Journal of Scientific Research & Reports

18(1): 1-7, 2018; Article no.JSRR.26859
ISSN: 2320-0227

Effect of Pretreatment on the Functional, Pasting and Baking Characteristics of Cocoyam Flour

O. Akinlua[1], S. S. Nupo[1*], J. V. Akinlotan[2] and Nofisat Sunmonu[2]

[1]*Department of Food Technology, Moshood Abiola Polytechnic, Ojere, Nigeria.*
[2]*Department of Nutrition and Dietetics, Moshood Abiola Polytechnic, Ojere, Nigeria.*

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JSRR/2018/26859
Editor(s):
(1) Surapong Pinitglang, Department of Food Science and Technology, School of Science and Technology, University of the Thai Chamber of Commerce, Thailand.
Reviewers:
(1) Sherif Ramzy Mohamed, Egypt.
(2) Karen Breshears, University of Central Missouri, USA.
(3) J. A. A. C. Wijesinghe, University of Sri Jayewardenapura, Sri Lanka.
Complete Peer review History: http://www.sciencedomain.org/review-history/23221

Original Research Article

Received 6th May 2016
Accepted 11th June 2016
Published 16th February 2018

ABSTRACT

Cookies were produced from pretreated cocoyam flour (*Xanthosoma sagittoforus*). Pretreatment such as fermentation, blanching and soaking in potassium metabisulphite was done. The pretreated flours were used to bake cookies. Functional and pasting properties of the flours were determined. Packed capacity of the flours ranged from 0.95- 0.97 g/cm. The water absorption capacity ranged from 1.98-2.3 g/g. The oil absorption capacity and swelling power ranges from 1.97-2.08 g/g and 5.74 - 8.04 g/cm respectively. Fermented cocoyam flour had the highest peak, trough, breakdown, and final viscosity and setback values. The peak viscosity and setback value ranges from 2278 – 2873 cP and 850 – 1088 cP respectively, the trough and breakdown set point value falls between 1757.5 – 2056 and 476 – 782.5 cP respectively. The panelist preferred cookies made from potassium metabisulphite cocoyam flour (100%), and blanched cocoyam flour (100%). It can therefore be concluded that cookies can be produced from pretreated and untreated cocoyam flour.

Keywords: Fermentation; blanching; soaking; viscosity; absorption.

**Corresponding author: E-mail: nupo.sunday@mapoly.edu.ng;*

1. INTRODUCTION

Cocoyam is an ancient crop grown for its edible corm, cormels and other traditional uses by subsistence farmers [1]. Unlike potato, cocoyam has not fully entered the international trade market. Nigeria is the world's leading producer of cocoyam accounting for about 40% of total production [2]. Cocoyam contribute a significant portion of the carbohydrate content of the diet in many regions in developing countries and provide edible starchy storage corms and cormels. Although, they are less important than other tropical root crops such as yam, cassava and sweet potato, they are still a major staple in some part of the tropics and sub-tropics. It is used to produce ebiripo which is a local food eaten by the Ijebu's, a small community in the southeast of Nigeria.

Cocoyam contains digestible starch, protein of good qualities, vitamin C, thiamine, riboflavin, niacin and high source of amino acids [3]. All these are underexploited to man because of low utilization. Cocoyam has a fine granular starch, which improves binding and reduces breakage of snack products [4]. Snack food such as cookies is produced from wheat. Wheat is cultivated in many parts of the world, but, imported by countries with unfavorable climatic conditions such as Nigeria [5]. The need to source for other non wheat flour arises as the demand and price of this product (wheat flour) is high. It contains carbohydrate, between 17-26%, crude fiber 0.6-1.9%. Fiber has the physical properties that have the potential of binding fats, cholesterol and minerals such as zinc, copper, iron and magnesium [6].

Pretreatment such as fermentation, blanching and soaking has been known to affect root, cereals and tuber crops [7]. Blanching inactivate enzymes. It has also resulted in the increased drying rate of products such as apple and peaches, red pepper [8]. Fermentation is a process which not only modifies some physical characteristics of crops, but also increases the level of nutrients, digestibility, and bioavailability and decreases the level of anti nutrient in crops [9].

The need to develop adequate substitute for wheat as the demand and price of this product is high. Cocoyam has a fine granular starch, which improves binding and reduces breakage of snack products. Pretreatment such as blanching inactive enzymes, fermentation increases bioactivity, digestibility and decreases anti-nutrients in crops. The aim of the research is to investigate the effect of pretreatment on the functional, pasting and baking characteristics of cocoyam flours.

2. MATERIALS AND METHODS

Matured cocoyam of about 12 months grown in Abeokuta was bought from a market in Abeokuta. The cocoyam corms were peeled and sliced. The slices were divided into four portions. The first portion was fermented for 24 hrs and dried according to the method of Oke and Bolarinwa [10]. The second portion was blanched in hot air for 5 min and sun dried according to the method of Amadikwa [11]. The third portion was soaked into 0.75% metabisulphite for 5 min [12]. Barbosa and Vega [13] method was used to process untreated cocoyam flour, which was the last portion.

3. COOKIE PRODUCTION

The cocoyam flour is to be mixed with other ingredients to form dough for 3 min. The dough was sheeted and cut into circular shapes using a cookie cutter. The shapes were placed on an aluminum tray baked for 10 min at 160°C. Cooled and stored in air-tight containers at ambient temperature.

Table 1.a. Cookie recipe

Recipe	Quantity
Flour	400 g
Powdered sugar	160 g
Butter	160 g
Baking powder	2 g
Salt	pinch
Egg	24 g

3.1 Moisture Content

This was done according to AOAC (1995). An empty dish and lid was dried in an oven at 105°c for 3 h and transfer to a desiccator to cool. The empty dish and lid was weighed. Five g of sample was weighed into a dish and spread uniformly. The dish with the sample is placed into the oven at 105°c until a constant weight was observed. After drying the dish partially covered with lid was transferred into the desiccator to cool. The dish and its dry sample is reweighed.

$$\text{Moisture (\%)} = \frac{(w_1 - w_2)}{W} \times 100$$

Where

$w_{1=}$ weight of sample before drying
w_2= weight of sample after drying

3.2 Functional Property

3.2.1 Water absorption capacity

Water absorption capacity was done according to Onwuka, [14]. One g of sample was weighed into a clean conical graduated centrifuge tube and mixed thoroughly with 10 ml of water using a stirrer for 30 secs. The sample was then allowed to stand for 30 min at room temperature after which centrifuged at 5000 rpm for 30 min. After centrifugation, the volume of the free water (supernatant) was read directly from the graduated centrifuge tube. The absorbed water was converted to weight (g) by multiplying the density of water (1 g/ml). The water absorption capacity is expressed in grams of water absorbed per gram of flour sample.

3.2.2 Oil absorption capacity

Oil absorption capacity of the samples was done according to Onwuka [14]. One g of sample was weighed into a clean conical graduated centrifuge tube and mixed thoroughly with 10 ml of oil using a stirrer for 30 secs. The sample was allowed to stand for 30 min at room temperature after which it was centrifuged at 5000 rpm for 30 min. After centrifugation, the volume of the free oil (supernatant) was read directly from the graduated centrifuge tube. The absorbed oil is then converted to weight (g) by multiplying the density of oil (1 g/ml). The oil absorption capacity is expressed in grams of oil absorbed per gram of flour sample.

3.3 Bulk Density

Bulk density was determined by placing 20 g of the sample into a weighed measuring cylinder and tapped gently to eliminate air spaces, the resulting volume was recorded and loose density was determined by placing 20 g of the sample into a measuring cylinder and the volume was recorded without tapping.

3.4 Pasting Properties

This was analyzed using the method of Delcour et al. [15]. Rapid Visco Analyser (RVA) model 3c was used to analyse. Five g of sample was accurately weighted into a weighing vessel. Twenty five ml of distilled water was dispensed into a new test canister. Sample was transferred into the water surface in the canister after which the paddle is placed into the canister. The blade was vigorously joggled up and down through the sample ten times or more until no flour lumps remain neither on the water surface nor in the paddle. The paddle is place in the canister and both insert firmly into the paddle coupling. The measurement cycle was initiated by depressing the motor power of the instrument. The test is allowed to proceed and terminate automatically.

3.5 Swelling Power

Swelling power was carried out according to Leach et al. [16]. One g of sample was accurately weighed and quantitatively transferred into a clean dried test tube and weighed (w_1). The sample was then dispersed in 10 ml of distilled water. The resultant slurry was heated at 70°C for 30 min. in a water bath. The mixture is cooled and centrifuged at 500 rpm for 15 min. Approximately 5 ml of the supernatant was dried to a constant weight at 110°C. The residue obtained after drying the supernatant represent the amount of starch solubilized in water. Swelling power was calculated on dry weight basis. The residue obtained from the above experiment (after centrifugal) with water was retained and transferred to a clean dried test tube used earlier and weighed (w_2).

3.6 Diameter

Cookie diameter (cm) was measured by laying six cookies edge to edge with the help of scale and the rotating them by 90°C and re-measuring. The average diameter of the cookie was taken as the average of the two readings divide by six. This measurement is to be taken from 2 set of cookie from the same batch. For each variation and values is to be presented as mean ± standard deviation [16].

3.7 Thickness

The thickness of four cookies was measured using a micrometer. The thickness of each cookie is recorded four times and the average measurement was noted [16].

3.8 Spread Ratio

The ratio of average diameter to an average thickness of the cookies [16].

3.9 Sensory Evaluation

This was carried out using a standard method [17]. The sensory attributes of the cookies was evaluated by 20 panelists consisting of students of the Moshood Abiola Polytechnic. Samples were evaluated using a nine point Hedionic scale for preference and multi- comparism for the different test where “1” equaled “dislike very much” and “9” equaled “like very much“. Each sample was served and presented in a white plastic coded with a random set of 3 digit numbers. The panelists were given drinking water to rinse their mouth before evaluating each sample. The attribute to be evaluated are color, taste, crunchiness, appearance, texture and overall acceptability. The data collected was analysis using statistical package for the social sciences and Analysis of Variance (ANOVA) were used to separate means.

4. RESULTS AND DISCUSSION

Functional properties of the pretreated cocoyam flour (Table 1b) shows that the loose bulk density of the flours is 0.49 g/cm with no significant differences between metabisulphite and fermented cocoyam flour, while there is a significant difference ($p<0.05$) between the samples in packed bulk density which ranged from 0.95 g/cm to 0.97 g/cm. The water absorption capacity ranged from 1.98 g/g to 2.3 g/g. Metabisulphite and untreated cocoyam flour had the lowest and highest value in water absorption capacity respectively. The swelling power of the samples was between 5.74 g/cm – 8.04 g/cm, blanched cocoyam flour had the highest swelling power. Functional properties such as water absorption capacity, gelling and rheology are influenced by the type and nature of proteins found in the flour [18]. Ayernor [19] stated that the degree of disintegration of the native starch granule influences the water binding ability of the starchy system. The highest values in water absorption capacity, oil absorption capacity and packed bulk density were recorded in untreated, metabisulphite, and blanched cocoyam flour respectively. As the water absorption of the flour increases, the viscosity decreases. The low swelling capacity of metabisulphite cocoyam flour could be attributed to its low water absorption capacity. Low bulk density is advantageous for the infants as both calorie and nutrient density [20]. High bulk density is a good physical attribute when determining mixing quality of particulate matter [21]. Water absorption capacity is a useful indication of whether flours can be incorporated into aqueous food formulation especially those involving dough handling. Niba et al. [22] also stated that W.A.C is important in bulking and consistency of products as well as baking applications. The oil absorption capacity of fermented cocoyam flour has 1.97 g/g which is the lowest and metabisulphite cocoyam flour having 2.08 g/g which is the highest with untreated cocoyam flour and blanched cocoyam flour having 2.03 g/g and 1.99 g/g respectively. Oil acts as a flavor retainer and helps improve sensory properties of baked products. Blanched cocoyam flour has the highest swelling capacity of 8.04 g/g followed by fermented cocoyam flour 6.46 g/g and metabisulphite cocoyam flour having the lowest swelling power (5.74 g/g).

The pasting property (Table 2) shows that the peak viscosity value ranged from 2278 to 2838 cP. The highest peak viscosity was recorded in fermented cocoyam flour while blanched cocoyam flour had the lowest peak viscosity. Peak viscosity is the maximum viscosity attained during or soon after the heating portion of the test in cP. The trough value ranged from 1757.5 to 2056 cP in blanched and fermented cocoyam flour respectively. Break down set point ranged from 476 to 782.5 cP with untreated cocoyam flour and fermented cocoyam flour having the lowest and highest value respectively. Set back value ranged from 850 to 1088 cP in blanched and fermented cocoyam flour respectively. The highest peak time and temperature was recorded in blanched cocoyam flour and the lowest in untreated cocoyam flour. Peak viscosity indicates the water binding capacity of the flours and it occurs at the equilibrium point between swelling, causing an increase in viscosity rupture and alignment leading to its decrease. Set back has been correlated with texture of various products. There is a relationship between amylase content and set back; high amylase indicates high leaching hence high set back. Pasting temperature gives an indication of gelatinization time during processing [23]. It is the temperature at which the first detectable viscosity is measured and an index characterized by initial change due to swelling of the flour. It has been reported to relate to water binding capacity, a high pasting temperature implies higher water binding capacity [24] (Table 3). Physical characteristics of the cookies produced from pretreated and untreated cocoyam flour. The thickness, diameter, spread ratio and shrinkage of the cookies ranged from 0.48 to 8.94 for wheat flour, 0.48 to 9.29 for untreated cocoyam flour, 0.55 to 7.67 for blanched cocoyam flour, 0.49 to 7.67 for metabisulphite cocoyam flour and 0.5 to 8.56 for fermented cocoyam flour. As the percentage of cookies increased, spread ratio and diameter increases, the thickness decreases, which could be due to the water absorption capacity. Cookies having a higher spread ratio are considered the most desirable.

Mean sensory scores of cookies produced from pretreated cocoyam flour (Table 4) indicates that the taste, crunchiness, texture, color and overall acceptance value ranged from 2.2-4.6, 3.4-4.65, 2.5–4.8, 5.25-6.65 and 3.05-4.45 respectively. Cookies from blanched, metabisulphite and untreated flours are similar to one another in taste, texture and overall acceptability. Cookie from fermented cocoyam flour was different from other sample in taste and similar to untreated cocoyam flour in crunchiness. While in color no significant differences exist between the samples. From the result, it can be deduced that the blanched cocoyam cookie was slightly different from the other samples.

Table 1.b. Functional properties of pretreated cocoyam flour

Sample (g/cm)	LBD	PBD	W.A.C	O.A.C	SP
BCF	0.49^{c}	0.96^{c}	2.09^{b}	1.99^{a}	8.04^{d}
UCF	0.49^{b}	0.97^{d}	2.3^{d}	2.03^{b}	6.75^{c}
MCF	0.49^{a}	0.96^{b}	1.98^{a}	2.08^{c}	5.74^{a}
FCF	0.49^{a}	0.95^{a}	2.19^{c}	1.97^{a}	6.46^{b}

Mean value with different letters within a column are significantly different (p<0.05)
***LBD, Loose Bulk Density; PBD, Packed Bulk Density; W.A.C, Water Absorption Capacity; O.A.C- Oil Absorption Capacity; SP, Swelling Power*

Table 2. Pasting properties of pretreated cocoyam flour

Sample (g/cm)	BCF	FCF	MCF	UTC
Peak (cP)	2278^{a}±12.02	2838^{b}±88.39	2437^{ab}±316.1	2297^{b}±19.09
Trough (cP)	1757^{a}±3.54	2056^{a}±41.01	1857^{a}±221.32	1821^{a}±21.21
Breakdown (cP)	521^{a}±15.56	782^{b}±47.38	580^{a}±94.75	476^{a}±2.12
Final Visco (cP)	2608^{a}±1.41	3144^{b}±62.93	2796^{ab}±345.8	2675^{ab}±0.71
Setback (cP)	850^{a}±4.59	1088^{b}±21.92	941^{ab}±119.6	854.5^{a}±20.51
Pasting Time (min)	5.07^{a}±0.09	5.04^{a}±0.05	5.07^{a}±0.0	4.97^{a}±0.49
Pasting Temp (^{0}C)	86.43^{a}±0.035	86.34^{a}±0.98	86.35^{a}±0.0	85.6^{a}±1.06

**Mean value with the same letters within a row are not significantly different (p>0.05)*
Legend: BCF: Blanched Cocoyam Flour, FCF: Fermented Cocoyam Flour, MCF: Metabisulphite Cocoyam Flour, UTC: Untreated Cocoyam Flour

Table 3. Physical characteristics of the cookies produced from pretreated and untreated cocoyam flour

Samples (cm)	Thickness	Diameter	Spread ratio	Shrinkage (%)
Wheat flour 0%	0.48	4.29	4.9	8.94
Untreated cocoyam flour %	0.48	4.46	0.10	9.29
Blanched cocoyam flour 0%	0.55	4.22	1.86	7.67
Metabisulphite cocoyam flour %	0.49	4.45	1.86	7.67
Fermented cocoyam flour 0%	0.5	4.28	1.74	8.56

Table 4. Mean sensory scores of cookies produced from pretreated cocoyam flour

Pretreatment	Taste	Crunchiness	Texture	Color	Overall acceptance
Blanched	4.6^{b}±0.94	4.65^{b}±1.14	4.8^{b}±1.0	5.95^{a}±1.05	4.45^{b}±1.43
Metabisulphite	4.7^{b}±1.84	4.95^{b}±0.39	4.35^{b}±1.63	6.6^{a}±1.14	4.3^{ab}±1.08
Untreated	3.8^{b}±1.61	3.0^{a}±1.52	4.10^{b}±1.12	6.65^{a}±1.81	3.55^{ab}±1.36
Fermented	2.2^{a}±1.15	3.4^{a}±2.11	2.5^{a}±1.1	5.25^{a}±2.83	3.05^{a}±2.09

Mean scores with different letters within a column are significantly different (p<0.05)

5. CONCLUSION

Good quality cookies can be produced from blanched, metabisulphite and untreated cocoyam flours. Cookies from blanched, metabisulphite and untreated flours had similar taste, texture and overall acceptability. The use of cocoyam will go a long way in reducing foreign exchange used in importing wheat.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Miyasaka S, Ogosh RM, Tsuji GY, Kodani LS. Site and planting date effects on Taro growth: Comparison with aroid model predictions. Agron. J. 2003;95:545-557.
2. Eze CC, Okorji EC. Cocoyam production by women farmers under improved and local technologies in Imo State. Nigeria African Journal. 2003;5:113-116. F.A.O. Roots, tubers, plantains and bananas in human nutrition. Food and Agricultural Organization of the United Nations, Rome; 1990.
3. Onayemi O, Nwigwe NC. Effect of processing on the oxalate content of cocoyam. Journal of Food Science and Technology. 1989;20(6):263-295.
4. Huang D. Selecting an optimum starch for snack development. (Online); 2005. Available:Http://Www.Food-Innovation.Com/Pdf/Selecting%20optimal%20starch.Pdf
5. Okpala Laura, Eric Okoli, Emelem Udensi. Physico-chemical and sensory properties of cookies made from blends of germinated pigeon pea, fermented sorghum and cocoyam flours. Journal of Food Science and Nutrition. 2012;565.
6. Nnabuko Eddy, Emmanual Essien, Eno Ebenso, Richard AU. Industrial potential of two varieties of cocoyam in bread making. Journal of Chemistry. 2012;4(1):451-464.
7. F.A.O. Roots, tubers, plantains and bananas in human nutrition. Food and Agricultural Organization of the United Nations, Rome; 2000.
8. Agarry SE, Durojaiye AO, Afolabi TJ. Effect of pretreatment on the drying rate and drying time of potato. Journal of Food Technology. 2005;3(3):361-364.
9. Onweluzo JC, Nwabugwu CC. Fermentation of millet (*Pennisetun americanum*) and pigeon pea (*Cajanus cajan*) seeds for flour production: Effect on composition and selected functional properties. Pakistan Journal of Nutrition. 2009;8(6):737-744.
10. Oke MO, Bolarinwa IF. Effect of fermentation on physicochemical properties and oxalate content of cocoyam (*Colocasia esculenta)* flour. International Scholarly Research Network ISRN Agronomy. 2012;4. Article ID: 978709.
11. Amandikwa Chinyere. Proximate and functional properties of open air, solar and oven dried cocoyam flour. Journal of Agricultural and Rural Development. 2012;15(2):988-994.
12. Awokoya KN, Moronkola BA, Taiwo OO. Characterization of starches from cocoyam (*Colocasia Esculenta*) and white cocoyam (*Colocasia antiquorium*) Cormels. Food Science and Quality Management Journal. 2012;5. ISSN: 2224-6088
13. Barbosa-Canovas G, Vega-Mercado H. Dehydration of foods. 1st Ed New York. Springer. 1996;330.
14. Onwuka GI. Food analysis and instrumentation: Theory and practice. Napthali Prints, Lagos; 2005.
15. Delcour JA, Vanstelandt J, Hythier MC, Abecassis J. Fractionation and reconstitution experiments provide insight into the role of starch gelatinization and pasting properties in pasta quality. Journal of Agriculture Food Chemistry. 2000;48: 377-378.
16. Leach HW, Cower, Mccower LD, Scotch IJ. Structure of starch granule swelling and solubility pattern of various starches. Cereal Chemistry. 1959;36:334-544.
17. Chong LC, Aziz NA. Effects of banana flour and B-Glucan on the nutritional and sensory evaluation of noodles. Food Chemistry. 2010;9(1):34-40.
18. Nwanekezi EC, Owuamanam CI, Ihediohama NC, Iwouno JO. Fuctional, particle size and sorption isotherm of cocoyam cormels flour. Pakistan Journal of Nutrition. 2010;9(10):973-979.
19. Ayernor SG. The yam (*Discorea*) starches. In: Advance in Yam Research. United Industries and Shipping Inc. Enugu. 1983; 79-87.

20. Onimawo AI, Egbekun KM. Comprehensive food science and nutrition. Revised Education Grace Foundation Pub. Jos; 1998.
21. Lewis NJ. Physical properties of processing systems. Hartnolls Ltd Bodman; Cornwall, Great Britain; 1990.
22. Niba LL, Bokanga M, Jackson FI, Schlimme DS, Li BW. Physio – chemical properties and starch granular characteristics of flour from various *Manihot esculenta* (cassava) genotype. Journal of Educational Science. 2001;67:1701.
23. Adegunwa MO, Alamu EO, Omilogun LA. Effect of processing on the nutritional contents of yam and cocoyam tubers. Journal of Applied Biosciences. 2011;46: 3086-3092.
24. Kulkarni KD, Ingle UM. Sorghum malt based weaning formulations preparation, functional properties and nutritive value. Food and Nutritional Bulletin Journal. 1991;13(4):322-327.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/23221