

Use of Starch Extract from *Colocasia esculenta* (Taro) and *Xanthosoma sagittifolium* (Tannia) for Pharmaceutical Preparations

E. OWUSU-ANSAH*, A.N.M. PAPPOE† and Y. AMEYAW‡

Department of Chemistry, University of Cape Coast, Cape Coast, Ghana

E-mail: eowusu_ansah@yahoo.com

The starch content and properties in *Colocasia esculenta* and *Xanthosoma sagittifolium* were studied. Results were compared with the British Pharmacopoeia, United States Pharmacopoeia and the National Formulary specifications. The pH of 20% slurry was 7.21 and 7.3 respectively. Loss on drying and residue on ignition were identical, 1.5 and 0.5% respectively, for both species. Sulphonated ash was 0.4% in *Colocasia esculenta* and 0.35% in *Xanthosoma sagittifolium*. With the exception of sulphur dioxide whose percentages 0.014 and 0.044 exceeded the limits of specification, all other values were within the limits of acceptable standards for tableting. *Colocasia esculenta* had lower percentages for water binding capacity, solubility in water, ethanol and *n*-hexane than *Xanthosoma sagittifolium*. Starch obtained from *Colocasia esculenta* and *Xanthosoma sagittifolium* might be good for tableting.

Key Words: Starch extract, *Colocasia esculenta*, *Xanthosoma sagittifolium*.

INTRODUCTION

Colocasia esculenta (Taro) and *Xanthosoma sagittifolium* (Cocoyam or Tania) are staple foods found especially in the tropical rain forests of the Pacific islands and West Africa. They belong to the family Araceae (the aroids), which contains several root crops known as corm and cornels¹.

They store carbohydrate as starch in their underground stem. Starch can, in general, be separated into at least two chemically distinguishable entities; amylose, a mixture of essentially linear polymers and amylopectin, a mixture of very highly branched polymers. It is produced from various starch-containing materials like maize, cassava, potatoes, wheat, rye, etc. Different technologies are used to recover the starch in each food material. Starch is modified to meet the needs of the end user by changing reaction conditions like temperature, pH, additives, etc., in a strict process control technique. Such modified starch is used for industrial purposes².

†Department of Environmental Science, University of Cape Coast, Ghana.

‡Centre for Scientific Research into Plant Medicine, Akwapim Mampong, Ghana.

Starch from rye, potato, maize or wheat is used as special diluent for the preparation of standardised titrates, colorants and potent drugs to facilitate subsequent mixing or blending processes in manufacturing operations. The particle size of starch granules is of great importance in drug formulation and manufacture. The particle size of starch granules from cocoyam and taro is smaller and more easily digested than that of yam, cassava or sweet potato³.

Starch from cocoyam and taro is able to absorb water and swell, thus facilitating its possible rupture to release the active ingredient. Starch is employed in pharmaceutical technology as diluent or disintegrant⁴. It is used either for coating tablets or as a binder in tablet formulation.

For starch to be used for drug formulation, it must pass the British Pharmacopoeia (BP), United States Pharmacopoeia (USP) and the National Formulary (NF) specifications⁵⁻⁷. Starches extracted from tubers or other sources need to undergo refinements to meet the standards set for pharmaceutical purposes.

EXPERIMENTAL

The corms of *Colocasia esculenta* and the cormels of *Xanthosoma sagittifolium* were obtained from Jukwa in the Central Region of Ghana. They were washed, first in water and then in 10% ethanol. *C. esculenta* (450 g) were peeled and homogenized to form slurry. Cormels of *X. sagittifolium* (400 g) were also peeled and homogenized to form slurry. Each type of slurry was filtered, using a clean white calico and the filtrate was allowed to settle. The slurries were decanted, the starch residues were dried and bagged in transparent polythene bags.

Pharmacopoeial specification tests

The following pharmacopoeia specification tests were performed on the starch residue.

pH determination: 20 g of each starch residue were mixed with 100 mL distilled water to produce slurry. The slurry was agitated for 5 min and the pH was taken to the nearest 0.1 unit, using a pH-meter.

Loss on drying: 3 g of each starch were weighed into a vessel and dried in an oven at 120°C for 3 h to constant weight.

Residue on ignition: 3 g of each starch were weighed into three different crucibles and ignited in a furnace at 600°C for 45 min.

Sulphur dioxide determination: 20 g of starch was weighed and carefully transferred into a 500 mL flask. Distilled water (200 mL) was added and swirled for 5 min to obtain a suspension, which was filtered through clean white calico. 3 mL of test starch was added to distilled water (100 mL) and titrated with iodine solution (0.005 M).

Determination of sulphonated ash: A platinum dish was heated to 800°C for 10 min and allowed to cool in a desiccator. A sample of starch (1.0 g) was weighed into the dish, moistened with a few drops of H₂SO₄ (1 M) and ignited at 800°C for 15 min. The platinum dish with its contents was removed, allowed to cool and reweighed.

Solubility: A sample of starch (0.24 g) was weighed separately into 3 centrifuge tubes. Distilled water (15 mL) were added to the starch in each tube. The mixture was swirled and warmed at 40°C over a water bath for 10 min amidst swirling and centrifuged at 200 rpm for 15 min. The supernatant liquid was decanted and the residue was evaporated to dryness. The weight of the solid residue was determined and recorded. The percentage solubility was calculated thus:

$$\% \text{ solubility} = (\text{weight of soluble starch} / \text{weight of dry starch}) \times 100$$

The procedure was repeated using ethanol and *n*-hexane in place of distilled water.

Determination of water binding capacity: 10 g of each starch sample were dissolved in 17 mL of distilled water. The suspension formed was agitated on a Stuart scientific flask shaker at the speed of 4000 sc/min for 1 h. The starch solution so formed was centrifuged at 2200 rpm for 10 min. The supernatant solution was decanted. The residual paste was weighed and the water binding capacity (WBC) calculated as follows:

$$\% \text{ WBC} = (\text{amount of water bound} / \text{weight of dry starch}) \times 100$$

RESULTS AND DISCUSSION

Appreciable quantities of starch were found in the two types of underground stem. 450 g of *Colocasia esculenta* (Taro) yielded 137.4 g or 30.5% of starch while 400 g of *Xanthosoma sagittifolium* (Tannia) produced 110 g or 27.5% starch. The pharmacopoeial tests on the starch from both species are presented in Tables 1 and 2 below:

TABLE-1
PHARMACOPOEIAL FINDINGS ON *C. ESCULENTA* AND *X. SAGITTIFOLIUM*

Test	<i>C. Esculenta</i>		<i>X. Sagittifolium</i>	
	Result	Limits	Result	Limits
pH (20% slurry)	7.210	4.5–8.0	7.300	4.5–8.0
Loss on drying	1.500	≤ 14.0–20.0%	1.500	≤ 14.0–20.0%
Residue on ignition	0.500	0.5	0.500	0.5
Sulphonated ash	0.400	≤ 0.6–0.8%	0.350	≤ 0.6–0.8%
Sulphur dioxide	0.014	≤ 0.005%	0.044	≤ 0.6–0.8% (B.P.)

TABLE-2
WATER BINDING CAPACITY, SOLUBILITY AND SWELLING
PROPERTIES OF *C. ESCULENTA* AND *X. SAGITTIFOLIUM*

	<i>C. esculenta</i>	<i>X. sagittifolium</i>
% WBC	150.70	157.20
% Solubility (water)	30.00	33.10
% Solubility (ethanol)	3.20	5.00
% Solubility (<i>n</i> -hexane)	0.04	0.50
% Swelling power	16.40	20.80

Comparable amounts of starch were found in *Colocasia esculenta* and *Xanthosoma sagittifolium*. The yield from *Colocasia esculenta* was 30.5% and that from *Xanthosoma sagittifolium* was 27.5%. These amounts fall within the pharmacopoeially acceptable specifications. Thus, taro and tannia contain starch that can be tapped for industrial purposes. The pH on 20% slurry was 7.2 and 7.3 for *Colocasia esculenta* and *Xanthosoma sagittifolium*, respectively. These values fall within the specification (4.5–8.0) for pharmaceutical tableting principles. This shows that the starch from these food crops can be used as an alternative for tableting thereby reducing pressure on the use of starch from cassava, wheat, rye and maize, which are staple foods. Loss on drying for both *Colocasia esculenta* and *Xanthosoma sagittifolium* is similar but less than the lower limit of the expected specification. This indicates that the starch from these crops will lose only a small amount of water on exposure to the atmosphere. The levels of sulphonated ash were within the limits of specification (Table-1). These levels are quite tolerable for use in pharmaceutical tableting as high levels may react with the active ingredients in the drug and reduce its potency. Again, low levels of sulphur may lessen the toxicity of the drug. The high level of sulphur dioxide could be due to the sulphur content of the soil in which the crops were cultivated. Upon analysis, it was observed that tannia had solubility of 33.1% and taro 30.1%. Starch is known to be relatively insoluble in water at room temperature but at elevated temperatures it becomes quite soluble. The starch from both taro and tannia was found to be insoluble in ethanol and *n*-hexane at room temperatures. The oral administration of a drug through tablets demands that the starch granules imbibe water and get swollen to release the active ingredient from the starch matrix. This means that the higher the swelling power of the starch granules, the better would be its efficacy. From the analysis, the swelling powers of taro and tannia were 16.4 and 20.8% respectively (Tables-2).

The analysis revealed that taro has binding capacity of 150.7% and tannia 157.2%. Thus, tannia has a higher binding capacity than taro. The water binding capacity is the ability of the starch to firmly bind the active ingredient so that the tablet formed does not crumble easily but at the same time be able to dissolve easily in the aqueous medium in the gut to release the active ingredient.

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