International Journal of Life Science and Agriculture Research

ISSN (Print): 2833-2091, ISSN (Online): 2833-2105

Volume 02 Issue 10 October 2023

DOI: https://doi.org/10.55677/ijlsar/V02I10Y2023-07

Page No : 387-392

Nutrient Composition, Functional and Pasting Properties of High Quality Cassava Flour from two Varieties Pro-Vitamin a Cassava

Olatunde, S.J.[1], Ohijeagbon, O.R.[2]*, Adesola, M. O.[3], Aremu, O.P.[4]

[1,2,3,4] Department of Food Science, Faculty of Food and Consumer Sciences, Ladoke Akintola University of Technology, Ogbomoso.

ABSTRACT: The study evaluated high quality cassava flour from two varieties of pro-vitamin A (pro-vitamin A white and pro-vitamin A yellow). The flours were analyzed for proximate composition, functional properties, pasting properties, Beta-carotene and cyanide. The data obtained was subjected to statistical analysis. The values of protein ranged from (8.667% and 9.563%), fat (4.819% and 5.387%), ash (1.269% and 1.426%), fibre (4.819% and 5.387%), moisture content (6.946% and 7.185%), carbohydrate (74.105% and 74.421%), Beta-carotene (24.300% and 24.700%) and hydrocyanide content (1.225ppm and 1.775ppm). There were little significance differences between the functional properties such water absorption capacity (108.200% to 125.840%), oil absorption capacity (173.420% to 184.720%), Bulk density(0.813% to 0.825%), swelling capacity (30.000% to 40.000%), solubility (0.743% to 1.372%), Dispersibility (0.884% to 1.098%). The result of the pasting properties ranged from 83.000 to 137.000RVU, 125.500 to 134.000RVU, 58.000 to 63.000RVU, 34.000 to 82.000RVU, 9.000 to 18.000RVU, 3.530 to 6.000mins, and 73.000 to 83.100ºc for peak, trough, breakdown, final viscosity, setback, peak time and pasting temperature, respectively. The results of this study revealed that there was no significant difference in the chemical composition of the two samples, but there were differences in the functional and pasting properties.

Published Online: 20 October 2023

Corresponding Author: Ohijeagbon, O.R.

1. INTRODUCTION

Cassava (*Manihot esculenta Crantz*) is a drought resistant root crop and the most commonly eaten staple food in Nigeria after rice and maize (Ohimain, 2015). They are lacking in many protein and essential micronutrient though rich in carbohydrates and fibre (Aniedu and Omodamiro, 2012). The root contains a higher percentage of starch which has a larger calorie. Relying on cassava-based diets can cause poor health, stunted growth, reduced capacity for physical activity, high occurrence of anemia, corneal blindness and impairment of immunity (Saltzman *et al*., 2013). The conventional white cassava provides daily body energy requirements but cannot cater for essential proteins and micronutrients like vitamin A which is required for healthy growth. The problem of malnutrition as a result of vitamin A deficiency in the developing countries remains a challenge (Mayer *et al*., 2008). Millions of people in the world not minding the vulnerable group now get fewer vitamins than what is needed in the diet. Provitamin A cassava is a biofortified yellow cassava that has great potential to alleviate vitamin A deficiency in sub-Saharan Africa. Most research institutes got involved in bio-fortification of some major stable crops such as cassava roots to curb vitamin A malnutrition (Mayer *et al*., 2008; Tanumihardjo, 2008). The yellow root cassava or β-carotene cassava varieties introduced in the recent times could improves the nutritional status of the consumers by providing up to 25% of daily vitamin A required by the body (Ferreira *et al.*, 2008). Therefore, there is a need to evaluate flour from varieties of these newly breed crops for value addition as well as enhancing better and wide range utilization of the crop (Mayer *et al*., 2008).

2. MATERIALS AND METHODS

Two different varieties of Pro-Vitamin A cassava (white and yellow cassava) were obtained from Ladoke Akintola University of Technology Teaching and Research farm. Cassava flour was produced from freshly harvested pro-vitamin A cassava roots according to the traditional method of Abass *et al*. (1998). The roots were peeled, washed and cut into chips. The cassava chips were grated, dewatered and it was sun-dried, the dried chips were milled into a fine powder and then it was packaged in a moisture proof material.

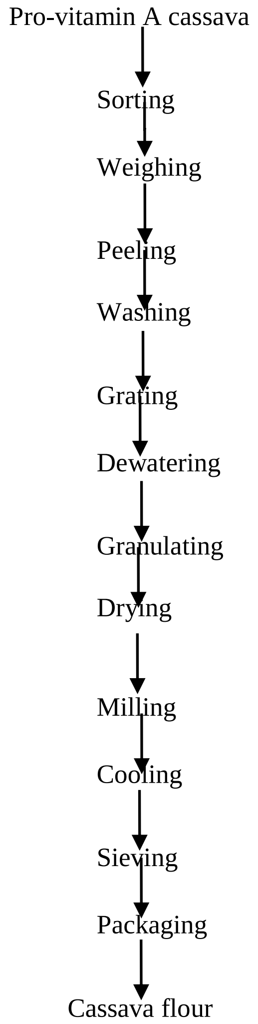

Figure1: Flowchart for the processing of cassava flour.

Proximate analysis of cassava flour

Moisture, fat, protein, ash, crude fibre and carbohydrate by difference were carried out by AOAC (2015).

Determination of residual hydrogen cyanide:

The sample (10g) was weighed into a beaker and 100 ml of distilled water was added and filtered with the use of filter paper. 25 ml of the filtrate was added into a conical flask and 5ml of 0.1M of $Mg(OH)_3$ was added. 3 drops of potassium dichromate was added into conical flask while the burette is then filled with 0.1M of $AgNO_3$. Titration was carried out until the mixture in the conical flask turns brown and the titre value was recorded (Esser *et al*. 1993).

Determination of Functional Properties

Bulk density was determined by Onimawo and Akubor (2005), 10 g of the sample was weighed into 100 ml graduated measuring cylinder, the initial volume was recorded. The measuring cylinder was tapped on the table continuously until the volume became constant, the final volume was recorded and the bulk density (g/ml) was calculated. Swelling capacity was carried out by Dhingra *et al.* (1992), water absorption capacity by Abbey and Ibeh (1988), oil absorption capacity (SefaDedeh et al., 2004). Dispersibility was determined by the method described by Kulkarni et al (1991).

Determination of pasting properties of flour

A Rapid Visco Analyzer (RVA) was used to evaluate the pasting properties of flour sample. 3 g of sample was weighed into a canister and made into slurry by adding 25 mL of distilled water. The canister (covered with a stirrer) was inserted into the RVA. The slurry was heated from 50 to 95°C with a holding time of 2 min followed by cooling to 50°C with 2 min holding time while maintaining a rotation speed of 160 rpm. The viscosity was expressed as Rapid Viscosity Units (RVU). Records of peak viscosity, breakdown viscosity, setback viscosity, final viscosity, pasting temperature (°C) and peak time (min) were taken (Falade & Olugbuyi, 2010).

3. RESULTS AND DISCUSSION

Table 1: Chemical Composition of provitamin A cassava flour

Property	Sample A	Sample B
Moisture (%)	6.946±0.317[a]	7.185±0.216[a]
Ash (%)	1.269±0.083[a]	1.426±0.133[b]
Lipid (%)	2.094±0.009[b]	2.018±0.141[a]
Crude fibre (%)	4.819±0.359[a]	5.387±2.070[b]
Protein (%)	8.667±0.074[a]	9.563±0.061[b]
CHO (%)	74.105±0.112[a]	74.421±2.499[a]
CalorificValue (kj100g^{-1})	149.620±0.478[b]	147.630±3.472[a]
Beta carotene (%)	24.700±0.141[a]	24.300±0.141[a]

Chemical composition of cassava flour made from pro-vitamin A cassava varieties

The chemical composition of the yellow and white flour samples is presented in Table 1. The moisture content ranged from 6.94% in pro-vitamin A yellow flour (PVAYF) sample to 7.19% in pro-vitamin A white flour (PVAWF). Flour products with MC less than 13% are more stable from moisture dependent deterioration (Shahzadi *et al*., 2005). Low MC is also desirable in cassava flour since it decreases hydrogen cyanide content as well as improves the palatability of cassava flour produced (Cumbana et al.,2007). The ash content ranged from 1.27% to 1.43% in PVAYF and PVAWF. The total ash content of the blends was higher in PVAWF. The values recorded were higher compared to results obtained by Rodríguez-Sandoval *et al.* (2008) in which ash content ranged from 0.1% to 0.7%. This suggests that the two samples contain high minerals. The composition of ash in cassava is influenced by mineral content in the soil where the cassava grows (Niba *et al*. 2001).

The fat content was between 2.09% in PVAYF and 2.04% in PVAWF. The relatively low fat content of the flours make them suitable raw materials in the formulation of a variety of food products for the elderly. The crude fiber content was between 4.82% in PVAYF and 5.39% in PVAWF. The fiber content increased as the percentage inclusion of PPF and UBF increased. This shows that the flour samples are good sources of fiber and can be used in the formulation of functional food products. Correlation between the consumption of high fiber food products and the reduction in high blood pressure, diabetes, hermorrhoids, and obesity has been reported (Chukwu *et al*., 2013; Jaja and Yarhere, 2015). The carbohydrate content ranged from 74.11%

Means within the same row with different alphabets are significantly different (p≤0.05)

Sample A Fortified provitamin-A yellow cassava flour
Sample B Fortified Provitamin-A cassava white flour

(PVAYF) to 74.42% (PVAWF). The increase in the level of carbohydrate in PVAWF might be as result of high amount of starch and sugar content in the white variety of pro-vitamin A (Ayo-Omogie and Ogunsakin, 2013). The energy content was between 149.62 and 146.67 kj/100g. This high-energy content of the flour may be advantageous for formulation of breakfast cereal and complementary foods (Iwe *et al.*, 2001). The flour samples had carotenoid content ranging between 24.300 to 24.700 µg/g. Orange-fleshed sweetpotato roots have been reported (Mills et al., 2015) to possess a higher amount of carotenoids than other varieties of sweetpotato root.

Functional properties of cassava flour made from pro-vitamin A cassava root

Table 2 shows the functional properties of cassava flour made from pro-vitamin A cassava root are presented. The value of water absorption capacity for sample A and B ranges between 108.200 to 125.840% and oil absorption capacity of the flour ranged from 173.420 to 184.720% respectively, Sample A had higher water absorption capacity and oil absorption capacity than Sample B. There was significant difference (P<0.05) in the water and oil absorption capacity of the flour samples, this agreed with (Svanberg, 1987) which stated that water absorption capacity is a useful indication of whether flour can be incorporated into aqueous food formulations. The flour samples have bulk density values of 0.813 to 0.825 with sample B which is a little higher than sample A. There was no significant difference (P<0.05). The values obtained were higher than brown tiger flour (*Cyperus esculentus*) as reported by Oladele and Aina (2007).Bulk density is a measure of the heaviness of a flour sample. Karuna et al. (1996) and Jones et al. (2000) reported that bulk density is generally affected by the particle size and density of the flour and it is one of the essential parameters in determining the type of packaging material, handling and application in the food industry. Swelling capacity and solubility as shown in Table 4.1 ranged from 30.000 - 40,000 and 0.743 - 1.372 respectively. Sample B have the lower swelling capacity and solubility than sample A. Significant difference exist ($P<0.05$) in the swelling index and solubility of the flour samples.

Table 2. Functional properties of Cassava Flour from pro-vitamin A cassava varieties

Property	Sample A	Sample B
Water Absorption Capacity (%)	125.840±6.936[b]	108.200±4.145[a]
Oil Absorption Capacity (%)	184.720±5.980[b]	173.420±2.337[a]
Bulk Density	0.813.300±0.023a	0.825.000±0.013[b]
Swelling Capacity (%)	40.000±0.000[b]	30.000±0.000[a]
Solubility (%)	1.372±0.277[b]	0.743±0.404[a]
Dispersibility	1.098±0.222[b]	0.844±0.031[a]

Means within the same row with different alphabets are significantly different ($p\leq0.05$)

Sample A Fortified provitamin-A yellow cassava flour
Sample B Fortified Provitamin-A cassava white flour

Pasting Properties of cassava flour made from pro-vitamin A cassava roots

Table 3 depicts the pasting properties of cassava flour made from pro-vitamin A cassava root. The pasting temperature of the samples ranges from 73.000^{0}c to 83.100^{0}c. There was significant difference in the pasting temperature of the samples. The pasting temperature provides an indication of the minimum temperature required for sample cooking, energy cost involved and other component stability (Ikegwu *et al*., 2015). It also gives an indication of the gelatinization time during processing (Odedeji and Adeleke, 2017). Peak viscosity is an index of the ability of starch-based food to swell freely before their physical breakdown (Sanni *et al*., 2008). The peak viscosity for the samples ranged from 83.000-137.000%. The Trough viscosity for the samples ranged from 125.000 to 134.000%. The trough is the minimum viscosity value in the constant

Table 3: pasting properties of two varieties provitamin A cassava flour

Property	Sample A	Sample B
Peak (RVU)	83.000±1.414[b]	137.000±0.000[a]
Trough (RVU)	125.500±0.000[b]	134.000±0.000[a]
Breakdown(RVU)	58.000±0.000[b]	63.000±1.414[a]
Final viscosity(RVU)	34.000±1.414[b]	63.000±1.414[a]
Setback(RVU)	34.000±1.414[b]	18.000±1.414[a]
Peak time(min)	3.530±0.014[b]	6.000±1.414[a]
Pasting temperature(°c)	73.000±0.000[b]	83.100±0.141[a]

Means within the same row with different alphabets are significantly different ($p\leq0.05$)

Sample A Fortified provitamin-A yellow cassava flour
Sample B Fortified Provitamin-A cassava white flour

Temperature phase of the RVA pasting profile and it measures the ability of the paste to withstand breakdown during cooling (Adebowale *et al*., 2012). The final Viscosity for the samples ranged from 34.000 to 82.000%. The final viscosity is commonly used to define the quality of particular starch-based flour, since it indicates the ability of the flour to form a viscous paste after cooking and cooling (Adebowale *et al*., 2012). The setback viscosity for the samples ranged from 9.000 to 18%. Setback viscosities are an indication of the extent of retrogradation Low setback viscosities of starches indicate that the products have a lower tendency to retrograde and vice versa (Adeyemi and Idowu, 1990). The peak time for the samples ranged from 3.530 to 6.000, peak time is a measure of the cooking time.

REFERENCES

1. Abass, A.B., Onabolu, A.O.&Bokanga, M. (1998). Impact of the high quality cassava flour technology in Nigeria. In root crops in the 21st century. Compiled by Akoroda, M.O. and Ngeve,J.M. Proceedings of the7th Triennial Symposium of the International Society for Tropical Root Crops-Africa Branch (ISTRC-AB). Centre International Conferences, Cotonou, Benin, 11-17 October, 1998.
2. Adesina, B. S., & Bolaji, O. T. (2013). Effect of milling machines and sieve sizes on cooked cassava flour quality. Nigerian Food Journal, 31(1), 115–119. https ://doi.org/10.1016/S0189-7241(15) 30065-5
3. Adetuyi, F. O., Badejo, O. F., Ikujenlola, A. V, & Omosuli, S. V. (2009). Storage influence on the functional properties of malted and unmalted maize (Zea mays LSSP mays) and soybean (Glycine max L Merill) flour blends. African Journal of Food Science 3: 56-60.
4. Adisa, R. S., Adefalu, L. L., Olatinwo, L. K., Balogun, K. S., & Ogunmadeko, O. O. (2015). Determinants of post-harvest losses of yam among yam farmers in Ekiti State, Nigeria. Bulletin of the Institute of Tropical Agriculture, Kyushu University, 38, 073-078.
5. Ahaotu, N. N., Anyogu, A., Obioha, P., Aririatu, L., Ibekwe, V. I., Oranusi, S.,&Ouoba, L. I. I. (2017). Influence of soy fortification on microbial diversity during cassava fermentation and subsequent physicochemical characteristics of garri. Food Microbiology, 66, 165–172. https :// doi.org/10.1016/j.fm.2017.04.019
6. Akingbala, J. O., Falade, K. O., and Ogunjobi, M. A. (2011). The effect of root maturity, preprocess holding and flour storage on the quality of cassava biscuit. Food and Bioprocess Technology, 4(3), 451–457. https ://doi.org/10.1007/s11947-009-0185-z
7. AOAC. (2015): Official methods of analysis (17th edition.). Washington DC: Association of official Analytical Chemists.
8. Apea-Bah F.B., Oduro I., Ellis W.O., Safo-Kantanka O. (2011) Factor Analysis and Age at Harvest Effect on the Quality of Flour from Four Cassava Varieties. World Journal of Dairy & Food Sciences 6: 43-54
9. Bala, A., Gul, K., and Riar, C. S. (2015). Functional and sensory properties of cookies prepared from wheat flour supplemented with cassava and water chestnut flours. Cogent Food & Agriculture, 1(1), 1019815. https ://doi.org/10.1080/23311 932.2015.1019815
10. Balagopalan,C.,Padmaja,G.,Nanda,S.K.,andMoorthy,S.M.(1988).Cassavainfood,feed,andindustry. CRCPress,BocaRaton,Florida,USA,p.205.
11. Beuchat, L. R. (1977). Functional and electrophoretic characteristics of succinylated peanut flour protein. Journal of Agricultural and Food Chemistry, 25, 258–261. http://dx.doi.org/10.1021/jf60210a044
12. Dudu, O. E., Lin, L., Oyedeji, A. B., Oyeyinka, S. A., & Ying, M. (2019). Structural and functional characteristics of optimised dry-heat-moisture treated cassava flour and starch. International Journal of Biological Macromolecules, 133, 1219–1227. https ://doi.org/10.1016/j.ijbio mac.2019.04.202
13. Dudu, O. E., Oyedeji, A. B., Oyeyinka, S. A., & Ying, M. (2019). Impact of steam-heat-moisture treatment on structural and functional properties of cassava flour and starch. International Journal of Biological Macromolecules, 126, 1056–1064. https ://doi.org/10.1016/j.ijbio mac.2018.12.210
14. Dziedzoave N.T., Abass A.B., Amoa-Awua W.K.A., Sablah M. (2006), Quality Management Manual for Production of High Quality Cassava Flour. International Institute of Tropical Agriculture.
15. Falade K., Akingbala J. (2008) Improved Nutrition and National Development Through the Utilization of Cassava in Baked Foods. Chapter 10 from Using Food Science and Technology to Improve Nutrition and Promote National Development, Robertson, G.L. & Lupien, J.R. (Eds), © International Union of Food Science & Technology
16. Falade K., Akingbala J. (2010): Utilization of Cassava for Food, Food Reviews International, 27:1, 51-83
17. Falade,K.O. and Akingbala,J.O.(2009). Utilization of cassava for food. Food Reviews International.
18. Falola, A., Salami, M., Bello, A., and Olaoye, T. (2017). Effect of yam storage techniques usage on farm income in Kwara State, Nigeria. Agrosearch, 17(1), 54-65.
19. Ferreira, C. F., Alves, E., Pestana, K. N., Junghans, D. T., Kobayashi, A. K., Santos, V. J., … Fukuda, W. (2008). Molecular characterization of Cassava (Manihot esculenta Crantz) with yellow-orange roots for beta-carotene improvement. Crop Breeding and Applied Biotechnology, 8, 23–29.
20. Gyedu-Akoto, E., & Laryea, D. (2013). Evaluation of cassava flour in the production of cocoa powder-based biscuits. Nutrition and Food Science, 43(1), 55–59. https ://doi.org/10.1108/00346 65131 1295914
21. Ilona, P "Delivery of vitamin a cassava in Nigeria. CIAT-HarvestPlus survey," in The 2nd Global Conference on Biofortification: Getting Nutritious Foods to People. Conference Brief #23a, IITA, 2012.
22. Mayer, J. E., Pfeiffer, W. H., and Beyer, P. (2008). Biofortified crops to alleviate micronutrient malnutrition. Current Opinion in Plant Biology, 11, 166–170.

23. Ministry of Food and Agriculture, Ghana (2005). Cassava development in Ghana. A review of cassava in Africa with country case studies on Nigeria, Ghana, the United Republic of Tanzania, Uganda and Benin. FAO, Rome available http://www.fao.org/docrep/009/a0154e/A0154E07.htm#ch4 [2012-10-14]
24. Mlingi, N., Mtunda, K., Ndunguru, G.T.,Kiriwaggulu, A. and Mahungu, N.M. (1998). Promotion of cassava utilization for improvementof food security and income generation in Tanzania: Viability of processing cassava flour for biscuit productionin Dares-Salaam. In:Root Crops in the 21st Century. Compiled by Akoroda, M.O. and Ngeve, J.M., Proceedings of the 7th Triennial Symposium of the International Society for Tropical Root Crops-Africa Branch (ISTRC-AB). Centre Internationaldes Conferences, Cotonou, Benin, 11-17October,1998.
25. Montagnac J.A., Davis R.C., and Tanumihardjo S.A. (2009) Nutritional value of Cassava for use as a staple food and recent advances for improvement. Comprehensive reviews in food science and food safety. Vol 8. Pp 181-194. Institute of Food technologists.
26. Muoki, P. N., Kock, L. H., and Emmambux, M. N. (2012). Effect of soy flour addition and heat-processing method on nutritional quality and consumer acceptability of cassava complementary porridges. Journal of Food Agriculture Science, 92, 1771–1779.
27. NRCRI, "National root crops research institute, Umudike," Annual Report, 2014.
28. Oladele, A. K., and Aina, J. O. (2007). Chemical composition and functional properties of flour produced from two varieties of tigernut (Cyperus esculentus). African Journal of. Biotechnology, 6, 2473–2476. http://dx.doi.org/10.5897/AJB
29. Onabolu,A.and Bokanga,M.(1995).Promotion of high quality cassava flour (HQFC) for the food industry in Nigeria. Proc.6th Symposium of the International Society for Tropical Root Crops- African Branch (ISTRC-AB),pp.263-269.
30. P. Ilona, H. Bouis, M. Palenberg, M. Moursi, and A. Oparinde, "Vitamin a cassava in Nigeria: Crop development and delivery," African Journal of Food, Agriculture, Nutrition and Development, vol. 17, pp. 12000-12025, 2017. Available at: https://doi.org/10.18697/ajfand.78.harvestplus09.
31. Root and Tuber Improvement Programme RTIP (2004), Cassava processing in Ghana. An Information guide. Ministry of Food and Agriculture, Ghana
32. Tanumihardjo, S. A. (2008). Food-based approaches for ensuring adequate vitamin A nutrition. Tapioca starch materials. Beijing Ligong Daxue Xuebao, 26, 549–552.
33. Cumbana, A., Mirione, E., Cliff, J. and Bradbury, J.H. (2007). Reduction of cyanide content of cassava flour in Mozambique by the wetting method.Food Chemistry, 101(3), 894 – 897. https://doi.org/10.1016/j.foodchem.2006.02.062
34. Chandra, K.D. and Samsher, A.Y. (2013). Assessment of functional properties of different flours. African Journal of Agricultural Research, 8(38), 4849-4852.
35. Hsu, C.L., Chen, W., Weng, Y.M. and Tseng, C.Y. (2003). Chemical composition, physical properties, and antioxidant activities of yam flours as affected by different drying methods. Food Chemistry, 83(1)
36. Rodríguez-Sandoval, E., Fernández Quintero, A., Cuvelier, G., Relkin, P.and Bello-Pérez, L. (2008). Starch retrogradation in cassava flour from cooked parenchyma. Starch/Stärke, 60(34), 174-180. https://doi.org/10.1002/star.200700683
37. Niba, L.L., Bokanga, M.M., Jackson, E.L., Schlimme, D.S. and Li, B.W. (2001). Physicochemical properties and starch granular characteristics of flour from various Manihot esculenta (cassava) genotypes.
38. Sanni, L.O., Adebowale, A.A., Maziya-Dixon, B. and Dixon, A.G.O. (2008). Chemical Composition and pasting properties of cmd resistant cassava clones planted at different locations. Journal of Food Agriculture and Environmental, 6(2), 97–104.