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AMYLOSE CONTENT OF SOME TROPICAL STARCHES

by

F. DELPEUCH and J.C. FAVIER
Nutrition Section of O.R.S.T.O.M.
Yaoundé (Cameroon)

The suitability of starchy foods for various technological methods of processing and the practical use of their starch depend on the composition, structure and physico-chemical properties of the starch. The search for industrial outlets for tropical starchy products therefor entails systematic study of the physico-chemical characteristics of their starch and, in particular their amylose and amylopectin contents. The respective proportions of these two constituents partly determine their behaviour during the cooking process (RAO, 1) and suitability for certain industrial applications such as the manufacture of protective films and thickening agents (DEATHERAGE, 2 ; WOLF, 3).

Whereas there has been considerable work on the amylose contents of cereal starches during the last twenty years, revealing in particular the presence of varieties of maize with very different amylose contents (waxy maize between 0 and 6 per cent and amylomaize with 64 per cent), very few studies have been made on the starches of tubers, roots and starchy fruits although these form the basis of the diet of the populations of the humid tropical area.

Data on the amylose content of starches of tropical origin have been given by ROY and MITRA (4) for Taros and Pachyrrhizus in India ; by DEATHERAGE (2), BERRIOS and others (5) for cocoyams and Dioscorea rotundata yam in Puerto Rico ; by CORREA (6) and ROSENTHAL (7) for breadfruit and Diosc. alata yam in Brazil.

In Africa, the amylose content of the starches of some species of cultivated yams has been assessed by RASPER and COURSEY (8) in Ghana and by HOLLO and GUILBOT (9) in Ivory Coast.

The present study consists of an interspecific and intervarietal analysis of the amylose content of yam starches and a few other starchy foods among those most commonly eaten in Cameroon. It forms part of a comprehensive work on the physico-chemical characteristics of these starches.

Material

Determinations were made on starches extracted in the laboratory from the following tubers, edible roots and vegetable fruits :

- eight species of the Dioscorea (yam) some being represented by several varieties ;
- three sweet potatoes (Ipomea batatas) ;
- two cocoyams (Xanthosoma saggitifolium) ;
- three taros (Colocasia antiquorum) ;
- one local carrot (Coleus esculentus)
- one leguminous plant with tuber, the yam-bean (Pachyrrhizus erosus) ;
- two varieties of breadfruit (Artocarpus communis) ;
- one jackfruit (Artocarpus integra).

Most of the samples analysed come from the IRAT Agricultural Experimental Station at Bambui, situated at an altitude of 1 330 meters in West Cameroon, but two varieties of D. dumetorum and the breadfruits were obtained in Yaounde.

Methods

After peeling, the foodstuffs are ground in a 0.01 M solution of mercuric chloride ; the suspension obtained is filtered through muslin. The starch is purified by a series of washings in deionized water then by stirring in a 4 % solution of sodium chloride with toluene to eliminate the proteins. After another series of washings in water, the starch is finally dried at a temperature below 45° C, moderately ground and sieved through a 0.25 mm mesh.

The following reading were taken on all the samples :

- starch content by the modified DIMLER (10) polarimetric method ;
- water content by drying between 104° and 107° C to a constant weight ;
- ash content by calcination at 550° C for 8 hours ;
- total nitrogen content by the Kjeldahl micromethod and conversion into proteins using coefficient 6.25 ;
- iodine absorption and amylose content by J.N. BEMILLER (11) amperometric titration method, taking 19.9 per cent as a coefficient of theoretical absorption of iodine by pure amylose (TOLLIER and GUILBOT, 12). The lipid content of our samples, between 0.1 and 0.6 % is not high enough to interfere with the iodine bounding. Two samples of cassava are taken as reference (theoretical absorption = 18.6 per cent). The titration curves obtained are of the type shown in Figure 1. The sample for analysis varies according to the starches between 70 and 200 mg of the product ; readings were taken at 20° C.

Results

The starch content of products extracted in thelaboratory reveals that the sum of the non-glucidic substances in general represent 1 to 3 % of starch (Tables 1 and 2). They are chiefly impurities of protein origin, particularly in yam and taros starches. The degree of purity obtained neverthless permits an assessment of the percentage of maylose. Judgment must be qualified in the case of D. schimperiana whose starch still possesses a high percentage of fiber after extraction.

Table 1 sets out the quantities of bound iodine and the amylose contents of yam starches.

Tableau 1

Amylose content of yam starches

Starch source	Starch p. cent of extraded starch (dry matter)	Bound iodine p. cent of pure starch	Amylose p. cent of pure starch
YAMS			
D. rotundata ogoja	97,2	4.56	23.0
D. rotundata (conical)	97.0	4.32	21.7
D. cayenensis (long yellow)	98.7	4.37	22.0
D. cayenensis (white, table yam)	97.8	3.88	19.5
D. schimperiana	84.1	3.28 to 3.88	15.2 to 19.5
D. bulbifera ex gwofon	97.7	5.30	26.6
D. esculenta	97.9	2.69	13.5
D. alata ex Bafut	96.2	4.57	23.0
D. libreschiana	99.0	6.89	34.5
D. dumetorum yellow hairy (Yaoundé 71)	98.1	2.02	10.2
D. dumetorum yellow hairy (Bambui 70)	97.2	2.05	10.3
D. dumetorum yellow smooth (Bambui 70)	97.7	2.02	10.2
D. dumetorum yellow smooth (Bambui 71)	97.1	2.23	11.2
D. dumetorum white smooth (Bambui 70)	98.0	2.06	10.4
D. dumetorum white smooth (Yaoundé 71)	97.6	1.92	9.7

The amylose content varies from 9.7 to 34.5 per cent according to species. The starches of all varieties of D. rotundata, D. cayenensis and D. alata have contents between 19.5 and 23 per cent, in the same range of potato and arrowroot contents as well as the values found by RASPER and COURSEY (8) for the same species. ROSENTHAL (7) gives a 4.5 per cent iodine affinity for D. alata. It should be noted, however, that using a colorimetric procedure, BERRIOS (5) finds a 34 per cent amylose content in a D. rotundata of an unspecified variety, cultivated in Puerto Rico. This may be due to an intervarietal difference or geographical situation as this difference is not to be found between Ghanian and Cameroonian varieties.

The amylose contents of starches extracted from D. libreschiana and the aerial bulbils of the D. bulbifera yam are appreciably higher, namely 34.5 and 26.6 per cent.

On the other hand the starch of three cultivars of the D. dumetorum species tends to possess a low iodine affinity. Their amylose content lies between 9.7 and 11.2 per cent. The ecological conditions of production do not seem to affect the amylose content since it remains appreciably the same from one year to the next (1970 and 1971) and from one place of cultivation to another (Yaounde and Bambui with different altitudes and climates). The starch of D. dumetorum is not unlike the starches of the waxy type with respect to its amylose content.

The iodine affinity of the D. esculenta starch is also lower than that of most other species of Dioscorea, 2.69 per cent, giving an amylose content of 13.5 per cent.

RASPER and COURSEY (8) give amylose contents of 14 to 15 per cent for D. dumetorum and D. esculenta. The starches of these two species have very small granules 1 to 3 u for D. dumetorum, 1 to 5 u for D. esculenta. These granules have a special shape and

in addition produce low-strength gels which make them unsuitable for preparing "foufous" (a paste of cooked and ground tubers which is traditional in a large number of African countries).

Moreover the X-rays diffraction spectra obtained by CHARBONNIERE (13) on our specimens are of type A for D. dumetorum varieties obtained in 1970 and 1971 whereas they are of type B for all the other species of yams. The type of spectrum, which shows the crystalline organization of the starch granule may consequently vary according to the species of Dioscorea and for this botanical type it seems to be related to the amylose content.

These characteristics of D. dumetorum starch are perhaps to be considered against one of its agronomical characteristics which limits the expansion of its cultivation in Cameroon. D. dumerotum has a high yield (30 to 40 tons/hectare) and does not require propping but the day after collection the tuber becomes hard, it cracks and is unsuitable for eating (LYONGA, 14). It retains these defects even after cooking. To avoid this drawback, which does not seem to have been reported elsewhere but in Cameroon, it must be cooked immediately after it has been pulled ; this prevents storage and marketing. If the characteristics of the physico-chemical properties of the D. dumetorum starch are related to its genetic origins, they might be connected to this problem of hardening. Moreover, it is wellknown that amylomaize grains are less resistant to grinding than normal maize or waxy-maize grains (12). However, other factors such as cell-walls constituants might interfere in the hardening process.

The amylose contents of sweet potatoes, 17 to 18 per cent, and of cocoyams, 21 to 23 per cent, show no intervarietal differences (Table 2). The variety of taros ex Bafou, on the other hand, have an appreciably lower iodine affinity than the other taros.

In the same way, the two varieties of breadfruit have very different iodine affinities but it must be pointed out that it is grain starch in the case of A. seminifera and pulp starch in the case A. apyrena. The 9.2 per cent amylose content of A. apyrena confirms the result obtained in Brazil (9.0 %) by CORREA (6) in respect of the same variety.

Tableau 2

Amylose content of various tropical starches

Starch source	Starch p. cent of extraded starch (dry matter)	Bound iodine p. cent of pure starch	Amylose p. cent of pure starch
CASSAVA			
Manihot esculenta (red)	98.3	3.15	16.9
Manihot esculenta (white)	99.4	3.18	17.1
SWEET POTATOES			
Ipomea batatas yello ex america	98.7	3.54	17.8
white ex Manjo	98.8	3.48	17.5
RED EX Nkolbisson	98.0	3.64	18.3
"COCO YAMS"			
Xanthosoma sagittifolium red	98.5	4.53	22.8
white	98.1	4.19	21.1
TAROS			
Colocasia antiquorum white Fulani type	97.4	2.81	14.2
red ex Nkambe	94.3	3.43	17.3
small size ex Bafou	97.7	1.89	9.5
LOCAL CARROT			
Coleus esculentus	97.9	2.96	14.8
YAM - BEAN			
Pachyrrhizus erosus	98.8	3.31	16.6
BREADFRUIT			
Artocarpus communis apyrena (pulp)	97.0	1.84	9.2
seminifera (seeds)	93.3	4.34	21.8
JACKFRUIT			
Artocarpus integra (seeds)	97.7	4.52	22.7

Further work is attempted to try to establish a relation between the various physico-chemical properties of these starches : amylose content, X-rays diffraction spectra, amylase susceptibility, swelling power and solubility in water.

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Summary

The starches of several species and varieties of yams and other tropical starchy foods were extracted in the laboratory ; readings were taken of bound iodine and the amylose content. With respect to yams, D. esculenta and particularly D. dumetorum had lower amylose contents (13.5 and between 10 and 11 per cent) than the other species. This low iodine affinity is considered in connection with other physico-chemical characteristics of the starches of D. esculenta and D. dumetorum and related to the crystalline organization of the starch granule.

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FICHE SIGNALETIQUE

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Amylose content of some tropical starches (Teneur en amylose de quelques amidons tropicaux). 6 pages, 2 tableaux, 1 figure, 14 références.

Teneur en amylose de certains amidons alimentaires tropicaux : dioscorea (ignames), ipomea (patates), colocasia (taros), xanthosoma (macabos), coleus, pachyrrhizus, artocarpus (fruits à pain).