IOSR Journal of Applied Chemistry (IOSR-JAC)
e-ISSN: 2278-5736.Volume 11, Issue 5 Ver. I (May. 2018), PP 43-46
www.iosrjournals.org

Comparison of Functional and Mineral Characteristics of Yam; Cassava; Cocoyam and Plantain Flour.

Salami Lukuman A.[1,2]* Ajibola Tawakalitu. [2]akinjohnson Elizabeth. [2]
[1]*Industrial unit, Chemistry Department, Faculty of Science, University of Ibadan, Ibadan, Nigeria*
[2]*Scientific Research Unit, Research and Development Department, Prototype Engineering Development Institute, Ilesa. Nigeria.*
Corresponding Author: Salami Lukuman A.

Abstract: *The functional characteristics and mineral composition of yam; cassava; cocoyam and plantain flour were analyzed and their results were compared to recommend their combination for classes of people like infant, adult and aged. The yam and cocoyam flour were found to be a good sources of minerals; calcium 198.72 ± 0.021 and 135.40 ± 0.020 mg/100g respectively, magnesium 140.23± 0.052 and 69.20 ± 0.055 mg/100g respectively. All the flour sample are good sources of potassium of 453.36 ± 1.001, 272.10 ± 0.921, 219.00 ± 1.100 and 445.200 ± 2.150mg/100g respectively. Among the selected functional properties determined, all the flour samples have high dispersibility, Yam flour (92.6 ± 0.01), Cassava flour (78.35 ± 0.06), Cocoyam flour (45.7 ± 0.03) and Plantain flour (50.15 ± 0.01). Plantain flour has the highest bulk density of 0.77 ± 0.02 g/mg and highest solubility of 17.92 % with the lowest swelling power (g/g) 5.42 ± 0.03. The water absorption index of cassava flour of 74.15 5 %is very high compare with others that were less than 2 %.*

Keywords: *Functional properties, water absorption index*

Date of Submission: 26-04-2018 Date of acceptance: 14-05-2018

I. Introduction

Food security remain an unfulfilled dream for more than 800 million people (Anuonye, 2011), who are unable to leave healthy and active lives because they lack access to safe and nutritious food. More than 840 million people lack access to enough food to meet their daily basic needs, while more than one third of the world's children are stunted due to diets inadequate in quantity and quality (WHO, 2001). Yam (Discorea esculenta) Cocoyam (Colocasia esculenta) and Cassava Manihot esculanta spp. are some of the major staple food crops in Nigeria supplying about 70% of the daily calorie to over 50 million Nigerians. World consumption of cassava for food is concentrated in the developing countries. For instance, in Africa about 70% of cassava production is used as food and most popular processed products are garri, lafun, fufu, kpokpo gariand a dry granular meal made from moist and fermented cassava is most commonly used in West Africa (Sanni, et al., 2009).

Yam (Discorea esculenta) Cocoyam (Colocasia esculenta) and Cassava Manihot esculanta spp. are commonly consumed with sauces after boiling, roasting or frying. They can also be mashed or pounded into dough after boiling.

Cocoyam (Colocasia esculenta) is an edible, highly nutritious and an underutilized crop that belongs to the family, Araceae. About 30 – 40 species of cocoyam have been identified but only 5 – 6 species produce edible parts (Nwanekezi et al,2010). Nutritionally, the tubers contain easily digestible starch and are known to contain substantial amounts of protein, fibre, vitamin C, thiamine, riboflavin, potassium, sodium, phosphorus, magnesium, calcium and niacin. The leaves are rich in iron, folic acid and beta carotene (Niba, 2003).

The chemical composition of plantain varies with the variety, maturity, degree of ripeness and where it is grown (soil type). The water content in the green plant is about 61% and increases on ripen to about 68%. The increase in water is presumably due to the breakdown of carbohydrates during respiration. Green plantain contains starch which is in the range of 21 to 26%. The starch in the unripe plantain is mainly amylose and amylopectin and this is replaced by sucrose, fructose and glucose during the ripening stage due to the hydrolysis of the starch (Marriot et al., 1981). Plantains therefore have a high carbohydrate content (31g/100g) and low fat content (0.4g/100g). They are good sources of vitamins and minerals (Adeniji et al., 2006), particularly iron (24mg/kg), potassium (9.5mg/kg), calcium (715mg/kg), vitamin A, ascorbic acid, thiamin, riboflavin and niacin. The amino acid components include B-alanine, aminobutyric acid, glutamine, asparagine, histidine, serinr, arginine and leucine. The ascorbic acid is high compared to that of banana. As a starchy staple food, plantain supply about 1g protein/100g edible portion (USDA, 2009).

This study, therefore, investigates the nutritional qualities of the powdered yam, cassava, cocoyam and plantain for the purpose of comparison and recommend the adequate and appropriate nutrients for different classes of people like infant, adult and aged.

II. Materials and Methods

Matured tubers of yam, cocoyam and cassava together with a matured bunch of plantain were purchased / sourced from Kajola market in Osun state.

2.1 Production of yam; cassava and cocoyam flour (Elubo)

The tubers were washed with clean water to remove adhering soil and other undesirable materials. The tubers were then hand-peeled using kitchen knives and sliced into sizes of 2 to
3cm thickness. The slices of those tubers were parboiled separately in water at 50^{o}C for 2 hours after which the sliced tubers were removed. The parboiled sliced samples were steeped for 24 hours to allow them attain a flabby nature. Each samples were drained and transferred into the cabinet dryer to dry. The dried slices were milled separately using locally fabricated hammer mill and sealed in polythene prior to analysis (Babajide *et al,* 2006).

2.2 Digestion of Sample for Mineral Analysis

Two-grammes each of the flour samples were weighed into different 125ml Erlenmeyer flasks which had been previously washed with acid and distilled water. Each set-up were followed by addition of 4ml perchloric acid, 25ml of conc. HNO_3 and 2ml conc. H_2S0_4 under a fume hood.

The contents were in each flask were mixed and heated gently at low heat on a hot plate until dense white fumes appeared. They were finally heated strongly for half a minute and then allowed to cool. About 40–50ml distilled water was added and the solution boiled for half a minute on the same plate at medium heat. The resulting solutions emerged were allowed to cool and filtered completely into different 100ml Pyrex volumetric flask before making-up to mark with distilled water and later filtered with Whatman No 42 filter paper (9cm) (AOAC, 2000).

2.3 Determination of Minerals

Four (4) macro (Ca, Na, K, Mg) and four (4) trace minerals (Fe, Cu, Mn, P) were determined from each flour samples with Atomic Absorption Spectrophotometer (EDX 3600B Spectrophotometer). Standard solutions with optimum range for each element were prepared and all the operational instructions for setting up the instrument for the analysis of specific element were strictly followed. Phosphorus in each flour samples were determined calorimetrically using ascorbic acid method as described by AOAC (2000).

2.4 Determination of Functional Properties of Flour

2.4.1 Bulk density determination of Flour

The bulk density was determined by the method of Wang and Kinssela (1976). A known amount of the sample was weighed into 50ml graduated measuring cylinder. The samples were packed by gently tapping the cylinder on the bench top 10 times from height of 5cm. the volume of the sample was recorded.

$$\text{Bulk density (g/ml or g/cm}^3\text{)} = \frac{\text{Weight of the sample}}{\text{Volume of the sample after tapping}}$$

2.4.2 Swelling power determination of Flour

Swelling power and solubility index was determined by Takashi and Sieb (1988) method. It involves weighing 1g of flour sample into 5ml centrifuge tube; 50ml of distilled water is added and mixed gently. The slurry was heated in a water bath at temperatures (70, 80, 90, and 100) ^{o}C respectively for 15 minutes. During heating, the slurry is stirred gently to prevent clumping of the flour. On completion of 15 minutes, the tube containing the paste is centrifuged at 3000rpm for 10 minutes. The supernatant will be decanted immediately after centrifuging. The weight of the sediment is then taken and recorded. The moisture content of the sediment gel was used to determine the dry matter content of the gel.

$$\text{Swelling power} = \frac{\text{Weight of wet mass sediment}}{\text{Weight of dry matter in gel (100- wt. of moisture content)}}$$

2.4.3 Dispersibility determination of Flour

Dispersibility was determined using the method described by Kulkarniet al., (1991). Ten grams of the flour sample was weighed into 100ml measuring cylinder, water was added to each volume of 100ml. the set up stirred vigorously and allowed to stand for three hours. The volume of settled particles was recorded and subtracted from 100. The differences reported as percentage Dispersibility

% Dispersibility = 100 - volume of settled particle.

2.4.4 Water absorption index determination of Flour

Water absorption index was determined using the modified method of (Ruales et al., 1993). Yam Flour sample (2.5g) was suspended in 30ml distilled water at 300C in a centrifuge tube, stirred for 30 minutes intermittently and then centrifuged at 300rpm for 10 minutes. The supernatant is decanted and the weight of the gel formed was recorded. The water absorption index (WAI) was calculated as gel weight per gram dry sample

$$\text{Water absorption index (WAI)} = \frac{\text{Bound water (g) x100}}{\text{Weight of sample}}$$

2.4.5 Solubility Index Determination

Solubility for each flour samples were done by weighing 1g of each sample into 20ml distilled water in test tube. They were subjected to heating in a water bath at a temperature of 60^0C for 30mins because there was no appreciable heating, they were subjected to centrifugation at 1200 rpm for 20mins and 10ml of the each supernatant were decanted and dried to constant weight. The solubility was expressed as the percentage by weight of the dissolved starch from a heated solution.

III. Discussion

Table 1 shows the selected functional properties of the four different flour samples.

Plantain flour has the highest bulk density (mass- density ratio) of 0.77 g/ml compare to 0.529 g/ml of yam flour. Cassava flour has the highest water absorption index of 74.15 % while cocoyam flour has the lowest water absorption index of 0.23%. Yam flour has a very high dispersibility value of 92.6 % compare to 45.7 % dispersibility of cocoyam flour. The solubility of plantain flour has the highest solubility value of 17.92 % while the solubility of the cassava flour is the lowest (5.22%) of the four flour samples. The swelling power of cocoyam; yam; cassava and plantain flour are arranged in a descending order (9.10; 8.20; 7.99 and 5.42) g/g

Table 2 presents the mineral composition of four different flour samples. Sodium ion has the highest value of 473.95 mg/100g in Yam flour and lowest value of 1.135 mg/100g in Plantain flour. The low content of sodium, potassium and iron in plantain flour is in line with the work reported by USDA, 2009. Yam and Plantain flour are very rich in Potassium with 453.36 mg/100g and 445.20 mg/100g respectively. Manganese, Copper and Zinc composition are very small in the four different flour sample compared to other elemental composition. Calcium is also high in yam and cocoyam flour with 198.72 mg/100g and 135.40 mg/100g. Iron is high in Yam and plantain flour with 3.64mg/100g and 2.96mg/100g respectively compare to 0.28 mg/100g and 0.08 mg/100g of cassava and cocoyam flour samples respectively.

IV. Conclusion

The very high value of calcium mineral in yam and cocoyam flour make it a good source of food for infants in order to develop a strong bone and teeth. Plantain flour has the highest potassium content and is therefore recommended for adult people to boost their response to stimuli. Plantain flour also has low swelling power which facilitate its rate of digestion and consequently recommended for the aged people.

Acknowledgements

The authors thank the Department of Chemistry,University of Ibadan, and Prototype Engineering Development Institute, Ilesa, Nigeria for making their facilities available.

References

[1]. Adeniji T.A. Sanni L.O, Barimalaa I,S, Hart A,D (2006). Determination of micronutrients and colour variability among newplantain and banana hybrids flours. World J. Chem. 1(1):23 – 27.

[2]. Anuonye , J.C. (2011). Soybean utilization and fortification of indigenous foods in times of climate changes. Available online: www.interchopen.com. ISBN 978 – 958; 307-534 -1

[3]. Babajide, J.M., Oyewole, O.B, and Obadina, O.A (2006). An assessment of the microbial safety of dry yam (gbodo) processed in southwest Nigeria, *African Journal ofBiotechnology*, 5(2):157-161.

[4]. IITA (2001).International Institute of Tropical Agriculture: Operation manual for the series 3 rapid visco analyzer using thermoclinefor windows. Newport scientific property Ltd.Standard Univ. Press. Stanford, CA, USA. Pp315.

[5]. Kulkarni K.O., Kulkarni, D.N. and Ingle, U.M (1991): Sorghum malt based weaning food formulation preparation, functional properties and Nutritive Value. Food and Nutrition Bulletin.13, (14):322-327.

[6]. Niba L.L (2003). Processing effects on susceptibility of starch to digestion in some dietary starch sources. Int. J. Food Sci. Nutr., 54, 97-109.

[7]. Nwanekezi EC, Owuamanam CI, Ihediohanma NC, Iwouno J.O (2010). Functional, particle size and sorption isotherm of cocoyam cormel flours. Journal of nutrition, 9:973-979.

[8]. Ruales,J., Valencia, S and Nair, B (1993).Effect of processing on the physiochemical characteristics of guinea flour.(Chenopodium guinea Wild) starch 46(1); 13 -19.

[9]. Sanni, L.O., Onadipe, O.O., ILONA, P., Mussagy, M.D., Abass, A. and Dixon, A.G.O. (2009). Success and Challenges of cassava enterprises in West Africa; A case study of Nigeria, Benin and Sierra Leone International Institute of Agriculture (IITA). www.iita.org.

[10]. Takashi, S. and Sieb,P.A.(1988)Paste and gel properties ofprime corn and wheat starches with and without native lipids.Cerealschemistry 65;47.

[11]. (USDA, 2009). National Nutrient Database for Standard Reference.http://www.nal.usda.gov/fric/foodcomp/plantain/.

[12]. Wang,J.C. and Kinsella,J.E (1976).Functional property of Novel Protein Alfafa protein Journal of Food Science 4:286 -296.

Table 1. The functional properties

Parameters	Yam flour	Cassava flour	Cocoyam flour	Plantain flour
Bulk density (g/ml)	0.529 ± 0.01	0.60 ± 0.01	0.64 ± 0.02	0.77 ± 0.02
WAI (%)	1.63 ± 1.41	74.15 ± 1.05	0.23 ± 0.03	1.05 ± 0.11
Dispersibility (%)	92.6 ± 0.01	78.35 ± 0.06	45.7 ± 0.03	50.15 ± 0.01
Solubility (%)	6.75 ± 0.22	5.22 ± 0.17	7.25 ± 0.12	17.92 ± 0.20
Swelling Power (g/g)	8.20 ± 0.15	7.99 ± 0.22	9.10 ± 0.11	5.42 ± 0.03
OAI (%)	167 ± 2.80	71.25 ± 1.30	3..65 ± 0.02	23.25 ± 0.18

Mean ± SD of three replications

Table 2. Mineral composition

Minerals	Yam flour (mg/100g)	Cassava flour (mg/100g)	Cocoyam flour (mg/100g)	Plantain flour (mg/100g)
Sodium (Na^{+})	473.95± 0.015	14.55 ± 0.075	191.50 ± 0.017	1.135 ± 0.031
Calcium (Ca^{2+})	198.72 ± 0.021	16.05 ± 0.025	135.40 ± 0.020	0.422 ± 0.010
Iron (Fe^{2+})	3.64 ± 0.011	0.28 ± 0.021	0.08 ± 0.016	2.959 ± 0.052
Potassium (K^{+})	453.36 ± 1.001	272.10 ± 0.921	219.00 ± 1.100	445.200 ± 2.150
Phosphorus (P^{2+})	127.76 ± 0.022	27.67 ± 0.032	61.25 ± 0.035	0.299 ± 0.005
Magnesium (Mg^{2+})	140.23± 0.052	21.99 ± 0.003	69.20 ± 0.055	42.35 ± 0.047
Manganese (Mn^{2+})	3.64 ± 0.100	0.388 ± 0.120	0.08 ± 0.001	1.75 ± 0.210
Copper (Cu^{2+})	4.77 ± 0.004	0.198 ±0.002	1.08 ±0.001	0.96 ± 0.002
Zinc (Zn^{2+})	0.29 ± 0.002	0.354 ± 0.018	0.15 ± 0.013	0.51 ± 0.020

Mean ± SD of three replications

Salami Lukuman A "Comparison of Functional and Mineral Characteristics of Yam; Cassava; Cocoyam and Plantain Flour." IOSR Journal of Applied Chemistry (IOSR-JAC) 11.5 (2018): 43-46.