EVALUATION OF PHYSICO-CHEMICAL PROPERTIES OF COCOYAM *(Xanthosoma)* FLOUR

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ABSTRACT

The physico-chemical characteristics of cocoyam flour were evaluated. The fiber, ash and carbohydrate contents of cocoyam flour were higher than those of wheat flour. Gelatinization of the starch fraction was noted to be between 68 and 72°C. Least gelating concentration was optimum at 8%; water and fat absorption capacities were 87.5% and 97.1%, respectively; and maximum viscosity was observed at a concentration of 8%.

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KEY WORDS: Cocoyam. Fiber. Ash. Carbohydrates. Gelatinization. Viscosity. Fat and water absorption.

INTRODUCTION

Several varieties of *Xanthosoma* sp. or cocoyam are growing abundantly in the Philippines but this root crop has remained relatively unknown to date. *Xanthosoma* closely resembles *Colocasia* (taro or gabi) in appearance but cocoyam plants are generally bigger than taro plants. It has central tuberous roots called cormels which are primarily used for human consumption. The corms are used as animal feed and for planting purposes.

Cocoyam is comparable to potato in nutritive value. Although deficient in lysine, methionine and cystine; it is nevertheless rich in vitamins and minerals. Despite these qualities, cocoyam has received little attention from researchers and food processors as possible source of human food thus, this rootcrop is relatively unexplored.

In Cameroon, cocoyam is a major staple food. Young leaves and buds are made into a special thick sauce called *vembe* (Karikari,

1971). In Africa, both the corms and the cormels are utilized for food (Lyonga, 1979; Wilson, 1979).

In the Philippines, cocoyam cormels are commonly used as an ingredient in a delicacy called *guinataan* and in some vegetable dishes. Being starchy in nature, they can also be used in preparing cocoyam flour which has great potential as a substitute for wheat flour in the production of bakery items, as binders in processed meat, and in noodle and kropeck preparations. However, the potential of cocoyam as a flour substitute has not been fully investigated.

Among the important considerations in selecting flour substitutes are the physico-chemical properties of that substitute. These include proximate composition, water and fat absorption, viscosity, gelatinization temperature and least gelating concentration. Since knowledge on these is wanting, this study was thus carried out. Knowledge of the physico-chemical characteristics of cocoyam might also expand its use as a food ingredient particularly as a wheat flour substitute.

MATERIALS AND METHODS

Preparation of Flour

Preparation of flour from cocoyam involved washing of the cormels to remove dirt, peeling, and then slicing into thin pieces. The slices were washed with water and dehydrated in a cabinet drier maintained at 50 ± 5°C. The dried slices were ground in a cereal mill and passed through a 60-mesh sieve. The resulting flour was stored in an airtight container until use.

Chemical Analysis

Proximate composition of the flour was determined employing the methods prescribed by the AOAC (1980). Properties analyzed were moisture, ash, crude protein, fat, fiber and total carbohydrates.

Gelatinization Temperature of Starch

Starch from cocoyam was isolated following the procedure of Badenhuizen (1964). Gelatinization temperature was determined using the method of MacMasters (1964).

Functional Properties

Water absorption capacity of the flour was evaluated employing the method prescribed by Sollars (1973). The technique described by Lin et al. (1974) for the assessment of the fat absorption capacity of flour was adapted. The modified method of Coffman and Garcia (1977) for the measurement of the least gelating concentration of flour was used. Apparent viscosity of different flour dispersions was determined using the modified process of Circle et al. (1964).

RESULTS AND DISCUSSION

Proximate Composition

The proximate composition of fresh cocoyam cormels and its flour

is summarized in Tables 1 and 2, respectively. The data obtained for the fresh cormels were quite similar to those obtained by Doku (1967) especially the crude protein, moisture and carbohydrate (NFE) contents. However, the ash and crude fat values in the present study were slightly higher. The amount of crude fiber was found to be low and this agrees with the report of Kundu (1967) that cocoyam cormels are not fibrous in nature.

The flour prepared from cocoyam had a moisture content of 11.6 % which is lower than the commercial standard moisture of 14% for wheat flour. Crude protein of cocoyam flour was less than that of wheat flour as reported by Matz (1960) and Kasarda et al. (1971). Protein content of wheat flour ranged from 7.5 to 15% on a 14% moisture-free basis. Crude fat of cocoyam flour was also lower than that of wheat flour. However; the ash, fiber and carbohydrate contents of cocoyam flour were higher than those of wheat flour.

Gelatinization Temperature

The starch granules of cocoyam started to gelatinize at 68°C. However, 72°C was considered as the gelatinization temperature of the starch since it was at this temperature that Congo red stained all the undamaged starch granules. The gelatinization temperature was noted to be between 68 to 72°C which was quite similar to that of wheat starch although conflicting results were reported on the gelatinization temperature of the latter. Leach (1965) observed that wheat starch swelled at 52 to 63°C while Schoch (1967) noted swelling at 59.5 to 64°C. However, both agreed that

Table 1. Proximate composition of freshly peeled cocoyam cormels.

Parameter	Proximate Composition[1] (%)
Moisture	61.6
Crude protein	2.2
Crude fat	0.9
Crude fiber	0.8
Ash	0.7
Carbohydrate (NFE)	34.2

[1] n = 3

Table 2. Proximate composition of cocoyam flour.

Parameter	Proximate Composition[1] (%)
Moisture	11.6
Crude protein	4.4
Crude fat	0.4
Crude fiber	2.0
Ash	2.2
Carbohydrate (NFE)	79.4

[1] n = 3

beyond 78°C, all granules of wheat starch gelatinized. The differences in swelling temperature among wheat starches can be attributed to varietal differences as well as to seasonal variations. Mangels (1934) reported that wheat starches produced during hot dry seasons are less susceptible to swelling than those produced during periods of lower temperature and abundant rainfall. On the other hand, differences in gelatinization temperature between cocoyam and wheat starches can be attributed to the fact that starches of plant families from temperate habitats have lower gelatinization temperature than those from tropical plant families (McNair, 1932). Since wheat is a temperate crop and cocoyam is a tropical crop, the swelling temperature of cocoyam starch is thus expected to be higher.

Table 3. Characteristics of gel formed using different concentrations of cocoyam flour.

Cocoyam Flour Concentration (%)	Gel Characteristics
2	viscous
4	viscous
6	very soft
8	moderately firm
10	very firm
12	very firm
14	very firm
16	very firm
18	very firm
20	very firm

Functional Properties

Least Gelating Concentration. Results revealed that upon heat application, cocoyam starch at concentrations of 6, 8 and 10% (Table 3) produced very soft, somewhat firm and very firm gel, respectively. To establish a more accurate gelation end point, additional trials were conducted using 6, 8 and 10% flour concentrations and the concentration at which the gel was soft but firm enough not to slip from an inverted test tube (least gelating concentration) was determined. At 6% concentration, a soft gel was formed but the gel was not strong enough and slipped when the test tube was inverted. At 10% concentration, the gel formed was very firm and hard. This suggests that at least 8% cocoyam flour should be added to a formulation for optimum gelation.

Water Absorption. The water absorption capacity of cocoyam flour was found to be 87.5% (Table 4). This means that 100 g of cocoyam flour can absorb 87.5 g of water. The high value obtained for cocoyam flour can be attributed to its high carbohydrate content. Narayana and Rao (1982) pointed out that carbohydrates play an important role in water absorption. Swelling of the crude fiber and starch granules could lead to an increased

Table 4. Liquid retention capacity of cocoyam flour per 100 g sample.

Liquid Used	Retention Capacity (%)
Water	87.5
Fat	97.1

n = 3

water absorption capacity of the flour. These suggest that the hydrophilic constituents like carbohydrates which constitute up to 79.4% of cocoyam flour, contribute to this functionality. Lin et al. (1974) also reported that water absorption capacity depends on the amount and nature of hydrophilic constituents in the flour. Kimura (1977), Connel (1976) and Kirman et al. (1974) observed that particle size could also influence water-holding capacity of the product. Heller et al. (1977) supported the above findings and reported that for certain dietary fibers, a reduction in particle size results in a significant decline in the estimated hemicellulose content, a constituent largely responsible for hydrophilic characteristics and water-holding capacity. The larger the particle, the higher is the water retention. These explanations are applicable to cocoyam flour since its carbohydrate content is high and particle size is coarser than that of commercial flour.

The water absorbing capacity of flour is one important factor related to its quality (Sweetman and McKellers, 1954). In baking, use of flour with higher water absorption capacity could result in higher dough yield (Pyler, 1952). Furthermore, Waldt and Kehoe (1959) claimed that flour with high water-holding capacity is a good binding agent since it can minimize shrinkage of the processed products. This was found true by Lauzon (1984) because cooking loss in meat loaf was very minimal when 100% cocoyam flour was used as binder instead of corn starch.

Fat Absorption. Cocoyam flour could absorb 97.1% fat per 100 g flour (Table 4). This relatively high value suggests that cocoyam flour can be a potential binder in products which are high in fat. Meat loaf formulations which used 100% cocoyam flour as binder showed significantly less amounts of dripping than formulations using corn starch (Lauzon, 1984).

The capacity of flour to hold fat is important since it can improve flavor and increase mouth feel of the product (Kinsella, 1970). These characteristics were noted in meat loaf with 100% cocoyam flour as binder (Lauzon, 1984). In all sensory attributes (flavor, texture and general acceptability) evaluated, meat loaf with 100% cocoyam flour was found superior to that containing corn starch.

Viscosity. Viscosity of different concentrations of wheat and cocoyam flour is presented in Table 5. Maximum viscosity of cocoyam flour was attained at 8% (825 cps) after which it started to decrease.

Table 5. Viscosity of wheat and cocoyam flour at different concentrations.

Flour Concentration %	Viscosity (cps)	
	Wheat Flour	Cocoyam Flour
1	0	0
2	0	100
3	0	200
4	100	400
5	200	500
6	350	550
7	450	700
8	550	825
9	650	600
10	750	350

On the other hand, the maximum viscosity of wheat flour could not be ascertained in this experiment since viscosity continuously increased with increase in wheat flour concentration. There seems to be a relationship between the least gelating concentration and the maximum viscosity in cocoyam flour since both parameters were observed at a concentration of 8%.

CONCLUSION

The results indicate that due to its high water and fat absorption capacities, cocoyam flour can be a good binder for food formulations containing high water and fat. Cooking losses may also be minimized with the use of cocoyam flour as binder. Furthermore, flavor and texture can be improved.

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