PROCESSING AND UTILIZATION OF TROPICAL ROOT CROPS I. PHYSICO-CHEMICAL CHARACTERIZATION OF COCOYAM STARCHES

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ABSTRACT

Starch was produced from red and white cocoyams following the method developed by the Food Science Section of the Department of Agricultural Chemistry and Food Science (DAC-FS), ViSCA, Baybay, Leyte. Purified starch samples were used in the analytical works. Granular size distribution and *x*-ray diffraction pattern determination were carried following the methods used by Kawabata *et al.* (1981) and Nakagawa (1973), respectively. Chemical properties were determined using the standard methods set by the Association of Official Analytical Chemist (AOAC, 1980).

Starch granules of red and white cocoyams were spherical and semi-spherical in shape. Starch granules of red cocoyam were bigger than starch granules of white cocoyam. Starches from both cocoyams belonged to C type. Moisture content of red and white cocoyam starch was 11.49% and 11.99%, respectively. Inorganic matters content (P, K, Ca and Mg) were higher in red cocoyam than in white cocoyam starch.

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KEY WORDS: Cocoyam. Starch. Granular size. *X*-ray diffraction. Moisture. Ash. Amylose. Iodine affinity.

INTRODUCTION

Rapid increase in world population would possibly lead to food shortage in the coming years. To minimize, if not totally solve this problem, improvement of food production as well as food processing and utilization should be given attention.

Several varieties of plants with great potential as source of food are abundant in the country. However, a number of these plant resources were given less attention thus making these plants unknown to many people today.

Root crops are considered potential sources of energy. Many species of root crops are grown all over the country, and one of these is cocoyam (*Xanthosoma* sp.) and its related species which remain quite unknown even at present. Cocoyam resembles taro (*Colocasia esculenta*) and is often confused with it. The cocoyam plant has a central tuberous root called corm and is surrounded by potato-like cormels. The cormels are used for human consumption while the corm is used as animal feed or for planting purposes. Cocoyam has leaves which are hastate and tend to be arrow-shaped with sharp tip and deep inside basal lobes and prominent marginal vein. The plant is usually larger than taro and is well adapted to a wide range of soil. It is usually propagated by means of corms or cormels and the cropping period is usually 9 months (Plucknett, 1970). Cocoyam cormel is comparable to sweetpotato in nutritive value. Inspite of this, cocoyam has not received wide attention as source of human food.

Being starchy in nature, cocoyam has a great potential as substitute for commercial starches in various food products. Physico-chemical properties and rheological characteristics are among the important considerations in selecting a starch substitute for any developed food item. In order to have a basis for future application in food product development there is a need to conduct a thorough study on the characteristics of cocoyam starch.

MATERIALS AND METHODS

Starch production

Cocoyam starch was produced employing the simplified method of the DAC-FS, ViSCA, Baybay, Leyte. Freshly harvested cocoyam cormels were washed, peeled and grated. Grates were placed in a container with enough water to cover it and sieved. Washed water was collected and crude starch was allowed to settle down. After decanting off the supernatant, the wet crude starch was dried, powdered, sifted, and kept in a closed container.

Starch purification

A 1000 ml distilled water was added to 100 g of starch and mixed thoroughly. The starch suspension was allowed to stand until the starch settled down. The supernatant was decanted and the process was repeated three times. Centrifugation followed at 25000 rpm for 15 min. Distilled water was added to the residue, thoroughly mixed and was made to pass through a 150 mesh sieve. The starch was allowed to settle and the supernatant was decanted, added with ethanol, thoroughly mixed, and then centrifuged. Diethyl ether was added to the residue and was mixed thoroughly. The starch suspension was allowed to dry inside a fumehood. Dried starch was defatted using a soxhlet extractor and 85% methanol. The pure starch was pulverized and stored in an airtight container.

Physical Analyses

Granular size distribution

The granular size distribution of cocoyam starch was determined employing the method used by Kawabata *et al.* (1981).

Starch granules were viewed under an Olympus POM microscope equipped with brightfield light optics. Distribution of starch granules was measured by using a coulter counter.

X-Ray diffraction

X-ray diffraction patterns were obtained employing the method used by Nakagawa (1973) using a Shimadzu *x*-ray diffractometer XD - 3 under the following conditions: *x*-ray tube, cuk voltage - 30 KV; current - 15 MA, time constant - 2 sec; range - 5 kcps; scanning speed - 2 degrees/min; chart speed - 10 mm/min; slits - 1-0-3-1.

The amount of sample needed depended upon the size and model of the cup of the *x*-ray machine used.

Chemical Analyses

Moisture and ash determination

Moisture content of starch samples was determined employing the method prescribed by AOAC (1980). Ash content of the sample was determined by incinerating starch sample in a furnace at 550°C for 5 hours and by weighing the ash left in the crucibles.

Inorganic matter

K, Na, Ca and Mg were analyzed using a flame photometer, (Kawabata, 1981) while P was determined employing a Spectrophotometer 100-20.

Amylose and iodine affinity determination

Amylose and iodine affinities were evaluated following the method of Nakagawa (1973) which uses a Hirama automatic recording titrator.

RESULTS AND DISCUSSION

Physical Properties

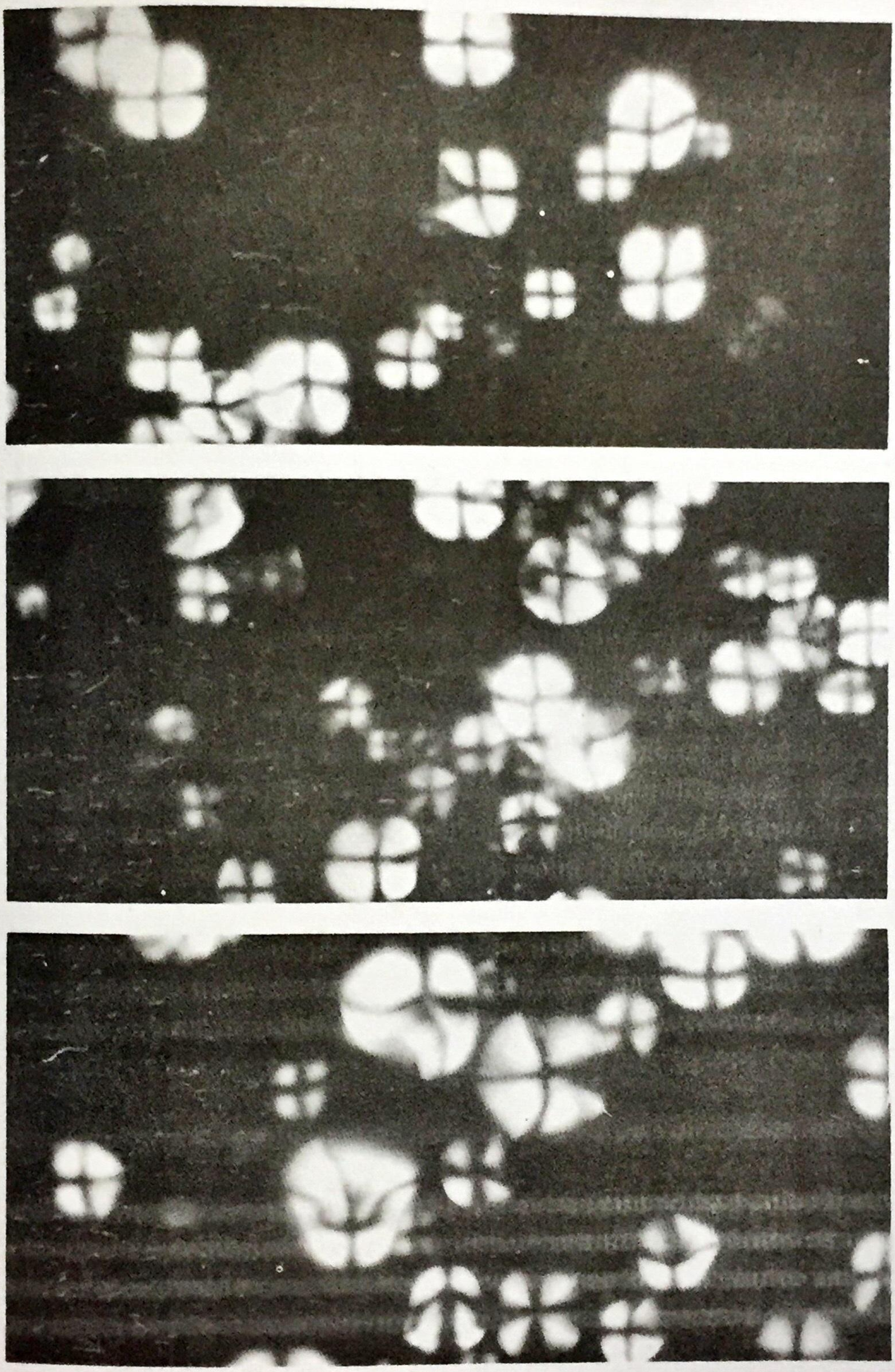
Granular size distribution

Red and white cocoyam starch granules were similar to sweetpotato starch granules which are semi-spherical to spherical in shape. The starch granules of cocoyams and sweetpotato showed distinct birefringence and dark cross which correspond to the hylum located at their center (Fig. 1).

The distribution of granular sizes is shown in Figure 2. The red and white cocoyam starches were found to have their peak distribution at granular size 29.0 and 31.3 mm, respectively, which is larger than sweetpotato starch granule (23.6 mm). The average size of starch granules for red and white cocoyam is 14.46 and 12.46 mm, respectively. These are relatively smaller compared to the average size of sweetpotato starch granules (18.65 mm). The difference in granular size of the three starches was clearly seen under the microscope (Fig. 3).

X-Ray diffraction

In terms of *x*-ray diffraction, Figure 4 revealed that both red and white cocoyam starches exhibited similar *x*-ray diffraction patterns to that of sweetpotato which showed a double peak on the fourth ring and a single peak on the third and sixth rings. These starches are believed to be C type.



A

B

C

Figure 1. Granules of red cocoyam (A), white cocoyam (B) and sweetpotato starches (C).

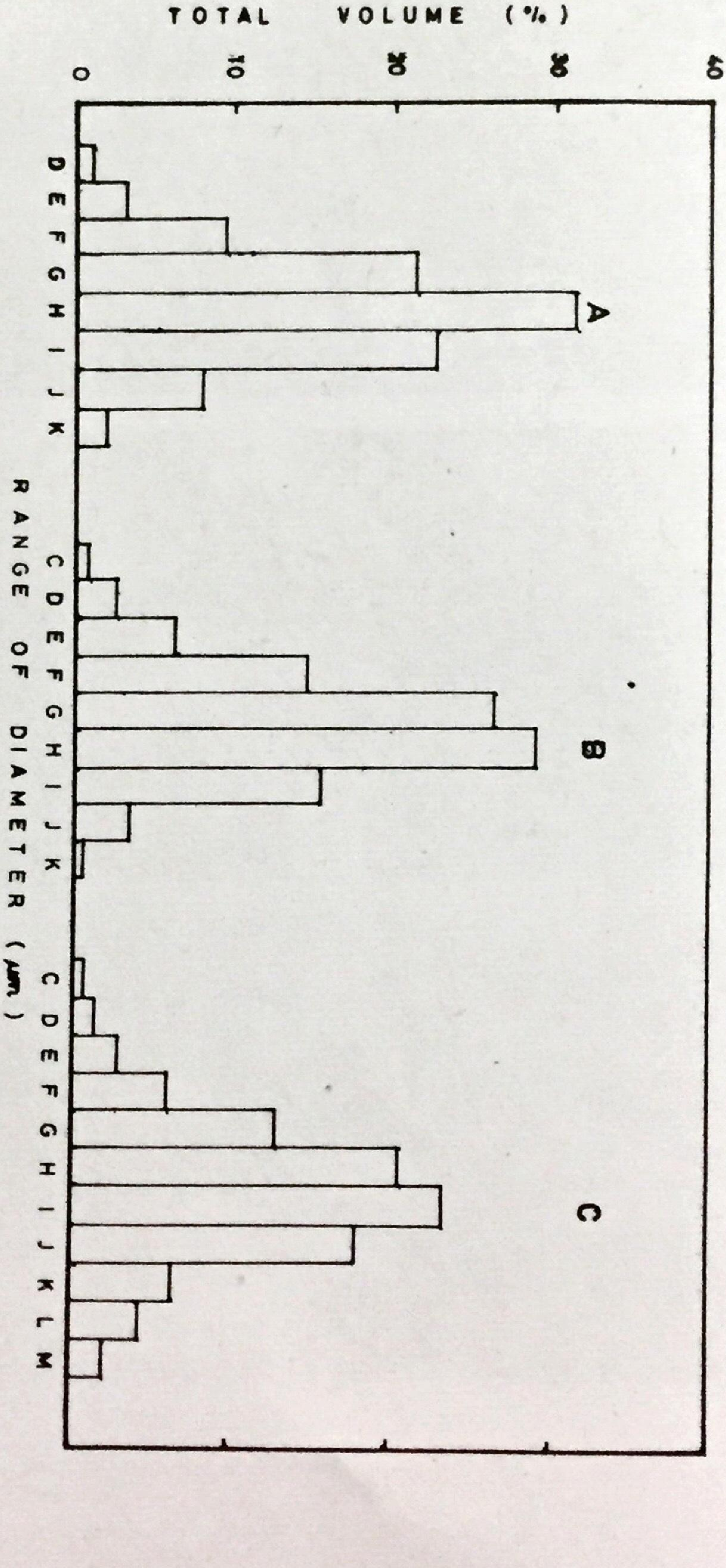
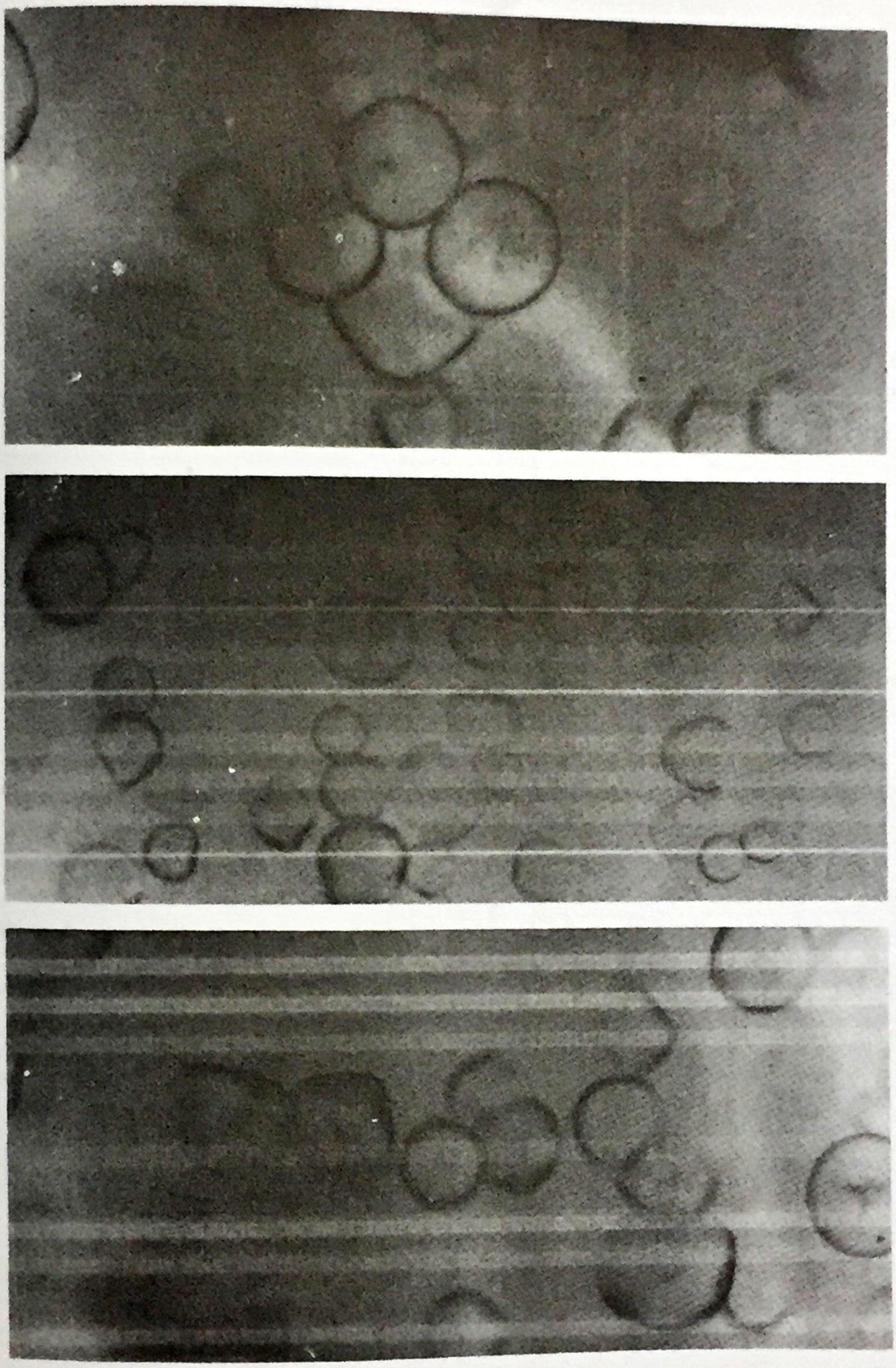


Figure 2. Distribution of granular size of cocoyam and sweetpotato starches. A - red cocoyam, B - white cocoyam and C - sweetpotato.



A

B

C

Figure 3. Granular size of red cocoyam (A), white cocoyam (B) and sweetpotato (C) starches seen under the microscope. Average granular size of red cocoyam, white cocoyam and sweetpotato starch is 14.16 mm, 12.46 mm and 18.65 mm, respectively.

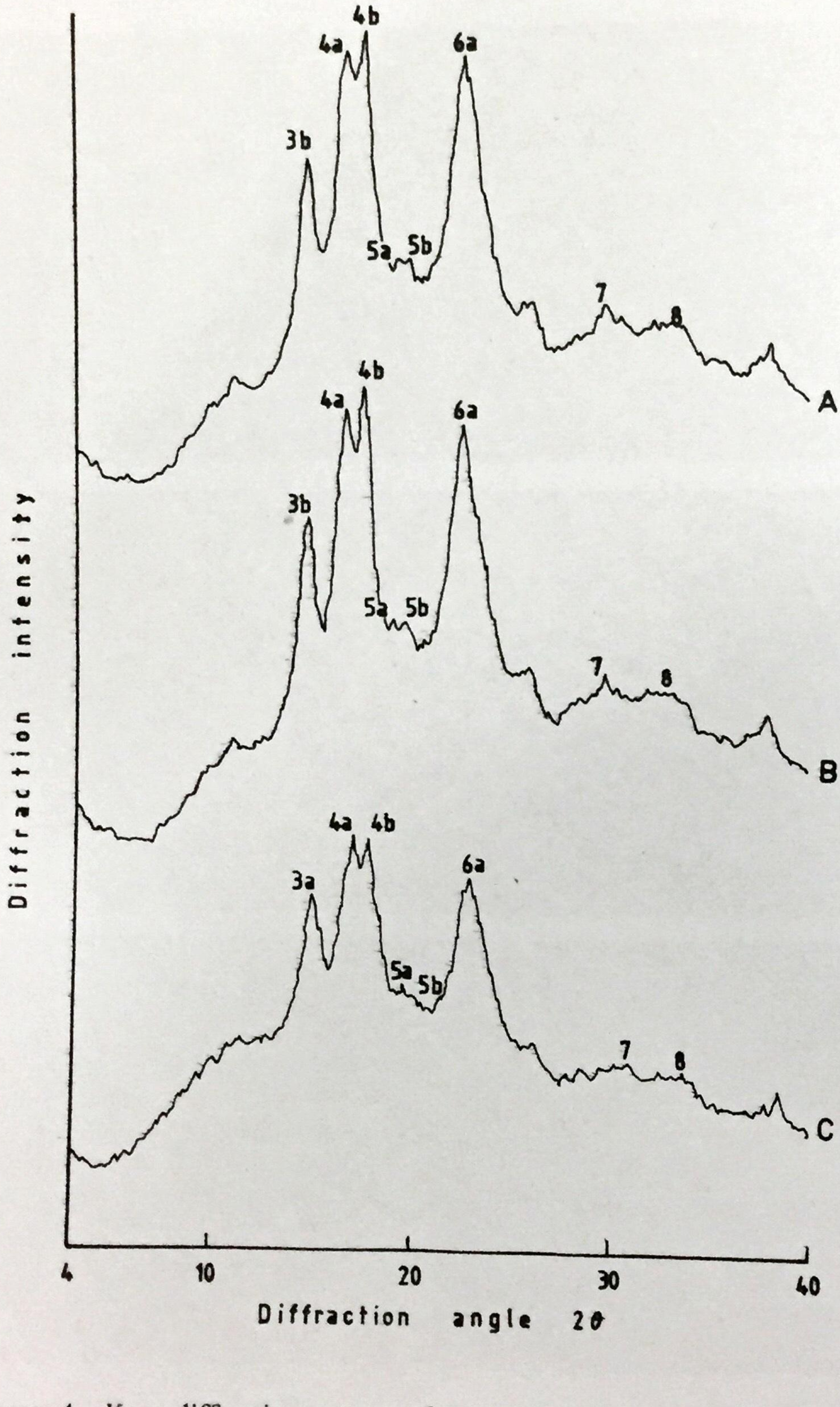


Figure 4. *X*-ray diffraction patterns of cocoyam and sweetpotato starches. A - red cocoyam, B - white cocoyam and C - sweetpotato.

Chemical Properties

Moisture and ash content

Moisture and ash contents of cocoyam starch are summarized in Table 1. Starch from red and white cocoyam has a moisture content of 11.49 and 11.99%, respectively, which is relatively lower than that of sweetpotato starch (12.02%).

This finding is supported by the result of Lauzon (1986) wherein red cocoyam flour has a moisture content relatively lower than that of white cocoyam flour although the difference was not significant. This can be attributed to the fact that red cocoyam cormels had higher dry matter content than that of white cocoyam.

Table 1. Moisture and ash contents of red and white cocoyam starch and that of sweetpotato.

Kind of Starch	Moisture (%)	Ash (%)
Red cocoyam	11.49	9.91
White cocoyam	11.99	9.78
Sweetpotato	12.02	12.13

Amylose and iodine affinity

The starch of red and white cocoyam was found to have iodine affinity of 4.96 and 4.80 mg/100 g, respectively, which is a little bit higher than that of sweetpotato starch (4.16 mg/100 g). The amylose content of the starch of the red and white cocoyam calculated from their iodine affinities exhibited higher value (25.43 and 24.62%, respectively) than that of sweetpotato (21.33%) (Table 2).

Inorganic matter

The red cocoyam starch was found to have higher inorganic matter than that of white cocoyam (Table 3). P, K, Ca and Mg contents of red cocoyam starch were found to be 13.9, 0.22, 21.7 and 29.1 mg/100 g, respectively. White cocoyam starch had lower values of 12.06, 0.12, 19.0 and 24.0 mg/100 g, respectively, for the same inorganic matters. Starch from both

Table 2. Iodine affinity and amylose content of red and white cocoyam starch and that of sweetpotato.

Kind of Starch	Iodine Affinity (mg/100 g)	Amylose Content (%)
Red cocoyam	4.96	25.43
White cocoyam	4.80	24.62
Sweetpotato	4.16	21.30

Table 3. Inorganic matters in red and white cocoyam starch (mg/100 g dry matter) and that of sweetpoato.

Kind of Starch	P	Na	K	Ca	Mg
Red cocoyam	13.90	trace	0.22	21.70	29.10
White cocoyam	12.06	trace	0.12	19.00	24.00
Sweet potato	19.94	0.32	0.38	18.30	1.69

cocoyams contained trace amount of Na. Although sweetpotato starch had higher P, Na and K contents its Ca and Mg contents were relatively lower compared to that of the cocoyams (Table 3).

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