Optimum Drying Temperature and Treatment for Commercial Production of Cocoyam Flour

Opeyemi O. Opadotun, B.Tech.[1]; Funke B. Olotu, Ph.D.[1]; K. Alaba Iyalabani, M.Tech.[2]; Funmilola M. Bolarin, M.Tech.[1]; and Olusola A. Ogunjirin, Ph.D.[1]

[1]National Centre for Agricultural Mechanization (NCAM), PMB 1525, Ilorin, Kwara State, Nigeria.
[2]Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomosho, Oyo State, Nigeria.

E-mail: hopeopa@gmail.com

ABSTRACT

Cocoyam is the third most important root crop cultivated in West Africa. To reduce post harvest loss and increase cocoyam utilization, there is need to investigate and adopt a process that optimizes the quality and quantity of cocoyam processed. Hence, this study established the optimum drying temperature and treatment for commercial production of cocoyam flour. The drying methods considered were laboratory drying using dryer and industrial drying using cabinet dryer; temperatures considered were 60, 65, 70, 75, 80 and 85°C; the soaking time were 12 and 24 hours while cold water soaking, hot water soaking and non-soaking were used. The experimental design was a randomized block design considering temperature, soaking time and soaking condition. The responses are moisture content, protein content, ash content, fat content, fiber content and carbohydrate content. The best quality of cocoyam flour was obtained at the 60°C, soaked with cold water for twenty-four 24 hours or soaked with hot water for twelve (12) hours given 7.20% moisture content, 4.39% protein, 1.78% ash, 2.92% fat, 2.10% fiber, and 81.61% carbohydrate. The most appropriate method of processing cocoyam deduced from this study is drying at 60°C with ambient temperature water soaking for 12 or 24 hours.

(Keywords: agriculture products, cocoyam, commercial production, optimum drying, treatment, utilization, post-harvest properties)

INTRODUCTION

Cocoyam (Figure 1) is the third most important root crop after yam and cassava cultivated in West Africa. *Colocasia (taro)* and *Xanthosoma (tannia)* are the two most important genera of the family *Aracea* (Ihekoronye and Ngoddy, 1985) and constitute one of the six most important root and tuber crops worldwide (Ekanem and Osuji, 2006).

Figure 1: Fresh Cocoyam Tuber.

According to Onwueme and Charles, 1994, cocoyam (*Colocasia spp.* and *Xanthosoma spp.*) is grown in the tropical and sub-tropical regions of the world particularly in Africa for human nutrition, animal feed, and cash income for both farmers and traders. Nigeria is the world's largest producer of cocoyam, accounting for about 40% of total world output; with the annual production estimated at 26.587 million tons and 27,900 hectares of land under cocoyam production (FAO, 2006).

Due to their perishable nature, poor postharvest handling, and inadequate storage facilities, about 40% of roots and tubers are lost annually (IITA, 2008). Corms can start rotting as early as two weeks after harvest, with *tannia* suffering less than *taro.* Such microbial decay can be controlled by pre-storage fungicide and sodium hypochlorite applications as dips, normally within 24 hours after harvest. Damage to cocoyam tissue is followed by enzymatic browning reactions from polyphenol oxidases catalyzing the oxidation of polyphenols resulting complex formation leading to the production of pigments that cause discolorations. Sprouting and chill injury at low storage temperature also reduce quality in stored corms. Most tubers (except cassava) store well in fresh weight either in barns, platforms, pits, etc. Cocoyam like other root crops deteriorate few weeks after harvesting due to inadequate post-harvest technologies which makes the crop scarce and expensive during off season.

Despite the economic importance, there is limited scientific information on post-harvest properties and related commercial food applications. This has limited the application of post-harvest technologies to maintain quality and improve marketing potential. Cocoyam production could benefit from application of technologies in areas of storage, drying and further value addition that could limit losses, improve market value, enhance nutritional qualities and increase shelf life. The need to widen the scope of information on the physical, chemical and engineering characteristics has been stressed by FAO (2006). This will improve cocoyam competitiveness alongside other roots and tubers thereby enhancing its application in other food systems and improve marketing potential. It is in this view that the study established the optimum drying temperature and treatment for commercial production of cocoyam flour.

MATERIALS AND METHOD

Sample Preparation

The cocoyam tuber was sourced from *Akoda* market, *Ede* North Local Government of *Osun* state for the research work. The drying process was in two forms: the laboratory drying using the Electric Utility Dryer (Figure 2a) and industrial drying using Cabinet Dryer (Figure 2b) developed by NCAM.

The drying temperatures considered in this experiment were 60, 65, 70, 75, 80, and 85 0C; the soaking time of 12 and 24 hours were used while cold water soaking, hot water soaking and non-soaking were considered for the soaking methods.

Portions of cocoyam tubers were manually peeled using the kitchen knives and NCAM peeling tools (Figure 2c); washed and soaked in hot and ambient water for 12 and 24 hours before chipping by NCAM chipping machine (Figure 2d) while for sliced samples, the cocoyam tubers were sliced using NCAM peeling tool. 100g of chipped and sliced cocoyam tubers were weighed using OHAUS Scout Pro SPU4001 digital weighing scale (Figure 3) which has accuracy range given as (±0.1%+1 digit).

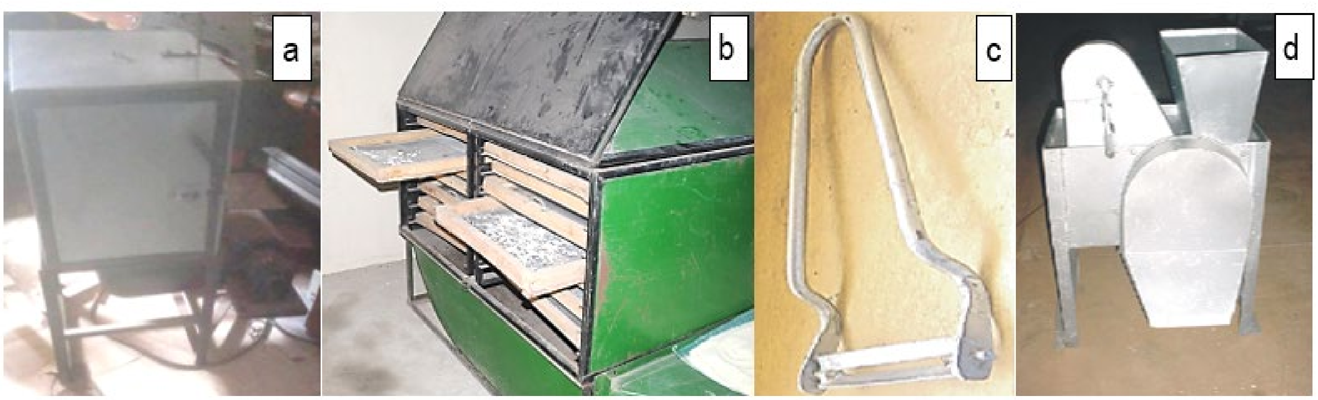

Figure 2: (a) Electric Utility Dryer, (b) NCAM Cabinet Dryer, (c) NCAM Peeling Tool and (d) NCAM Chipping Machine.

Figure 3: OHAUS Scout Pro SPU4001 Digital Weighing Scale.

The procedure was then repeated for cold water soaking. At the end of each soaking time, the soaked samples were fed into the laboratory dryer; the samples were weighed and recorded at thirty minutes (30) interval till a constant weight was achieved. The dried samples were then wrapped in foil paper and kept in the desiccator to prevent moisture absorption.

The samples were then taken to the laboratory for proximate analysis. The proximate analysis was carried out on the dried samples to determine their nutritional property so as to attain the best processing methods to be used. The processing methods that gave the best proximate analysis results were used to process cocoyam tubers into flour using NCAM cabinet dryer. The drying processes were carried out under strict guidance of the experimental layout, in the experimental layout three factors were considered which are drying temperature at six (6) levels, soaking time at two (2) levels and method of soaking at three (3) levels. The experimental design was 6 x 3 x 2 factorial design using sliced and chipped cocoyam. The experimental layout for the experiment is shown in Table 1.

Proximate Composition

The proximate analysis was conducted in the NCAM food laboratory; samples were analyzed for moisture, crude protein, crude fat, ash and crude fiber by the methods of AOAC (2003):

i. Moisture content

The percentage moisture content was calculated as follow:

$$MC = \frac{(B-C)-(D-C)}{A} \times 100 \qquad \textbf{(1)}$$

Where,

MC is moisture content (w.b) in %,
A is initial (wet) weight of sample, (g),
B is weight of Petri dish + sample before oven drying, (g),
C is weight of Petri dish (g),
D is weight of Petri dish + dry sample after oven drying (g).

ii. Protein Content

The percentage nitrogen was calculated as follow:

$$PN = 14 \times \frac{v}{100} \times 0.1 \times \frac{w}{100} \qquad \textbf{(2)}$$

Where,

PN is percentage nitrogen (%),
v = (ml of 0.1N acid added) - (ml of 0.1N NaOH used to neutralize the ammonia nitrogen),
W is weight of sample (g).

Table 1: Treatment Combination Layout.

T_1M_1	$T_1M_2H_1$	$T_1M_2H_2$	$T_1M_3H_1$	$T_1M_3H_2$
T_2M_1	$T_2M_2H_1$	$T_2M_2H_2$	$T_2M_3H_1$	$T_2M_3H_2$
T_3M_1	$T_3M_2H_1$	$T_3M_2H_2$	$T_3M_3H_1$	$T_3M_3H_2$
T_4M_1	$T_4M_2H_1$	$T_4M_2H_2$	$T_4M_3H_1$	$T_4M_3H_2$
T_5M_1	$T_5M_2H_1$	$T_5M_2H_2$	$T5M_3H_1$	$T5M_3H_2$
T_6M_1	$T_6M_2H_1$	$T_6M_2H_2$	$T6M_3H_1$	$T6M_3H_2$

Temperature- T = T_1 - 60°C, T_2 - 65°C, T_3 -70°C, T_4 - 75°C, T_5 -80°C, T_6 - 85°C
Soaking Method-M = M_1 – Non-soaking, M_2 –Normal water soaking, M_3 –Hot water soaking
Soaking Time- H = H_1 – 12 Hours, H_2 – 24 Hours

iii. Ash Content (Minerals)

The ash content was calculated thus:

$$AC = \frac{x - y}{w} \times 100 \quad \textbf{(3)}$$

Where,

AC is ash content (%),
X is weight of crucible + ash (g),
Y is weight of crucible (g),
W is weight of sample before ashing (g).

iv. Fat content

The weight was obtained as the percentage fat content was given as.

$$FC = \frac{A - B}{C} \times 100 \quad \textbf{(4)}$$

Where,

FC is percentage fat content (%),
A is initial weight of sample +thimble (g),
B is final weight of sample + thimble (g),
C is initial weight of sample (g).

v. Fiber Content

The percentage fiber is calculated thus:

Weight of fiber (g) = $C_1 - C_2$

$$CF = \frac{C_1 - C_2}{C_3} \times 100 \quad \textbf{(5)}$$

Where,

CF is crude fiber (%),
C_1 is weight of dried defatted sample (g),
C_2 is weight of defatted sample (g),
C_3 is weight of ashed sample (g).

vi. Carbohydrate Content

The total percentage carbohydrate content was determined by difference method. This involves adding the total values of protein, fat, fiber, ash and moisture content and subtracting it from 100 g.

RESULTS AND DISCUSSIONS

The result obtained from the proximate analysis of the dried cocoyam tubers which was initially carried out using the laboratory dryer shows that the best processing method that gave high quality cocoyam flour was obtained at the temperature of 60°C and it was discovered that it can be soaked with cold water for twenty-four (24) hours, or soaked with hot water for twelve (12) hours. The cocoyam that was not soaked but dried at 60°C immediately after peeling also gave high quality cocoyam flour. The result was the same for both chipped and sliced without any change in the quality as shown in Table 2.

These conditions were then imitated in the industrial cabinet dryer using 60°C drying temperature and cold water soaking for twenty-four (24) hours and another sample was dried without soaking and using the same temperature. Then proximate analysis was carried out on the dried cocoyam and results obtained were similar to the values obtained from the laboratory dryer as given in Table 2.

Table 2: Comparison of Proximate Analysis Results Obtained from Laboratory and Industrial Drying of Cocoyam at 60°C.

S/No	Sample	Protein (%)	Ash (%)	Fat & Oil (%)	Crude Fibre (%)	Moisture Content (%)	CHO (%)
1	Lab A	4.39	1.78	2.92	2.10	7.20	81.61
	M/c A	4.13	1.81	2.23	2.09	7.85	81.89
2	Lab B	4.27	1.63	2.52	2.86	7.71	81.01
	M/c B	4.45	1.49	2.76	2.29	7.82	81.19
3	Lab C	3.86	1.33	2.31	1.92	9.40	81.18
	M/c C	3.91	1.29	2.54	1.67	10.01	80.58
4	Lab D	3.74	1.28	2.68	1.66	9.54	81.01
	M/c D	3.62	1.37	2.35	1.84	9.26	81.56

Notation: M/c: Machine; **A**: Chipped Non-soaked; **B**: Sliced Non-soaked; **C**: Sliced Soaked and **D**: Chipped Soaked

CONCLUSION

The best quality of cocoyam flour for commercial production was obtained at drying temperature of 60°C for non-soaked; soaked with ambient temperature water soaking for 12 or 24 hours and soaking with hot water for 12 hours.

RECOMMENDATIONS

i. The cocoyam should be processed immediately after harvesting.

ii. The peeled cocoyam tubers should not be left unsoaked, if it is not going to be dried immediately.

iii. Hot water soaking should not exceed 12 hours before drying commences so as to minimize fermentation.

iv. Microbial analysis should be carried out to know the level of microbial load of the processed samples for further selection of the most appropriate processing methods.

v. A Burr mill machine could be used to mill the dried cocoyam sample into flour, but there might be high metal deposit. However, hammer mill with cyclone that has the suction ability on the light cocoyam flour particles might be appropriate for milling of the dried product.

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SUGGESTED CITATION

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