American Journal of Food Technology

ISSN 1557-4571

Academic Journals Inc.

www.academicjournals.com

OPEN ACCESS American Journal of Food Technology

ISSN 1557-4571
DOI: 10.3923/ajft.2020.22.27

Research Article
Physiochemical Properties of Potato Garri Supplemented with Soy Flour

[1]A.F. Ogori, [1]J. Amove and [2]J.A. Adoba

[1]Department of Home Science, Faculty of Agriculture, Federal University Gashua, Gashua, Yobe State, Nigeria
[2]Department of Food Science and Technology, Federal University of Agriculture, Makurdi, Benue State, Nigeria

Abstract

Background and Objective: Garri from Cassava has cyanogenic glycoside which is seldom totally removed after processing to garri. Garri is low in protein content compare to sweet potatoes and soybean. Main objective of the following study was the supplementation of garri with soybean flour to improve the protein content of soy potato garri. **Materials and Methods:** The potato tubers were washed and peeled. Tubers deepening in water to exclude oxygen, addition of sodium metabisulphite in the ratio of 2 g to 100 mL were added to the water to further control enzymatic thereby retarding enzymatic browning. Grated pulp were fermented in jut bags and pan fried to produce potatoes garri with soybean flour addition. The chemical properties determined were moisture content, ash content, crude fat, crude protein, crude fibre, pH, TTA using standard the methods. Total carbohydrate determination was by difference. Functional properties determined were bulk density, swelling capacity and gelation capacity were determined using standard methods. Sensory evaluation and statistical analysis of the blends were also determined using standard methods. **Results:** Blend ration of 65:35 soybean and potatoes had 17.29% protein values. The functional values decreased with increase in soybean flour addition. Increase in values were observed in acidity or alkalinity (6.87-7.20). Sensory significance difference exists in all sensory qualities. **Conclusion:** These could help alleviates household PEM and malnutrition.

Key words: Soybean, potatoes, flour, garri chemical, functional, malnutrition, sensory significance

Citation: A.F. Ogori, J. Amove and J.A. Adoba, 2020. Physiochemical properties of potato garri supplemented with soy flour. Am. J. Food Technol., 15: 22-27.

Corresponding Author: A.F. Ogori, Department of Home Science, Faculty of Agriculture, Federal University Gashua, Gashua, Yobe State, Nigeria

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Sweet potato (*Ipomoea batatas*) is a dicotyledonous plant in the Convolvulaceae family. It is a leafy plant with strong dark green to brown colour tracing or trimming stems. Sweet potato produces storage roots which sprout to give new plants and the crop is usually propagated by sexual method[1,2]. It is ranked the 7th in the world production after wheat, maize, rice, Irish potato, barley and cassava. Sweet potato is mostly grown in the northern part of Nigeria, especially in Benue and Zamfara States due to its semi-rainfall demands since it cannot tolerate drought and can thrive in a wide range of soils. The sweet potato tuber is rich in carbohydrate, a fair source of lipids and has low fibre content[2]. Moreover, when compared with other roots and tubers Sweet potato have the highest sugar, thiamine and vitamin C contents. Tubers are rich in diastase, an enzyme that change starch to malt, which is responsible for its peculiar sweetness. The yellow and orange varieties are very rich in carotenes and vitamin C. No toxic compound has been reported in sweet potatoes[1,2]. Soybean (*Glycine max*) is a legume native to East to Asia widely grown for its edible bean which has numerous uses. The plant is classed as an oilseed rather than a pulse by the UN Food and Agricultural Organisation[3]. Soybeans have significantly more protein than most other legumes[4]. Traditional non-fermented uses of soybeans include soya milk and from the latter tofu and tofu skin. Fermented foods include soy sauce, fermented bean paste, natto and tempeh, among others. Soybeans are considered by many agencies to be a source of complete protein[1]. For this reason, soybeans is a good source of protein, amongst many others, for vegetarians and vegans and for people who want to reduce the amount of meat they eat. Soybeans are great sources of lean protein, they can help maintain a healthy weight and increase lean muscle mass. Some research suggests that eating soy bean based food may help to avoid heart and diabetic diseases[3,4].

Garri is dehydrated food product. A fermented, partially gelatinized granular product usually produced from cassava, (*Mannihot* spp.) which is very popular in Nigeria[3,5]. It has been ranked as the most important and single traditional staple food in West Africa for about 100 million consumers.

However the major source of garri which come from cassava contains a toxic compound known as cyanogenic glucoside which is not totally removed even after processing for garri production. Cassava garri is also very low in protein content, especially when taken as a single food[6]. Sweet potatoes on the other hand, have higher protein content. Soybean is a source of complete protein. Main objective of this study was the supplementation of garri produced from sweet potatoes with soybean flour (soy potato garri) which, improves the protein content of the product (soy potato garri) because soybean is very rich in amino acids.

MATERIALS AND METHODS

Sources of raw materials: The sweet potatoes (orange-flesh) were bought from Wadata Market, Makurdi at the peat of production in August. The soybeans were bought from Wurukum Market, Makurdi. And the sodium metabisulphite was bought from EMOLE, located at High-Level, Makurdi. From there, they were transported to the processing laboratory of Food science and Technology Department, University of Agriculture Makurdi where the production process began in the 2017/2018 academic session.

Preparation and pretreatment of soy potato garri: Fresh sweet potato tubers free from insect damage and without serious cut were used for this process. The fresh sweet potato tubers were washed thoroughly to remove adhering soil. The peeled tubers were transferred immediately into water to prevent oxygen from getting in contact with them thereby retarding enzymatic browning. The well peeled sweet potatoes were then grated into fine pulp using a manual hand grater. A solution of sodium metabisulphite was made in the ratio of 2 g to 100 mL, this solution was added both to the water containing peeled sweet potatoes and also into the grated sweet potatoes to control enzymatic browning. The mash was packed into well labeled perforated sacks knotted at the open and to prevent the mash from pouring out of the bag.

The bags were pressed to remove the water from the mash (fermented) for 3 days. The pressed mash that appears as a solid cake was broken into separate individual particles by hand using a sieve. Fine particles obtained were roasted/fried in a shallow cast-iron pan over an open wood fire. A piece of calabash section was used to press the sieved mass against the hot surface of the shallow cast-iron pan, scrapping it quickly to prevent burning and to stir the mash vigorously until gelatinized. The dried granules of sweet potato garri were then packed into polythene bags. All the garri samples were cool before packaging as shown in Fig. 1.

Preparation of soybean flour: The soybeans were sorted to remove stone and dirt, it was washed and allowed to dry. The soybeans were poured into a dry pot and it was fried, frying went on till the skin could be easily peeled off. It was brown and crispy just like fried groundnuts when done. It was taken

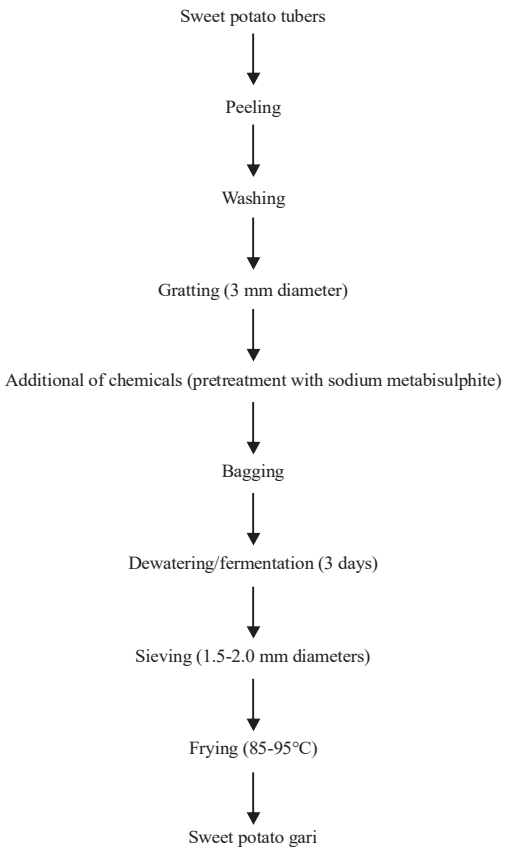

Fig. 1: Flow chart for the production of sweet potato garri
Source: Man and Jones[7]

to the mill for grinding (at the mill, it was slightly processed to remove the skin/chaff). And it was then ground to powder. The flour was ready and it was stored in an air tight container. Figure 2 shows the flow chart of production of soybean flour.

Supplementation of sweet potato garri with soybean flour: After the sweet potato garri and the soybean flour were produced respectively, the two products were mixed manually into their composite flour in different proportions with their respective ratios. At this stage the soybean fortified garri was ready both for consumption and analysis (Table 1).

Chemical properties: Moisture content, ash content, crude fat, crude protein, crude fibre, pH and TTA were determinated using the methods of Singh *et al.*[9]. Total carbohydrate determination was by difference as described by following equation[11]:

Carbohydrate (%) = 100-(Moisture+ash+protein+fat+fibre (%))

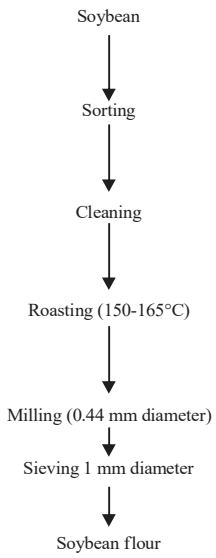

Fig. 2: Flow chart 6for the production of soybean flour
Source: Leakey and Wills[8]

Table 1: Ratios blends on supplementation

Samples	Sweet potato garri (%)	Soybean flour (%)
A	100	0
B	90	10
C	85	15
D	80	20
E	75	25
F	70	30
G	65	35

A: Sweet potato garri with 0% soybean flour (control), B: Sweet potato garri with 10% soybean flour, C: Sweet potato garri with 15% soybean flour, D: Sweet potato garri with 20% soybean flour, E: Sweet potato garri with 25% soybean flour, F: Sweet potato garri with 30% soybean flour, G: Sweet potato garri with 35% soybean flour

Functional properties: Bulk density, swelling capacity and gelation capacity were determined using the different methods[1,2].

Sensory evaluation: Seven coded samples produced from sweet potato and soybeans were presented to 15 semi-trained panelists familiar with garri. Soaked garri samples were evaluated for colour, flavour, mouth feel, particle sizes and over all acceptability, while the cooked samples (eba) were evaluated for colour, texture, aroma, drawability, mouldability and over all acceptability respectively (Table 1). Assessment was done on nine-point hedonic scale[10].

Statistical analysis: Data obtained were analyzed using of variance (ANOVA). Where treatment was found to be significantly different, LSD was used to separate the mean[10].

RESULTS

Results obtained from Table 2 shows that soybean flour has a significant effect ($p<0.05$) on the proximate values of the sweet potato garri product. As percentage quantity of soy protein increases, there were significant $p>0.5$ increase in ash, carbohydrates, fibre, fat and protein of the blends. But moisture content contents are not significantly difference at $p>0.5$ at blend percentage increase for sample B, C, D, E, F and G with respect to the samples.

Table 3 showed the functional properties of sweet potato garri supplemented with soybean flour. There was a significant difference ($p<0.05$), on the bulk density, gelation capacity, swelling index, pH and titratable acidity as blends percentages increases. Sample A is significantly different from sample B, C, D, E and G for bulk density sample B and C are not significant at $p>0.5$, with sample D, E F and G for bulk density. There existed significance differences on gelation capacity, swelling index and titratable acidity among sample at $p>0.5$. but no significance differences were found to existed among sample A and B, sample C, D, E and F for pH values at $p>0.5$ except for sample G respectively.

Results of the sensory evaluation shown on Table 4. It revealed that soybean flour has significant effect ($p<0.05$) on the sensory attributes of sweet potato garri sample. There exist no significance difference at ($p>0.5$) amongst samples for characteristic appearance, texture and flavor. But for sample on taste and general acceptability, significance differences do existed at ($p>0.5$) probability level.

Table 2: Chemical composition of sweet potato garri supplemented with soybean flour

	Percentage					
Samples	Ash	Carbohydrates	Fibre	Fat	Protein	Moisture
A	1.89±0.01^{g}	77.52±0.01^{a}	3.52±0.01^{a}	3.08±0.01^{g}	6.66±0.01^{g}	7.68±0.01^{a}
B	1.99±0.01^{f}	77.08±0.01^{b}	3.52±0.01^{ab}	3.08±0.01^{f}	7.91±0.01^{f}	7.42±0.01^{c}
C	2.01±0.01^{e}	75.49±0.01^{c}	3.40±0.01^{bc}	3.42±0.01^{e}	9.80±0.02^{e}	7.54±0.01^{b}
D	2.21±0.01^{d}	74.67±0.01^{d}	3.39±0.01^{c}	3.52±0.01^{d}	11.05±0.02^{d}	7.40±0.01^{c}
E	2.24±0.01^{c}	73.23±0.01^{e}	3.31±0.01^{d}	3.64±0.01^{c}	12.30±0.02^{c}	6.82±0.01^{d}
F	2.30±0.01^{b}	72.67±0.01^{f}	3.30±0.01^{d}	3.82±0.01^{b}	15.42±0.02^{b}	7.00±0.01^{c}
G	2.33±0.01^{a}	71.46±0.01^{g}	3.18±0.01^{e}	3.91±0.01^{a}	17.29±0.01^{a}	7.39±0.01^{c}

Values with the same superscripts within the same column are not significantly different ($p>0.05$), A: Sweet potato garri with 0% soybean flour (control), B: Sweet potato garri with 10% soybean flour, C: Sweet potato garri with 15% soybean flour, D: Sweet potato garri with 20% soybean flour, E: Sweet potato garri with 25% soybean flour, F: Sweet potato garri with 30% soybean flour, G: Sweet potato garri with 35% soybean flour

Table 3: Functional properties of sweet potato garri supplemented with soybean flour

Samples	Bulk density	Gelation capacity	Swelling index	pH	TTA
A	0.48±0.01^{d}	6.00±0.00^{g}	323.80±0.71^{a}	6.87±0.01^{b}	0.90±0.01^{a}
B	0.51±0.01^{c}	6.28±0.01^{f}	283.50±0.71^{b}	6.90±0.01^{b}	0.85±0.01^{b}
C	0.54±0.01^{c}	6.36±0.01^{a}	264.50±0.71^{c}	6.99±0.01^{c}	0.81±0.01^{c}
D	0.57±0.01^{a}	6.42±0.01^{d}	249.50±0.00^{d}	7.11±0.00^{c}	0.78±0.01^{d}
E	0.55±0.01^{b}	6.50±0.00^{c}	241.50±0.71^{e}	7.15±0.01^{c}	0.74±0.01^{e}
F	0.56±0.01^{ab}	6.67±0.01^{b}	196.50±0.71^{f}	7.17±0.01^{c}	0.63±0.01^{f}
G	0.54±0.01^{b}	6.71±0.01^{a}	161.50±0.71^{g}	7.20±0.01^{a}	0.06±0.01^{g}
LSD	0.02	0.01	1.55	0.16	0.02

Values with the same superscripts within the same column are not significantly different ($p>0.05$), A: Sweet potato garri with 0% soybean flour (control), B: Sweet potato garri with 10% soybean flour, C: Sweet potato garri with 15% soybean flour, D: Sweet potato garri with 20% soybean flour, E: Sweet potato garri with 25% soybean flour, F: Sweet potato garri with 30% soybean flour, G: Sweet potato garri with 35% soybean flour, LSD: Lower significant difference

Table 4: Sensory evaluation of sweet potato garri supplemented with soybean flour

Samples	Appearance	Taste	Texture	Flavour	General acceptance
A	7.33^{a}	7.53^{a}	7.47^{a}	7.33^{a}	7.87^{a}
B	7.13^{a}	6.80^{ab}	7.20^{a}	6.53^{a}	7.33^{ab}
C	6.73^{a}	6.40^{b}	6.67^{a}	6.60^{a}	6.67^{b}
D	6.67^{b}	6.67^{ab}	6.60^{a}	6.60^{a}	6.80^{b}
E	7.47^{a}	7.33^{ab}	6.80^{a}	7.13^{a}	7.67^{ab}
F	7.60^{a}	6.73^{ab}	6.73^{a}	7.00^{a}	7.13^{ab}
G	7.47^{a}	6.40^{b}	6.84^{a}	7.00^{a}	6.90^{ab}
LSD	0.92	0.94	0.87	0.82	0.89

Value with the same superscripts within the same column are not significantly different ($p>0.05$), A: Sweet potato garri with 0% soybean flour (control), B: Sweet potato garri with 10% soybean flour, C: Sweet potato garri with 15% soybean flour, D: Sweet potato garri with 20% soybean flour, E: Sweet potato garri with 25% soybean flour, F: Sweet potato garri with 30% soybean flour, G: Sweet potato garri with 35% soybean flour, LSD: Lower significant difference

DISCUSSION

Results from this study reflects that as percentage of soybean increases, chemical, functional and sensorial properties were favored. Indices obtained from the proximate composition are shown in Table 2. Soybean flour has a significant effect ($p<0.05$) on the quality of the sweet potato garri. As soybean flour increases, the ash content (1.89-2.33), the fat content (3.08-3.91) and the protein content (6.66-17.29) all increased. While the total carbohydrate (71.46-77.52) and the fibre content (3.18-3.52) both decreases at percentage soybean flour addition. However, the moisture content (6.82-7.68), was found to have an irregular increase and decrease pattern which could be attributed to the processing practices adopted in the production of the soy-supplemented sweet potato garri (breaking down of complexes and the fluctuation of toasting temperature). Notwithstanding, the moisture content of all the samples fell within an appreciable range which is in line with Onwuka[11] specification for quality garri (moisture content between 10-13% moisture content recommended for flour[12]. The moisture value obtained from these blend product reflected with that obtained by another method of Kure *et al.*[13], for garri made from sweet potatoes via fermentation[14], of garri from sweet potatoes supplemented with defatted soybean flour[15] and on sweet potato garri values. This implies that the product would have a longer shelf-life as there will be no free moisture to encourage microbial activity which will have an adverse effect on the quality of the garri. The value on crude fibre agreed with values obtained[13,14] for garri fermented via sweet potatoes and potatoes supplemented with defatted soybean flour respectively. However, the decrease in crude fiber implies the decrease in dietary fibre, which is essential for good peristalsis, which helps in preventing obesity, diabetes and cancer of the colon as well as other ailments associated with the gastrointestinal tract of man[12]. The increase in protein is obviously due to the high content of protein as a result of increase in soybean content. The observed soybean protein increase (Table 1) with blending were also observed within the same values[13-15]. Similar observation was reported for wheat-soy-plantain[16]. Fermented soybean-sweet potato[17] and soy-plantain[18]. And the decrease in carbohydrate was as a result of its displacement by protein, from soybean content increased[19].

Results on functional properties are shown in Table 3. Results revealed that as soybean flour content increased there was a significant effect ($p<0.05$), on the bulk density, gelation capacity, swelling index, pH and titratable acidity. It shows that as soybean flour content increases, there is a relative increase in pH (6.87-7.20), bulk density (0.48-0.54) and gelation capacity (6.00-6.71) respectively. While both the titratable acidity (TTA) (0.60-0.90) and swelling index (161.50-323.80) decreased with an increase in soybean flour content (Table 3). The increase in bulk density might be due to damage starch. According to Omoniyi *et al.*[14], increased bulk density value recorded for potatoes'garri might likely aid its industrial applications, while Oladebeye *et al.*[20] high bulk density-sweet potato blend functionality is a good drug binder and might be a disperser in pharmaceuticals industries.

The decrease in swelling index may be as a result of the increase in protein conent[13]; this was also directly proportional to the increase in gelatinization capacity. Protein and starch (cellulose) aids in water uptake of flour at room temperature[21] While the increase in pH can be attributed to the significant presence of phytic acid, alpha-linolenic acid and isoflavones in soya flour[12,22].

Results of the sensory evaluation are shown in Table 4. Result revealed that soybean flour has significant effect ($p<0.05$) on the sensory attributes of sweet potato garri samples. The result shows that soybean flour affects the quality of all the samples positively, as they changed significantly with increase in soybean flour content. Sample A was the most preferred sample. Although, this was not based on its nutritional content but the consumers' familiarity to sample A. however, based on both consumer preference and nutritional content, sample E the best. Because it strikes a perfect balance between these two most influential yard-sticks (consumer preference and nutritional content.

SIGNIFICANCE STATEMENT

This study discover the garri from sweet potatoes and supplemented could be made that can be beneficial for alleviating household protein energy malnutrition. This study will help the researcher to uncover the critical areas of tuber value chains in many household and rural settings.

CONCLUSION

From the quality evaluation of sweet potato garri supplemented with soybean flour can be made and meets the specification of garri products. Sweet potato which is readily available all year round can be used to produce a garri-like product hence diversification. Sweet potato garri supplemented with soybean flour could boost the protein content of the product and thereby offering the potential consumers the numerous benefits that come with this complete protein product. Soy potato garri could alleviate PEM in our local cites where root and tuber crops is a staple.

REFERENCES

1. IITA., 1987. Elite cassava clones assessed for Gari quality. IITA Annual Report and Research Highlights, International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, pp: 96-97.
2. Woolfe, J.A., 1992. Sweet Potato: An Untapped Food Resource. Cambridge University Press, Cambridge, MA., USA., ISBN-13: 9780521402958, Pages: 643.
3. FAO., 1986. Role of roots, tubers and plantains in food security in Sub-Sahara Africa. Report to the Committee on World Food Security, 11th Session, FAO, Rome, Italy.
4. FAO., 2008. Production statistics for 2008. Food and Agriculture Organization, Rome, Italy.
5. Odunfa, S.A., 1998. Cassava to gari. Niger. J. Sci. Technol., 1: 186-189.
6. Westby, A. and D.R. Twiddy, 1992. Characterization of *gari* and *fufu* preparation procedures in Nigeria. World J. Microbiol. Biotechnol., 8: 175-182.
7. Man, C.M.D. and A.A. Jones, 2000. Shelf Life Evaluation of Foods. 2nd Edn., Aspen Publishers, Gaithersburg, MD., USA., ISBN-13: 9780834217829, pp: 110-139.
8. Leakey, C.L.A. and J.B. Wills, 1977. Food Crops of the Lowland Tropics. Oxford University Press, Oxford, UK., ISBN-13: 9780198545170, pp: 80-81.
9. Singh, P., R. Kumar, S.N. Sabapathy and A.S. Bawa, 2008. Functional and edible uses of soy protein products. Compr. Rev. Food Sci. Food Saf., 7: 14-28.
10. Ukpabi, U.J. and C. Ndimele, 1990. Evaluation of the quality of gari produced in Imo State. Niger. Food J., 8: 105-110.
11. Onwuka, G.I., 2005. Food Analysis and Instrumentation: Theory and Practice. Napthali Prints, Lagos, Nigeria, pp: 200-204.
12. Odebode, S.O., 2004. Acceptability of sweet potato "sparri" and its potentials for enhancing food security and economic empowerment of rural women in Southwestern Nigeria. Niger. J. Rural Sociol., 4: 25-33.
13. Kure, O.A., L. Nwankwo and G. Wyasu, 2012. Production and quality evaluation of garri-like product from sweet potatoes. J. Nat. Prod. Plant Resour., 2: 318-321.
14. Omoniyi, S.A., S.O. Awonorin, M.A. Idowu and A.A. Adeola, 2016. Physico-chemical and functional properties of sweet potato-soybean flour blends. Applied Trop. Agric., 21: 84-88.
15. Giri, N.A. and B.K. Sakhale, 2019. Development of sweet potato flour based high protein and low calorie gluten free cookies. Curr. Res. Nutr. Food Sci. J., 7: 427-435.
16. Olaoye, O.A., A.A. Onilude and O.A. Idowu, 2006. Quality characteristics of bread produced from composite flours of wheat, plantain and soybeans. Afr. J. Biotechnol., 11: 1102-1106.
17. Abayomi, H.T., T.O. Oresanya, A.O. Opeifa and T.R. Rasheed, 2013. Quality evaluation of cookies produced from blends of sweet potato and fermented soybean flour. Int. J. Agric. Biosyst. Sci. Eng., 7: 356-361.
18. Abioye, V.F., B.I.O. Ade-Omowaye, G.O. Babarinde and M.K. Adesigbin, 2011. Chemical, physico-chemical and sensory properties of soy-plantain flour. Afr. J. Food Sci., 5: 176-180.
19. Oyewole, O.B. and A.M. Aibor, 1992. Fermentation of cassava with cowpea and soya bean for an enriched fufu. Trop. Sci., 33: 9-15.
20. Oladebeye, A.O., A.A. Oshodi and A.A. Oladebeye, 2009. Physicochemical properties of starches of sweet potato (*Ipomea batata*) and red cocoyam (*Colocasia esculenta*) cormels. Pak. J. Nutr., 8: 313-315.
21. Afoakwa, J.C., 1996. Water absorption capacity of legumes. B.Sc. Thesis, Department of Food Science and Technology, Federal University of Technology, Owerri, Nigeria.
22. Ingram, J.S., 1975. Standards, specifications and quality requirements for processed cassava products. Report G102, Tropical Product Institute, London, UK., pp: 1-26.