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Effect of Hydrothermal Treatment on Selected Properties of Cocoyam Corm *(Colocasia esculenta)* Flour

Adejumo, Bolanle Adenike [#], Asema, James Kator [*]

[#] *Department of Agricultural and Bioresources Engineering Federal University of Technology, Minna, Niger State, Nigeria*
E-mail: bolanleadejumo@gmail.com

* *Department of Agricultural and Bioresources Engineering Federal University of Technology, Minna, Niger State, Nigeria*
E-mail: jameskator294@gmail.com

#Corresponding author: E-mail address: jameskator294@gmail.com

Abstract- The aim of this work is to evaluate the effect of hydrothermal treatment on the physicochemical properties of cocoyam flour. Harvested cocoyam (Colocasia esculenta) was sorted, peeled, washed, sliced, washed, blanched at temperature 60˚C, 80˚C and 100˚C and soaked at different time of 12 hours, 24 hours and 48 hours after then oven dried. The dried samples were milled into flour labelled A, B, and C at three replicates (3×3×3=27) with unblanched and unsoaked sample D as control. The samples were packaged for analysis. Result showed that at temperature 60˚C for soaking time 12 hours, 24 hours and 48 hours, the moisture content are 4.16 %, 3.62 % and 5.01 %, fat 5.22 %, 5.22 % and 4.72 %, crude fibre 0.98 %, 0.99 % and 0.53 %, protein 1.75 %, 1.47 % and 1.61 %. It is concluded that hydrothermal treatment of cocoyam (colocasia esculenta) can modify the physicochemical properties of flour produced. However, the minimum effect occurred at 60˚C compared to 80˚C and 100˚C .thus, the quality of cocoyam flour can be improved using blanching temperature 60˚C and 12 hours soaking time.

***Keywords*— Cocoyam flour, blanching temperature, soaking time and physicochemical properties.**

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I. Introduction

Cocoyam (*colocasia esculenta*) constitutes one of the six most important corms worldwide and belongs to the family *Aracea* [1]. Corms are usually underground enlarged structures used in some plant species as storage organ of nutrients for all tuberous crops. Cocoyams are important tuberous plants cultivated for their edible corms and tender leaves [2]. However, little is known about their extent of production, cultivation, and taxonomy of the plant [3, 4]. The name cocoyam is generally applied to a variety of useful and edible species belonging to different genera including Colocasia, Xanthosoma, Alocasia, Crytospema and Amorphophallus [5]. There are two common specie of cocoyam planted as food crop; these can belong to *colocasia esculenta* or the *Xanthosoma sagittifolium* specie, which comprises an enlarged underground storing shoot, through which foliage leaves arise. The petioles of the foliage is positioned upright and can reach lengths in excess of 1 m, the foliage blades are large and heart-shaped and can extend to a dimension of 50 cm long. The storage organ yields lateral shoots that give rise to tubers, Cocoyam commonly reach in excess of 1m in height even though are perennials and many times cultivated yearly, thus harvesting it seasonally [1, 2].

Colocasia species which is also known as *taro* has its origin from Southeast or Central Asia while *xanthosoma* species has its origin from Central and South America and is commonly referred to as *tannia* [4]. *Colocasia esculenta* is known with various common names in the world because this type of specie can be grown under flooded conditions as it tolerate such environment for growth, this is as a result of the air space in the petiole that allow underwater gaseous interaction with the atmosphere [6, 1]. *Xanthosoma* specie originate from America but widely cultivated and adapted in other tropical regions and are grown because of its edible corm, some of its common names are *malanga*, *tannia*.

The leaves of most *xanthosoma* species are 40-200 cm long and subdivided into many segments [2]. Cocoyam which is nutritious and has high economic values can be cultivated with minimal management practices had however received minimum attention from all stakeholders such as the producers, consumers and researchers [7]. However, with appropriate processing methods cocoyam could be a rich source of starch for food and industrial applications with it corms having a potential for new product development [8]. Cocoyam corms are susceptible to physical damage during harvest which leads to high after-harvest losses [4]. Thus to overcome these losses, the corms may be processed into flour which stores much longer than the unprocessed corms of cocoyam [9, 10]. The potentials of cocoyam for food safety, revenue generation and nutritive enrichment in the domestic are wholly underexploited [10, 7]. Cocoyam are less essential compare to other tropical tuberous crops like sweet potato, cassava and yam, but are still a key staple diet in certain regions of the tropics and sub-tropics [11, 7]. Annual production of cocoyam in Nigeria is estimated at 26.587 million tonnes [12]. Nigeria has accounted for about 37% of cocoyam total world output, as well as being the largest producers in the world [12, 9].

II. MATERIAL AND METHODS

A. *Material and equipment*

Cocoyam corms used for this research work were purchased at *kure* market in Minna, Niger state Nigeria. Other materials used include; a stainless steel knife, musilin bags, conical flask, soxhlet apparatus, distil water, weighing balance, viscometer, kheldjal Apparatus, measuring cylinder (200 ml), oven, filter paper, thermometer, volumetric flask (250 ml), heating mantle, burettes, Milling machine.

2.1 Production of cocoyam flour sample

Freshly harvested Cocoyam (*colocasia esculenta*) was purchased at *kure* market Minna, Niger State and conveyed to Federal University of Technology for analysis were it was sorted. The sorted cocoyam was washed with distil water and peeled using stainless steel knife. The peeled tubers were washed in distil water to remove the mucilage. The washed cocoyam corm was cut into slices of about 2-3cm. The peeled cocoyam was washed again with distilled water, to remove the mucilage. The washed cocoyam corm was sliced, blanched, soaked, dewatered and oven dried, the sample were milled, sieved and packaged for analysis [11].

The experiment was carried out at three blanching temperature (60˚C, 80˚C, and 100˚C) and three soaking time (12, 24, 48 hours) at three replicates (3×3×3=27). The unblanched and unsoaked samples were used as control.

B. *Methods*

All the separately packaged and stored samples of cocoyam were analysed as prescribed by Association of Official Analytical Chemist [13, 14]. The physicochemical qualities of cocoyam flour were determined using standard methods. The physicochemical qualities of cocoyam flour samples determined are moisture content, ash, fat, crude fibre, protein, carbohydrate (by difference), bulk density, swelling capacity and viscosity. Data collected were analysed statistically to determine the Analysis of variance (ANOVA) and the mean separated.

III. RESULT AND DISCUSSION

The effect of hydrothermal treatment on the proximate physicochemical properties of cocoyam flour and the separated means are as presented in Table 1 to Table 3.

Table 1: The mean effect of hydrothermal treatment on some physicochemical properties of cocoyam flour at 60℃

Blanching Temperature		**60 ˚C**		
Sample Label	**A**	**B**	**C**	**D**
Soaking Time	**12hr**	**24hr**	**48hr**	**Control**
Moisture Content (%)	4.16±.00170[a]	3.62 ± .00416[c]	5.01 ± .02100[b]	4.36 ± .00808[b]
Ash (%)	2.89±.03200[b]	7.05 ± .13000[b]	4.49 ± .02100[a]	5.36 ± .02000[c]
Fat (%)	5.22±.00087[b]	5.22 ± .00087[c]	4.72 ± .00021[a]	4.78 ± .00026[d]
Crude fibre (%)	0.98±.00026[d]	0.99 ± .00026[a]	0.53 ± .00044[c]	1.55 ± .00056[b]
Protein (%)	1.75±.03800[d]	1.47 ± .02100[b]	1.61 ± .02100[b]	1.75 ± .03100[c]
Carbohydrate	84.99±.98000[a]	81.83 ± .03600[b]	83.61 ± .02600[b]	82.91 ± .03200[c]
Bulk density (g/ml)	0.73 ±.03200[d]	0.81 ± .00026[c]	0.82 ± .00021[b]	0.91 ± .00036[a]
Swelling (g/g)	7.79 ± .0044[b]	7.12 ± .00040[b]	5.81 ± .00040[b]	6.16 ± .00040[a]
Viscosity (mPa.s)	1974±2.6500[b]	1972 ±2.08200[b]	1972 ± 2.6500[a]	1972 ± 4.5800[b]

*Value followed by same superscript alphabet are not significantly different at (P<0.05) along the column. Values are Mean ± SEM of triplicate determination.

Table 2: The mean effect of hydrothermal treatment on some physicochemical properties of cocoyam flour at 80˚C

Blanching Temperature	80 ˚C			
Sample Label	**A**	**B**	**C**	**D**
Soaking Time	**12hr**	**24hr**	**48hr**	**Control**
Moisture Content (%)	2.98 ± .01528^{b}	1.72 ± .00416^{a}	5.13 ±.03055^{d}	4.36 ± .00808^{c}
Ash (%)	4.77 ± .23072^{a}	9.02 ± .07000^{d}	5.28 ±.06807^{b}	5.36 ± .02000^{b}
Fat (%)	4.49 ± .00021^{a}	7.42 ± .00036^{c}	8.01±.00265^{d}	4.78 ± .00026^{b}
Crude fibre (%)	1.10 ± .00026^{c}	1.027 ±.00030^{b}	0.69 ± .00021^{a}	1.55 ± .00056^{d}
Protein (%)	1.61 ± .03786^{a}	1.68 ±.03215^{ab}	1.68±.08622^{ab}	1.75 ± .03055^{d}
Carbohydrate	85.05 ±.03786^{c}	79.11±1.64385^{a}	79.21±.03055^{a}	82.91±.03215^{b}
Bulk density (g/ml)	0.81 ± .00026^{c}	0.78 ± .00025^{b}	0.74 ± .00050^{a}	0.91 ± .00036^{d}
Swelling (g/g)	8.26 ± .03606^{d}	5.49 ± .03606^{a}	6.42 ± .00046^{c}	6.16 ± .00040^{b}
Viscosity (mPa.s)	1970±2.64575^{b}	1972±2.08167^{b}	1806±2.64575^{a}	1972±4.58258^{b}

*Value followed by same superscript alphabet are not significantly different at (P<0.05) along the column. Values are Mean ± SEM of triplicate determination.

Table 3: The mean effect of hydrothermal treatment on some physicochemical properties of cocoyam flour at 100˚C.

Blanching Temperature	100 ˚C			
Sample Label	**A**	**B**	**C**	**D**
Soaking Time	**12hr**	**24hr**	**48hr**	**Control**
Moisture Content (%)	6.38 ± .00170^{a}	3.08 ± .00270^{b}	1.20 ± .00208^{a}	4.36 ± .00808^{c}
Ash (%)	3.40 ± .01000^{b}	3.66 ± .02100^{c}	2.57 ± .22000^{a}	5.36 ± .02000^{d}
Fat (%)	5.21 ± .00015^{d}	1.65 ± .00012^{a}	4.56 ± .00012^{b}	4.78 ± .00026^{c}
Crude fibre (%)	0.44 ± .00061^{a}	0.66 ± .00036^{b}	1.80 ± .00321^{d}	1.55 ± .00056^{c}
Protein (%)	1.68 ± .03600^{c}	1.62 ± .01500^{b}	1.47 ± .02100^{a}	1.75 ± .03100^{d}
Carbohydrate	82.88 ±12000^{a}	89.33 ± .04000^{b}	88.39 ± .9950^{b}	82.91 ± .03200^{a}
Bulk density (g/ml)	0.74 ± .00150^{b}	0.75 ± .00047^{c}	0.72 ± .00021^{a}	0.91 ± .00036^{d}
Swelling (g/g)	6.53 ± .00021^{d}	5.40 ± .00021^{c}	6.44 ± .00379^{c}	6.16 ± .00040^{b}
Viscosity (mPa.s)	1976±3.61000^{a}	1974 ± 2.6500^{a}	1974 ± 3.2100^{a}	1972 ± 4.5800^{a}

*Value followed by same superscript alphabet are not significantly different at (P<0.05) along the column. Values are Mean ± SEM of triplicate determination

i. Moisture content

The results showed that cocoyam flour produced at blanching temperature of 60˚ C decreased in moisture content from 4.16% to 3.62 % except for that soaked for 48hrs. And with a control sample flour of 4.36 %, cocoyam blanched at 80˚C also exhibited the same decrease but with same percentage value of 4.36% control. Moisture content of flour produced at blanching temperature of 100˚ C showed a decrease as the soaking time increased. Statistical analysis showed that there were significant difference (p<0.05) between the moisture content [15].

ii. Ash

The ash content of flour sample produced at 60˚C for 24 hours had the highest value of 7.05 % while that soaked for 12 hours had the least value of 2.89 %. At 80˚C, percentage ash had similar results as it ranged from 4.77 to 9.02 % for soaking time of 12 hours and 24 hours respectively. While ash content at 100˚C showed a similar trend, it increased from 3.40% to 3.66 % for soaking time of 12 hours and 24 hours.

iii. Fat

The percentage fat at 60˚C decreases within the range of 5.22 - 4.72 % for 12 hours, 24 hours and 48 hours respectively. This may be due to the defatted content of the cocoyam flour. At 80˚C, fat content ranged from 4.49 to 8.01 % which has a significant difference ($p < 0.05$) from each other for 12 hours, 24 hours and 48 hours as compared to sample blanched at 100˚C, only sample soaked at 12 hours and 24 hours showed a decrease from 5.21 to 1.65 % which is as a result of the effect of hydrothermal treatment on the flour that exposes the shell for defatting [16].

iv. Crude fibre

The crude fibre content of cocoyam flour produced at 60˚C blanching temperature ranged between 0.98 - 0.99 % for 12 hours and 24 hours except; that of 48 hours which is 0.53% while the control had 1.55 %. At 80 ºC, the value of the crude fibre ranged from 1.10 - 0.69 % and at 100˚C from 0.44 -1.80 %. The increase in the fibre content observed in flour blanched at 60˚C and 100˚C may be as a result of removal of moisture during drying which increases the concentration of fibre [15]. Generally, cocoyams are known to have fine fibres that are easily digestible.

v. Protein

Cocoyams are root and tuber which are generally known to have low protein value which ranges from 1.12 % to 1.15% [16, 17]. The protein content of cocoyam flour produced at blanching temperature of 60˚C decreased from 1.75 % at soaking time of 12 hours to 1.47 % at 24 hours. This may be due to the differences in soaking times. At 80˚C the protein content ranges from 1.61 % to 1.68 % with a control of 1.75% at 12 hours, 24 hours and 48 hours respectively. At 100˚C the protein content decreased from 1.68 % to 1. 47% at different soaking time, this may be due to the differences in temperatures used during blanching as these could denature the cells of the cocoyam flour which may eventually affects the nutritional protein content.

vi. Carbohydrate

Carbohydrate is the major constituent of cocoyam flour with the highest percentage [17]. Results showed that at soaking time of 12 hours, 24 hours and 48 hours, a total carbohydrate value range of 84.99 %, 81.83 % and 83. 61 % at 60˚C was obtained which is slightly higher than the previously reported values of [18]. This could be due to the differences in the specie or variety of cocoyam used. At 80˚C, carbohydrate values ranges from 85.05%, 79.11 % and 79.21 % at 12 hours, 24 hours and 48 hours respectively. While at 100˚C values ranges from 82.88 %, 89.33 % and 88.39 % with a control of 82.91 %. From the statistical analysis of variance which shows a significant effect ($p < 0.05$), cocoyam flour at 60˚C soaked for 12 hours will be more acceptable due to less effect of fermentation on the flour for short duration.

vii. Bulk density

The bulk density of the cocoyam flour determined at different soaking time of 12 hours, 24 hours and 48 hours showed a progressive increase in value of the flour at 60˚C from 0.73 to 0.82) g/ml. This could be as a result of compactness of the flour with respect to the temperature and soaking hour. At 80˚C for 12 hours, 24 hours and 48 hours, bulk density values were obtained as 0.81g/ml, 0.78g/ml and 0.74g/ml. The results obtained are similar to previous report on the quality attributes of yam flour (*Elubo*) as affected by blanching water temperature and soaking time whose values ranges from 0.73g/ml, 0.72g/ml and 0.72g/ml for 12 hours, 24 hours and 48 hours at both 40 ˚C, 50˚C and 60 ˚C [19, 18]. Slight changes in values could be attributed to differences in blanching temperature.

viii. Swelling capacity

Swelling capacity of cocoyam flour is simply its ability to form gelatinous slurry which is of great importance in confectionary industries for making dough or paste. The result obtained showed that at 60˚C and soaking time of 12 hours, 24 hours and 48 hours, the swelling power of the flour decreases from 7.79 to 5.81 g/g and from 8.26 to 6.42 g/g at 80˚C of the soaking time respectively. There was also a decrease from 6.53 to 5.40 g/g of the soaking time 12 hours and 24 hours at 100˚C.

The swelling capacity of starch-based food when blanched in water beyond a critical temperature, the granules takes in a large amount of water and swells to many times their original size. This is a characteristic peculiar to starch flour and undergoes an irreversible process known as gelatinization [20]. At higher temperatures, denaturisation and coagulation of protein occurs, thereby causing proteins swelling capacity to decrease [21].

ix. Viscosity

The results showed that the sample blanched at 80˚C had a viscosity value range of 1970, 1972 and 1806 mPa.s while that of the control sample is 1972 mPa.s at soaking time 12 hours, 24 hours and 48 hours respectively. However, there is a decrease at 100˚C from 1976 – 1974mPa.s and at 60˚C at soaking time 12 hours, 24 hours and 48 hours from 1974 to 1972 mPa.s. This could be attributed to an increase in blanching temperature which reduces the flour into particles of fine sizes during the evaluation [22, 23].

IV. CONCLUSION

It is concluded that hydrothermal treatment of cocoyam corm slices can modify and influence the physicochemical properties of cocoyam flour. The longer the soaking time of sliced cocoyam corm, the lower the protein content of the cocoyam flour produced. Hydrothermal treatment at 60˚C and soaking time of 12 hours is therefore recommended for the production of cocoyam flour.

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