INTERNATIONAL JOURNAL OF NATURAL AND APPLIED SCIENCES (IJNAS) ,VOL. 3, NOS.1& 2 (2008); P. 22– 27, 1 TABLE. 4 FIGS.

Evaluation of some physicochemical and functional properties of a novel weaning food processed from cooking banana, supplemented with cowpea and peanut.

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ABSTRACT

The physicochemical characteristics of a novel weaning food (WF) prepared from cooking banana, cowpea and peanut was analyzed and compared with those of two varieties of commercial weaning food prepared from banana and supplemented with rice (RB) and oats (OB) respectively. It was observed that the physicochemical properties of the weaning foods, WF, RB and OB were significantly different ($P \leq 0.05$)) with Duncan values of A, B and C respectively except for the pH which was in the same Duncan group for the three samples. The viscosity was in the order 155000, 27333.33 and 7333.33cps for OB, RB and WF respectively. Water absorption capacity followed the same order with values of 5.17, 4.63 and 3.57 for OB, RB and WF respectively. Moisture content was observed to be 5.45, 5.32 and 4.42 for OB, RB and WF respectively. OB was significantly darker followed by WF and RB, with l* values of 74.79, 77.04 and 85.53 respectively. The chroma values of WF and OB which were within the same Duncan grouping but were significantly different from that of RB.

INTRODUCTION

The study of non conventional food sources is important owing to the need for new food and feed products for humans and animals, and to increase the economic development of countries through the exploration of their resources (Padilla, et al., 1996).

Banana (M*usa sapientum*) is the fourth on the list of the developing world's most important food crops. The first three are rice, wheat and maize (Anon, 1999). Bananas are a major staple food for millions of people throughout the tropics and provide a valuable source of income through local and international trade, yet relatively speaking bananas and plantains have remained under researched (INIBAP, 2001; Bassey and Dosunmu, 2003). The importance of this crop - the world's largest herb, with numerous uses is only just beginning to be appreciated (INIBAP, 2001). Cooking bananas, unlike sweet desert-grown bananas, which are generally eaten raw, have a relatively short shelf-life, therefore, processing is important. They could be boiled, steamed, fried or roasted. Banana flour is also prepared by drying and milling either the green or ripe fruit. Medicinally, these bananas have a soothing effect when used in the treatment of gastric ulcers, diarrhea and vomiting since they are easy to digest and have similar chemical composition with the mucus of the stomach lining (INIBAP, 2001). Many starchy staples contain small amounts of potentially toxic substances and antinutritional factors. For example, cassava contains toxic cyanogenic glycosides and potato, glycoalkaloids. In contrast, bananas and plantains do not contain significant levels of any toxic compound (INIBAP, 2001).

In addition, banana contains tryptophan, which is an amino acid the body converts to serotonin. Unripe bananas made into flour through drying and grinding are said to be more digestible than cereal flour (INIBAP, 2001). In Australia, bananas are known as the good mood food due to their high vitamin contents, namely, pro vitamin A (carotene), B (thiamine, niacin, riboflavin and B6 pyridoxine) and C (ascorbic acid) and because they help to relieve stress and anxiety. Potato, cassava and cereals provide virtually no vitamin A at all (INIBAP, 2001). Unripe bananas are also used as a carbohydrate source for diabetic patients.

The production of protein-rich foods (leguminous seeds and particularly animal products) has been much less efficient in Nigeria and the sub-region. As a result, the protein in the diets of the population, derived mainly from plant origin, is usually very low in concentration and biological value, even though calorie requirements may be satisfied. In view of the more urgent need of protein sources to combat malnutrition in the tropical countries, screening efforts for new crops have focused more on potential sources of concentrated proteins (FAO, 1964. The production of plant protein concentrates (PCs) is of growing interest to the food industry because of the increasing utilization of plant proteins in food, especially in developing countries (Akintayo et al., 1998; and Sanchez-Vioque et al., 1999). The use of plant PCs in food as functional ingredients, either to improve the nutritional quality of the product or for economic reasons is very common (Qi et al., 1997).

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Manuscript received by the Editor July 3, 2006; revised manuscript accepted Februrary 21, 2007.
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Physicochemical and functional properties of a novel weaning food

Cowpeas (*Vigna unguiculata*) and peanuts (*Arachis hypogaea*) are legumes of major dietary and economic importance. They are favored world wide because of their palability, contribution to nutritional status, and low cost as a protein source compared to animal protein. Flours processed from cowpeas and peanuts have unique physico-chemical and sensory properties when used in composite flour mixtures (McWatters et al., 1995). One of the most important food applications for cowpeas is undoubtly as an ingredient in specially prepared food for weanling children (Phillips et al., 2003). Kluvitse, (1999) processed two weaning formulations using cowpeas, peanuts, soybeans, maize and soybean oil with unique physico-chemical properties.

The objective of this work was to evaluate the physicochemical characteristics of a novel weaning food processed from cooking banana supplemented with two popular legumes; cowpea and peanut.

MATERIALS AND METHODS

Weaning food prepared according to the method of Bassey et al. (2005), was obtained from a wa;l in storage (-18 °C) in the Department of Food Science and Technology, University of Georgia, Griffin GA.

Colour

Colour was determined using the method by Murphy et al. (2003). The Gardner XL 800 tristimulus colorimeter (Pacific Scientific, Bethesda, Maryland, U.S.A.) equipped with a yellow standard tile (L* = 83.47, a* = -2.35, b *= 28.37) was used.Each sample was evenly spread on the bottom of the calorimeter sample cup, to a depth of about 10mm. Surface colour differences were minimized by reporting an average of four readings per flour sample. This was done by rotating the cup at 90° each time before reading. The L* a* and b* values were recorded. Three replicates of each sample were analyzed. Derived attributes of chroma (C), hue angle (H) and total colour difference (ΔE) were determined using equations 1, 2, and 3 below. Thus:

$$\text{Chroma} = \sqrt{a^{*2} + b^{*2}} \quad (1)$$

$$\text{Hue angle} = \tan^{-1}(b^*/a^*) \quad (2)$$

$$\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2} \quad (3)$$

where L* =lightness (0=black, 100 = white), +b*(yellow), -b*(blue), +a*(red), -a*(green)

Bulk density

The bulk density of individual samples and weaning food was determined by the method of Murphy et al (2003). The sample was put into a 25ml graduated cylinder up to the 25ml mark. The cylinder was placed over a Fisher vortex (model G-560, Scientific Industries Inc., Bohemia, N.Y., USA) and agitated for 5 min. The weight of each sample was recorded and bulk density which is the weight / volume of sample (g/cm³) was calculated. Each sample was analyzed in triplicate.

pH

The pH was measured using the method of Murphy et al. (2003) with the aid of an AR 15 pH meter (Accumet Research, Fisher Scientific, Pittsburgh, Pennysylvania, U.S.A.). Each sample (2g) was mixed with 20ml distilled water and shaken mechanically for 5 min. The pH of each sample was then determined in triplicate.

Water absorption capacity

The water absorption capacity was determined through the modification of the method of Prinyawiwatkul et al (1996). Two gram (2g) of each sample was mixed with 10ml deionized water in a 25ml centrifuge tube and placed on a wrist action shaker (model 75, Burrel Corporation, Pittsburgh, Pennnysylvania, U.S.A.) and agitated for 30 min. The samples were transferred to a 1-703A model centrifuge (International Equipment Co., Needham Heights, Massachusetts, U.S.A.) and centrifuged at 4,000 rpm for 30 min. The volume of the decanted supernatant was measured and the tube and its content weighed. The tube and its content were then freeze dried at 20°C in a Genesis freeze drier (model 25ES, Virtis Company, New York, N.Y., U.S.A.) for 24 h and reweighed to determine the actual weight of dry sample that was in association with water retained after centrifugation. The density of water was assumed to be 1g/ml and the water absorption capacity was estimated as the ratio of the total moisture retained by the sample and the weight of the sample on dry matter basis. The mean of triplicate measurement was calculated.

Viscosity

50g of sample was added to 200ml boiling water in a mixing bowl to make a paste. The paste was mixed for 10 min with the aid of a 12-speed, double-blade household mixer (Sunbeam, Corp., model 2366, Delray Beach, Florida, U.S.A.) with the speed set to two. The homogeneous paste was then transferred to a 600ml beaker and paste temperature lowered to a range of 35 - 36°C. This temperature was chosen to simulate the temperature at which breast milk is fed to the baby. Paste viscosity was measured with a Brookfield digital viscometer (HATD model, Stoughton, Massachusetts, U.S.A.) equipped with a model C Helipath stand and TC spindle operated at 10rpm. The speed of the chart recorder was set to 3cm/min. The viscometer was levelled using the inbuilt leveller. Each reading was taken after the spindle was immersed in the paste after 10 rotations. The viscosity readings for all samples were taken in triplicate, and the viscosity determined as follows:

$$\text{Viscosity} = 20M/N \quad (4)$$

where M is a constant = 1000

and N is the RPM = 10.

Moisture content.

An Isotemp vacuum oven (Model 281A, Fisher Scientific, Pittsburgh, PA) was used to determine moisture content. Three grams of sample was weighed into a pre-dried aluminum weighing dish and covered with a lid. This was then placed in the oven for 14 h with the temperature and pressure kept at 105C and 25 mmHg, respectively. The sample was transferred to a desiccator to cool and then weighed. The residue was recorded as total solids and stored in a desiccator for fat analysis while the percentage moisture was calculated from loss in weight using the equation below:

% Moisture = Loss in wt x 100 / wt of sample (5)

Water activity

Water activity was determined by the method of Murphy et al (2003) using a water activity meter (Aqua lab, model 3TE, Decagon Devices Inc., Pullman, Washington, U.S.A.). Each sample (2g) was weighed into the measurement dish; the dish was placed in the drawer of the unit and the meter turned on. The measurements were carried out at room temperature. Measurement of each sample was done in triplicate

Statistical analysis

Data were analyzed statistically with the aid of the Statistics Analysis Software (SAS, 1990).

RESULTS

The pH of all the weaning food samples was in the same Duncan grouping (5.73A, 5.62A and 5.58A) showing that there was no significant difference for WF, RB and OB respectively (see table 1) Water absorption capacities (WAC) of the samples were significantly different with the formulated weaning food having the least value of 3.56 followed by RB with a value of 4.63 and OB with the highest value of 5.17. The water absorption capacities of the samples directly correlated with their viscosities (7,333, 27,333 and 155,000cps for WF, RB and OB respectively) as shown in figures 1and 2.

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Table 1. pH and colour measurements of novel weaning food.

Sample ID	pH	L*	a*	B*	Hue angle	Chroma	ΔE
WF	5.73A	77.04B	1.48B	23.08A	86.32A	267.50A	3.69C
RB	5.62A	85.53A	1.88A	20.99B	95.11B	222.15B	27.92A
OB	5.58A	74.79C	1.31B	22.84A	86.71A	261.75A	12.00B

Values not followed by the same letter (Duncan grouping) are significantly different ($P \leq 0.05$) as determined by Fisher's least significant difference test (LSD).

L* measures the degree of lightness of WF, RB and OB, from 0 = dark to 100 = light

a* measures colors in the region of green to red

b* measures colors in the region of blue to yellow

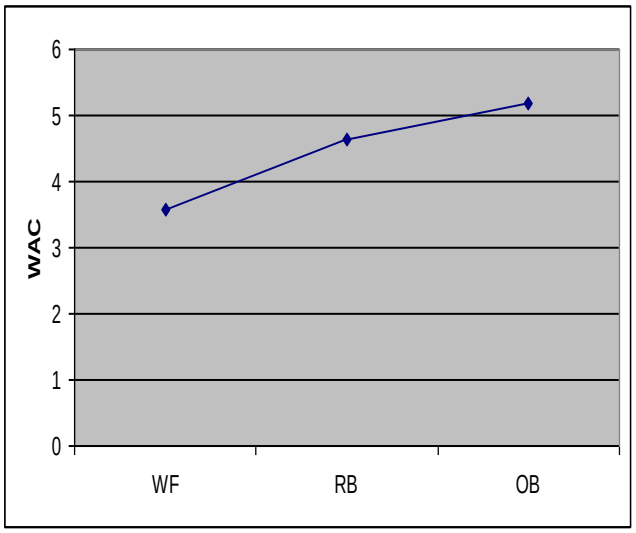

Fig. 1 Variation in WAC of WF, RB and OB

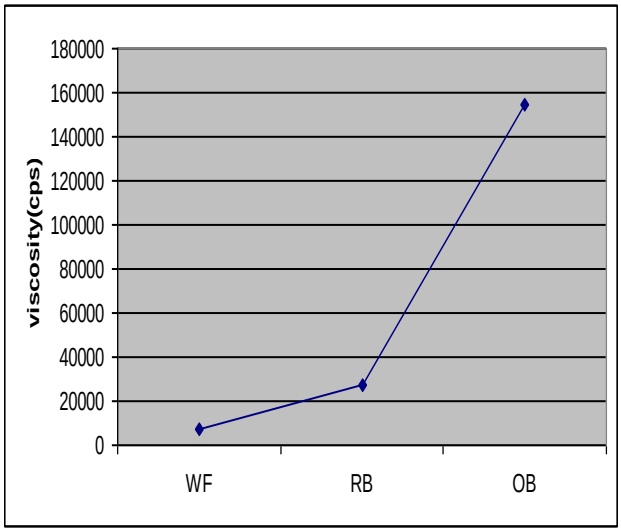

Fig. 2 Variation in viscosity of WF, RB and OB

The high WAC and viscosities for RB and OB could be attributed to the high temperatures employed in their drum drying (resulting in a totally gelatinized starch) compared to the drying temperature of the ripe cooking banana which was 60°C. Also the boiling temperature for the cowpea can equally not be compared with the high temperature used for drum drying RB and OB resulting in totally gelatinized starch which could be responsible for the high WAC. Narayana and Narasinga (1982) reported that heat processing resulted in higher water absorption capacities than in the raw flours. Anderson (1982) also reported that cooking temperature increased WAC for several grains. Protein denaturation, starch gelatinization and swelling of the crude fiber which occurred during drum drying could all be responsible for increased WAC of the drum dried products (RB and OB), compared with drying or boiling temperatures used for ripe banana and cowpea respectively. The very high WAC of RB and 0B could be related to starch damage (Milan–Carrillo et al, 2000; Vargas–Lopez et al., 1990).

The L* value (degree of lightness) for all the samples was significantly different ($P \leq 0.05$). OB was significantly darker (with the lowest l* value of 74.79) followed by WF and RB, with l* values of 77.04 and 85.53 respectively. The l* values for OB and WF were not significantly different but were significantly different from that of RB as seen in Table 1. The higher a* values of OB and WF indicates redness compared to the negative a* value of RB which is an indication of greenish coloration. The high chroma values of WF and OB which were within the same Duncan grouping and significantly different from that of RB suggests a more intense coloration for WF and OB. This is also in agreement with the higher b* (yellowness) values of WF and OB compared to that of RB. Angles of 0, 90 and 180 degrees represent red, yellow and green hues respectively (Prinyawiwatkul et al., 1996). Foods with hue angles between 0 and 90°tend towards orange-red whereas foods hue angles between 90° and 180° are more greenish yellow. WF and OB hues fall within 0 and 90 indicating reddish yellow while RB falls between 90 and 180 showing yellowish green coloration.

The low ΔE of 3.69 for RB, compared with 12.00 and 27.92 for WF and OB puts a seal on the intensity of WF and OB coloration. It can thus be deduced that WF and OB were reddish yellow in color while RB was greenish yellow.

The moisture content (mc) and water activity of the novel weaning food were significantly different from those of the other two whose moisture contents were in the same Duncan grouping; the same applies to water activity as seen in figures 3 and 4.

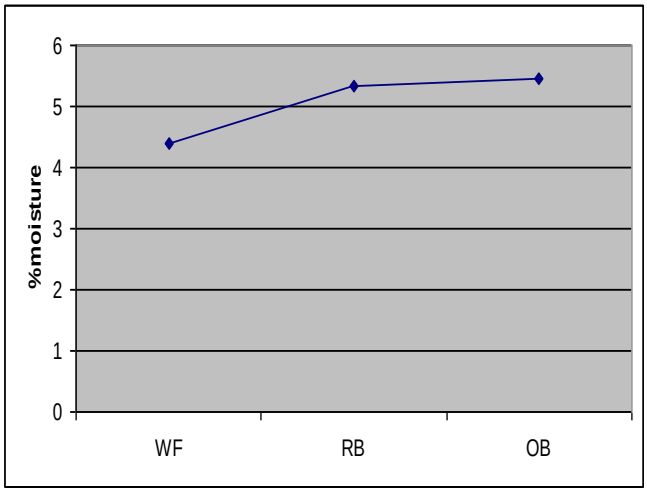

Fig. 3 Variation in moisture content of WF, RB and RB

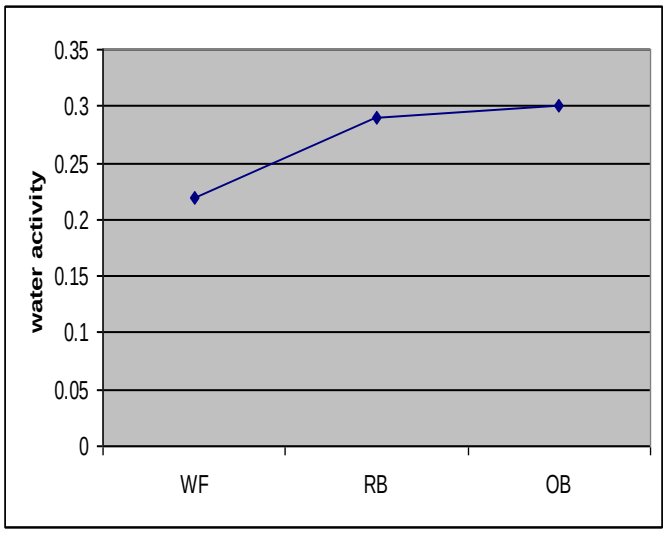

Fig. 4 Variation in water activity of WF, RB and RB

The low moisture content coupled with low water activity (0.22) of the weaning food will have a positive effect on its shelf stability as the higher the moisture content the less stable the food will be towards oxidation reactions if other environmental factors are favourable. Water activity is an important compositional determinant of reaction rates Numerous investigators have shown water activity to strongly influence the rate of enzyme-catalyzed reactions, lipid oxidation, non enzymatic browning (Maillard reaction), sucrose hydrolysis, chlorophyl degradation and anthocyanin degradation (Fennema, 1996).

Water activity of a food product influences the rate of Maillard reactions. It increases as water activity increases. A maximum is reached within a water activity (a_w) range of 0.6-0.7. Further increases in some cases interfere with Maillard reactions. Thus Maillard browning in some food can be controlled by controlling water activity as well as reactant concentrations, time and temperature. Stability of water soluble vitamins in food has been shown to be strongly influenced by water activity. Yeh et al (2002) in their work recorded excellent stability of some vitamins including vitamin C at 4^{O}C under conditions of low water activity

CONCLUSIONS

The low viscosity of the food coupled with its low absorption property compared to those of RB and OB is advantageous as low viscosity and low water absorption capacity allow for the feeding of the infant with a more concentrated preparation since only a minimum amount of water will be needed in the porridge preparation thus resulting in high nutrient/energy density. Similarly, the lower water activity and moisture content of the formulated food over those of RB and OB are advantageous as low moisture content/water activity of dry food enhances storage quality under good storage conditions

REFERENCES

Akintayo, E. T., Esuoso, K. O. and Oshodi, A. A. (1998). Emulsifying properties of some legume proteins. *International Journal of Food Science and Technology, 33:* 239 –246

Anderson, R. A. (1982). Water absorption and solubility and amylography characteristics of roll–cooked small grain products. *Cereal Chemistry, 59:* 265-269.

Bassey, F. I. and Dosunmu, M. I. (2003). Proximate composition and functional properties of raw and processed (steeped, boiled and roasted) Plantain (*Musa paradisiaca*) flour. *Global Journal of Pure and Applied Science* 9(4):503-509

Food and Agriculture Organisation (FAO) (1964). Protein at the heart of the world food problem. .*FAO/UN*, Rome.

Fennema, O. (1996). *Food Chemistry*. 3rd edition. Marcel Dekker, New York.

Iinternational Network for the Improvement of Banana and Plantain (NIBAP (2001). Banana–food and wealth. . *Parcific Scientific*. Http//. www.inibap.org

Kluvitse, Y. M. (1999). Nutritional, physicochemical, and sensory evaluation of extrusion-cooked cereal and legume weaning formulations. Ph.D Dissertation,. University of Georgia, Athens, 162pp.

McWatters, K. H., Resurreccion, A.V.A., Beuchat, L.R. and Phillips, R.D. (1995). Use of peanut and cowpea in wheat-based products containing composite flours. *Plant Foods for Human Nutrition, 47:* 71-87.

Milan–Carrillo, J., Reyes–Moreno, C., Armienta–Rodelo, A., Carobez–Trejo, O. and Mora-Escobel, R. (2000). Physicochemical and nutritional characteristics of extruded flours from fresh and hardened chicpeas. *Leben Sm-Wiss, 33:117-123.*

Murphy, M. G., Skonberg, D. I. and Camire, M. E.(2003). Chemical composition and physical properties of extruded snacks containing crab-processing by-product. *Journal of the Science of Food and Agriculture*, 83: 1163-1167.

Narayana, K. and Narasinga, R. M. S. (1982). Functional properties of raw and heat processed winged bean flour. *Journal of Food Science, 47*:1534–1538.

Padilla, F. C., Alvarez, M. T. and Alfaro, M. J. (1996). Functional properties of barinas nut flour (Caryodendron Orinocense Karst., Euphorbiacease) compared to those of soybean. *Food Chemistry* 57(2): 191-196.

Phillips, R. D., McWatters, K., Chinnan, M. S and Beuchat, L. R. (2003). Utilization of cowpeas for human food. *Field Crops Research, 82*: 193-213.

Prinyawiwatkul, W., McWatters, K. H., Beuchat, L.R., Phillips, R. D. (1996). Physical propertie s of cowpea paste and akara as affected by supplementation with peanut flour. *Journal of Agricultural and Food Chemistry, 42(8):* 1750-1756.

Qi, M., Hettiarachchy, N. S. and Kalapathy, U., (1997). Solubility and emulsifying properties of soy protein isolates modified by pancreatin. *Journal of Food Science, 62:* 1110 –1115.

Sanchez-Vioque, R., Clemente, J., Vioque, J., Bautista, J. and Millan, F. (1999). Protein isolates from chickpea (*Cicer arietinum* L.): chemical composition, functional properties and protein characterization. *Food Chemistry, 64*: 237–243.

SAS(1990). *SAS/START User's Guide, Version 6, 4th edn, Vol.2.* Statistical Analysis Systems Institute, Inc, Cary, NC.

Vargas–Lopez, J.M., Paredes–Lopez, O. and Espitia, E. (1990). Evaluation of lime heat treatment on some physicochemical properties of amaranth flour by response surface methodology. *Cereal Chemistry, 67*: 417 – 421.