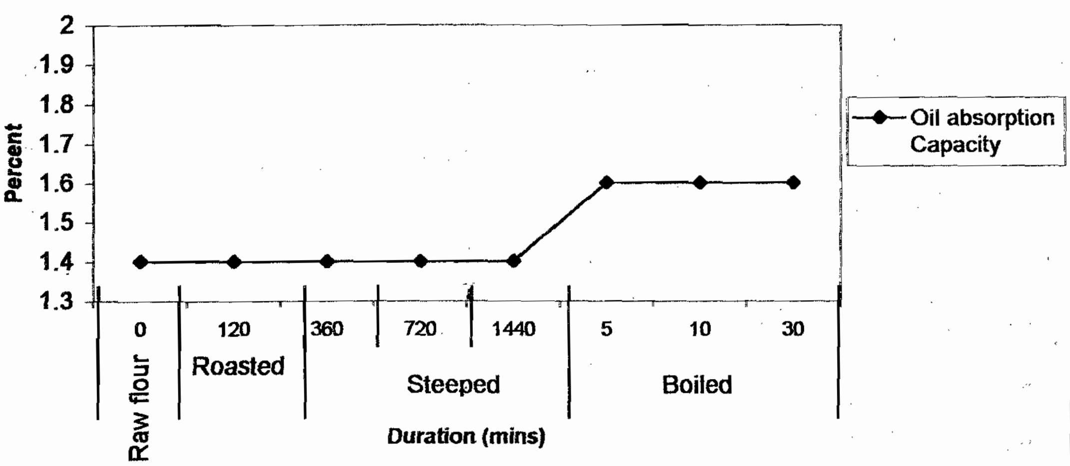

Fig. 4: Effect of processing (roasting steeping and boiling) on oil absorption in plantain flour Capacity

binding capacity of proteins as a result of dissociation of the sub unit structures of protein, the hydrogen and hydrophobic bonds appears to be responsible for decreasing protein solubility during heating.

Fat

Percentage fat content of unprocessed (control) flour as shown in Table 1 was 0.13. Processing led to increases in percentage fat, ranging from 0.24 to 0.66, the highest value of 0.66 being recorded for the roasted sample. These observed changes may not be as a result of actual increase or decrease in fatty acid content but could be as a result of heat degradation of heat labile amino acids such as lysine which led to a decrease in percentage protein, also decrease in moisture content, all accounting for proportionate increases in unaltered constituent (fat). Prinyawinwatkul, Beuchat, Walters and Philips (1996), while studying changes in fatty acid, simple sugar and oligosaccharide content of cowpea flour observed an increase in fatty acid due to boiling.

Crude fibre

All processing methods used led to decreases in percentage crude fibre by 20.8, 25.0 and 33.3 percent for steeped, roasted and boiled samples respectively

Amylose

Amylose content of flour samples ranged between 22.9 and 27 9 percent as shown in Table 1, figure 2. Amylose content increased with steeping time. This observed increase is as a result of the inert and stable nature of starch granules (Oates, 1997). Boiling on the other hand led to a decrease in percentage amylose with boiling time for all samples. Decrease in amylose content with boiling time is due to the swelling of the amorphous regions of starch granules and disruption of the radically ordered structure of the starch granules leading to the opening of the crystal structures as the polymer chains become increasingly hydrated resulting in a breakdown of the amylose-amylopectin chain and leaching out of amylose into the boiling water (Oates, 1997).

Water binding capacity

Water binding capacity increased after heat treatment. Roasting increased water-binding capacity by 50.97 percent while 10 mins boiling increased water-binding capacity by 128.10 percent as shown in Table 1, figure 3. Steeping had the least effect on this property. The lower values for the water binding capacity of the steeped samples is as a result of restricted water availability for the starch granules due to a more compact structure at low temperatures, Oates (1997). When temperatures increased, amylose —amylopectin chains separate forming expansible matrix, which resulted in a higher water holding ability (Colonna, Tayeb and Merrier, 1989). Hence the observed higher values of water binding capacity for the boiled and roasted samples.

Hermansson (1973) also pointed out that water holding capacity can be increased if swelling ability is enhanced.

Oil absorption capacity

Steeping was observed to have no significant effect on the oil absorption capacity while observed increase due to boiling and roasting was insignificant compared with the increase for water binding capacities resulting from boiling and roasting. This is in agreement with observations made by Iwoha and Kalu (1995) while studying the physicochemical properties of processed cocoyam tuber flours.

Ash

The ash content ranged between 1.66 to 1.71 percent, with the control (Unprocessed) sample having the highest value of 1.71% as shown in Table 1. It therefore appears that processing resulted in a decrease in percentage ash content of the sample.

CONCLUSION

Samples of steeped, roasted and boiled plantain flours were analyzed and evaluated for their proximate composition and functional properties. Properties like protein content and pH decreased remarkably with steeping time. Roasting reduced percentage protein while it increased the crude fibre. Boiling decreased the crude fibre content of plantain by 33.3 percent. Water binding capacity was affected in the order boiled > roasted > steeped > control. Boiling increased water-binding capacity of plantain by multiples of two. Depending on the desired product, food processors can choose the processing method that will enhance their productivity.

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