ASSESSMENT OF PASTING PROPERTIES AND ANTINUTRITIONAL FACTORS OF AERIAL YAM AND COCOYAM COMPOSITE FLOURS

*Ojo, M.O[1]. Femi, F. A[1]. and Dzungwe, H. M[1].
[1]Department of Food Science and Technology, Federal University of Technology Minna, Niger State.
*Author for correspondence: ojo@futminna.edu.ng

ABSTRACT

Aerial yam (*Dioscorea bulbifera*) bulbs and cocoyam (*Xanthosoma sagittifolium*) corms were processed into aerial yam flour (AYF) and cocoyam flour (CF) respectively and used to formulate composite flours blends in the ratio AYF:CF; 100:00 , 90:10, 80:20, 70:30, 60:40 and 50:50. The 100% aerial yam flour served as control. The pasting properties and the antinutritional factors were determined using standard procedures. Results of the pasting properties indicates that the composite flours containing 10% cocoyam flour was comparable to other blends trough, final and setback viscosities. The pasting temperature did not differ significantly ($P \geq 0.05$) within the composite blends and the 100% aerial yam. The result of the antinutritional factors showed that phytate, saponin, tannin, oxalate and cyanide were low and falls within the acceptable limits for consumption. The study concluded that the composite flours may find relevance in food applications as food thickener and consumption as stiff porridge especially in developing countries.

Keywords: Aerial yam, Cocoyam, Pasting properties, Antinutritional factors, flour blends

INTRODUCTION

Aerial yam (*Dioscorea bulbifera*) is an unpopular bulbil bearing, fast-growing variety of yam species with good source of calories and minerals such as iron, calcium and phosphorous among the edible yam (Nwosu, 2013). Aerial yam, also known as air potatoes is grown for some regions of Nigeria its bulbils are eaten during the famine season. Cocoyam is the third most important root and tuber crop in Nigeria following yam and cassava though consumption of cocoyam is assumed to be for low income earners of the society in some communities, because it is readily available at a relatively lower price (Amadi *et al.*, 2017). Cocoyam is grown for its edible roots though some hard-to-cook property has limited the consumption Cocoyam corms generally have been noted to contain anti nutrients. It is an underutilized tropical root plant in Nigeria, its utilization is still at the subsistence level, making it a highly neglected crop. Aerial yam and cocoyam are unpopular, one of the reasons being the presence of toxicants. Therefore, they are less studied, underutilized both at subsistence and commercial levels, and have received minimal interest and attention by food processors. In Nigeria, aerial yam and cocoyam are used as nutrition therapy management of some ailments like diabetes (Igbokwe *et al.*, 2017; Kalu *et al.*, 2021). The plant does not just serve as energy food but are also rich in phytochemicals which can be used for human wellbeing. However, the level of these antinutrients in food is important due to their adverse effects. They limit the availability of nutrients such as copper, iron and zinc in food. In some cases, antinutrients for example, tannins can also bind to toxic metal ions (heavy metals), reducing their absorption and therefore exerting a positive effect on health. Variations in the concentration of these antinutrients in plants differ with the specie, cultivar and processing methods. Therefore, processing such crops into flours will reduce post-harvest losses and characterizing the flour blends based on pasting profile could help complement other efforts been made to increase their usage, popularize and enhance the use of these food crops among the populace.

MATERIALS AND METHODS

Aerial yam(*Dioscorea bulbifera*) bulbs and cocoyam (*Xanthosoma sagittifolium*) corms were purchased from Gboko Main Market, Benue state, Nigeria and Kure Ultra-modern Market, Minna, Niger State Nigeria respectively. Both were transported to the Laboratory using jute bags. The aerial yam (AYF) and cocoyam flours (CF) were prepared and formulated into blends (AYF:CF) at ratios 100:00, 90:10, 80:20, 70:30, 60:40 and 50:50. Rapid Visco Analyzer (RVA), as defined by Newport Scientific (1998), was used to determine the pasting parameters. In the RVA container, 3 g of the various flour blends was mixed with 25 mL of distilled water to make slurry. The canister was lowered into the system after being placed in the tower. The slurry was heated to 95 °C for 14 minutes and then cooled to 50 °C. The peak, trough, final, breakdown, and setback viscosities were calculated, together with the pasting temperature and time to reach peak viscosity. The antinutritional factors: phytate, cyanide, tannin, saponin and oxalate were determined using the methods as described by Wada *et al.* (2019).

Statistical Analysis

Experiments were conducted in triplicates. One-Way Analysis of Variance (ANOVA) and Duncan Multiple Range Test at 5 % level of significance were performed using SPSS software version 23 to evaluate differences in data obtained for the flour blends

RESULTS AND DISCUSSION

The pasting properties of the cocoyam and aerial yam flour blends samples are presented in Table 1. Pasting property is one vital functional property which measures the ability of flour to form a paste. It dictates the textural integrity of products and the quality of flour (Adebowale *et al.*, 2008). The peak viscosity (PV) is the maximum viscosity a flour can reach before collapsing ranged from 2357.67 to 3085.33 cP while the trough viscosity (TV) which reflects a paste's ability to survive breakdown when heated, ranged from 2088.33 to 2544.33 cP. The 100 CF had the highest value and 60AYF:40CF the lowest. The breakdown viscosity (BV) demonstrates the paste's resistance to shear stress as well as its stability under thermal treatment (Falade and Okafor, 2015). The flour samples had BV ranging from 93.00 to 997.00 cP. Lower BV determines the paste's resistance to heat and shear disruptions, which is critical in determining paste stability (Adebowale *et al.*, 2008). These results suggest that 100 % CF and the composite flour samples with the low breakdown viscosities are more likely to

tolerate high heat treatments, shear stress, hence paste stability and these would be better suited for use in products that require high-temperature treatment. Final viscosity (FV) of the flour samples also ranged from 3014.00 (100CF) to 3998.66 cP (100AYF). FV describes the viscosity of the paste after the entire cooking and cooling process or the viscosity in actual use (Oyeyinka *et al.*, 2020), it could ensure a consistent stability of products when used as a food ingredient for thickening and stabilizing roles. According to Falade *et al.* (2015) a high setback viscosity suggests a lesser susceptibility to retrogradation. The highest setback value was recorded for 100% AYF. High setback indicates that these could be used in products that require cold temperature storage as well as for making pasta and some highly viscous local delicacies like *fufu*. Pasting time and temperature ranged from 4.87 (100 CF) to 7.00 min (60AYF:40CF) and 85.37°C (100 CF) to 86.60°C (50AYF:50CF) respectively. These findings are consistent with the study of Oyeyinka *et al.* (2020), which suggested that peak viscosity and pasting time and temperature are inversely proportional, meaning that higher peak viscosities have lower pasting times and temperatures.
The results for the antinutritional factors are as presented in Table 2. The most abundant of the antinutrients in the flour samples were saponin which ranged between 36.21 (100AYF) and 26.56mg/100g (100CF), followed by cyanide which ranged from 29.96 to 13.26 mg/100g (100AYF). Oxalate which ranged from 8.00 to 9.03mg/100g was the lowest in all the samples. Phytate ranged from 10.10 to 23.87 mg/100g while tannin ranged between 15.06 to 18.44 mg/100g. The cocoyam flour had the lowest value of saponin, phytate and tannin while the aerial yam flours had higher values. Therefore, composites of aerial yam and cocoyam flours may help lower the risk of antinutrients in food processing and applications. There was a significant ($p < 0.05$) difference among the samples. However no significant ($p < 0.05$) difference was observed with respect to oxalates among the composite flours. Variations in the concentration of these antinutrients in plants vary with the specie, cultivar and processing methods. The values reported here for the various flour samples are within the acceptable limits of 10 mg/g and at this level they are beneficial to human health (Ojinnaka *et al.*, 2017).

Table 1. Pasting properties of aerial yam and cocoyam flour blends

Parameters (cP)	Flour blends						
	100AYF	90AYF:10CF	80AYF:20CF	70AYF:30CF	60AYF:40CF	50AYF:50 CF	100CF
PV	$2822.00^{b}\pm3.46$	$2754.00^{c}\pm24.25$	$2502.33^{d}\pm23.09$	$2523.67^{d}\pm21.93$	$2357.67^{e}\pm11.54$	$2378.00^{e}\pm10.39$	$3085.33^{a}\pm15.01$
TV	$2544.33^{a}\pm5.77$	$2506.33^{a}\pm20.21$	$2310.00^{c}\pm67.55$	$2371.00^{b}\pm20.78$	$2227.67^{d}\pm15.94$	$2285.00^{c}\pm12.12$	$2088.33^{e}\pm20.21$
BV	$294.33^{b}\pm19.63$	$247.67^{c}\pm4.04$	$225.67^{d}\pm13.28$	$152.67^{e}\pm1.15$	$130.00^{f}\pm4.58$	$93.00^{g}\pm1.73$	$997.00^{a}\pm5.20$
FV	$3998.66^{a}\pm27.14$	$3948.33^{a}\pm12.70$	$3545.66^{b}\pm61.78$	$3430.67^{c}\pm98.15$	$3321.33^{d}\pm10.97$	$3231.67^{e}\pm23.09$	$3014.00^{f}\pm8.66$
SV	$1454.33^{a}\pm21.36$	$1442.00^{a}\pm32.91$	$1169.00^{b}\pm51.96$	$1059.67^{c}\pm77.36$	$1093.67^{c}\pm5.13$	$933.33^{d}\pm0.58$	$925.66^{d}\pm11.55$
P_{ti}(mins)	$6.26^{d}\pm0.11$	$6.42^{c}\pm0.04$	$6.70^{b}\pm0.03$	$6.78^{b}\pm0.15$	$7.00^{a}\pm0.00$	$6.68^{b}\pm0.07$	$4.87^{e}\pm0.07$
P_{te}(°C)	$86.17^{ab}\pm0.45$	$85.65^{ab}\pm0.05$	$85.62^{ab}\pm0.03$	$85.65^{ab}\pm0.05$	$85.68^{ab}\pm0.03$	$86.60^{a}\pm1.16$	$85.37^{b}\pm0.38$

Values represent means and standard deviation of triplicate determinations. Mean values with different superscript in a row are significantly ($p\leq0.05$) different from each other.
PV= peak viscosity, TV= trough viscosity BD= breakdown viscosity, FV= final viscosity
SV= setback viscosity P_{ti}= pasting time, P_{te}= pasting temperature . AYF=Aerial yam flour,

CF = Cocoyam flour

Table 2. Some antinutritional factors in aerial yam and cocoyam flour blends

ANFs mg/100g	Flour blends						
	100AYF	90AYF:10CF	80AYF:20CF	70AYF:30CF	60AYF:40CF	50AYF:50CF	100CF
Phytate	$23.87^{a}\pm 0.9$	$23.81^{a}\pm0.13$	$22.52^{b}\pm0.81$	$20.40^{c}\pm0.40$	$18.00^{d}\pm 0.82$	$14.01^{e}\pm0.02$	$10.10^{f}\pm0.37$
Cyanide	$13.26^{f}\pm 0.52$	$15.27^{e}\pm0.51$	$17.27^{d}\pm0.95$	$21.17^{c}\pm0.42$	$22.00^{c}\pm0.72$	$25.57^{b}\pm0.63$	$29.96^{a}\pm0.74$
Tannin	$18.44^{a}\pm0.41$	$18.00^{ab}\pm0.31$	$17.48^{abc}\pm0.40$	$17.62^{abc}\pm0.54$	$17.21^{bc}\pm0.59$	$16.85^{c}\pm0.71$	$15.06^{d}\pm0.77$
Saponin	$36.21^{a}\pm0.64$	$31.61^{b}\pm1.07$	$32.69^{b}\pm0.85$	$30.34^{c}\pm0.54$	$29.63^{cd}\pm0.55$	$28.45^{d}\pm0.59$	$26.56^{e}\pm0.58$
Oxalate	$8.00^{b}\pm0.20$	$8.00^{b}\pm0.10$	$8.30^{b}\pm0.01$	$8.00^{b}\pm0.01$	$8.07^{b}\pm0.00$	$8.40^{b}\pm0.01$	$9.03^{a}\pm0.02$

Values represent means and standard deviation of triplicate determinations. Mean values with different superscript in a row are significantly ($p\leq0.05$) different from each other
ANFs = antinutritional factors, AYF=Aerial yam flour, CF = Cocoyam flour

CONCLUSION

Based on the evaluation of the pasting properties and antinutritional factor of the aerial yam and cocoyam flour composite blends in this study, it can be summarized that the inclusion of cocoyam in the blends resulted in lower breakdown viscosities hence paste stability in high temperatures. They may well suit for consumption as stiff porridge which is consumed by a larger populace. Although the antinutritional factors varied in the composite flours their values are low and within the acceptable limit hence may not have serious adverse effect on nutrient bioavailability and at this quantities, it could be more advantageous to the consumer. Further work should be carried out on these blends in the area of micronutrients determinations, starch digestibility, sensory evaluation and nutritional evaluation such that individuals with diet related disease and diet restrictions like the obese and diabetics could benefit.

REFERENCES

Adebowale, A. A., Sanni, L. O., and Onitilo, M. O. (2008). Chemical composition and pasting properties of tapioca grits from different cassava varieties and roasting methods. *African Journal of Food Science, 2*(1), 77–82

Amadi, A. C. J. (2017). "Glycaemic index of three cocoyam varieties consumed in Imo State, Nigeria," *Journal of Dietitians Association of Nigeria*, 8, 12-31,

Falade, K. O., and Okafor, C. A. (2015). Physical, functional, and pasting properties of flours from corms of two cocoyam (*Colocasia esculenta* and *Xanthosoma sagittifolium*) cultivars. *Journal of Food Science and Technology, 52*(6), 3440–3448.

Kalu S. E., Osuagwu, A. N., Ekpo, I. A., Okonko, L. E., and Ubi, G. M. (2021). Morphological and physiological screening of aerial yam (*Dioscorea bulbifera L.*) for sodium chloride tolerance. *Annual of Research and Review in Biology, 36*(1), 44-52.

Igbokwe, C. J., Akubor, P.I., and Mbaeyi-Nwaoha, I. E. (2017) Effect of steam blanching and sulphiting on the antidiabetic potentials of aerial yam (*D. bulbifera*) amala flour fed alloxan induced diabetic rats. *Food Science and Technology 5*(3): 80-85,

Newport Scientific (1998). Applications manual for the rapid viscotmanalyzer using thermocline for windows. Newport Scientific Pty Ltd. Australia. P. 2-26.

Nwosu, J. N. (2013). Evaluation of the functional and sensory properties of biscuits produced from aerial yam (*Discorea bulbifera*). *International Science and Investigation Journal, 2*(5), 1-17.

Ojinnaka, M. C., Okudu, H., and Uzosike, F. (2017). Composition and functional properties of major cultivars of aerial yam (*Dioscorea bulbifera*) in Nigeria. *Food Science and Quality Management*, 62, 10-16

Oyeyinka, S. A., Adeloye, A. A., Olaomo, O. O., and Kayitesi, E. (2020). Effect of fermentation time on physicochemical properties of starch extracted from cassava root. *Food Bioscience, 33*(1), 1–8.

Wada, E., Feyissa, T., and Tesfaye, K (2019). Proximate, Mineral and Antinutrient Contents of Cocoyam (*Xanthosoma sagittifolium (L.)* Schott) from Ethiopia". *International Journal of Food Science*, Article ID 8965476, 7 pages. https://doi.org/10.1155/2019/8965476