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Carbohydrate metabolism in *Colocasia esculenta* Schott corms and cormels during sprouting

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The carbohydrate contents of corms and cormels of local white and pink varieties of *Colocasia esculenta* Schott were determined during sprouting. The two varieties were found to store starch, glucose, fructose and sucrose. Of these carbohydrates, starch was the most abundant while glucose was the least. Starch decreased gradually from planting to leaf flush, after which it increased. In contrast, the sugar contents increased from planting to leaf expansion and decreased appreciably at the leaf flush. The rate of increase of fructose and sucrose was found to be higher than that of glucose in most of the sampling periods. The white and pink varieties of *C. esculenta* did not show any difference in the metabolism of carbohydrates in the corms and cormels during sprouting. However, the pink corms were found to sprout earlier than the pink cormels.

INTRODUCTION

Colocasia esculenta Schott, commonly known as cocoyam, is an important food crop throughout the humid tropics. In West Africa, particularly in Ghana, Cameroon and Gabon, cocoyam cultivation is second to that of cassava in terms of acreage (Karikari, 1980; Lyonga, 1980; Knipscheer & Wilson, 1981). Onwueme and Sinha (1991) reported that Nigeria is the world's leading producer of cocoyam, with 31% of the world production.

Carbohydrate is the most abundant food nutrient stored in cocoyam corms and cormels. Coursey (1968) found that cocoyam corms contain 13–29% carbohydrate and 1·4–3·0% protein. Onwueme and Sinha (1991) reported that fresh cocoyam corm contains 20–25% starch, 1·5–3% protein and significant amounts of vitamin C, thiamine, riboflavin, niacin and carotene. During sprouting, the food reserves in perennating organs are metabolized. In *Dioscorea rotundata* tubers, starch is depleted, whereas the sugar level is increased during sprouting (Adesuyi, 1975). Izundu and Fasidi (1991) reported that proteinase activity increased during sprouting until after leaf flush in the tubers of *D. dumetorum*. Very little is known about the physiology of sprouting in cocoyam. An understanding of the mechanism of sprouting will help to provide the key to manipulating the dormancy period in *C. esculenta*, either to initiate sprouting or prolong dormancy and therefore the storage period. In the present work, the effect of sprouting on the carbohydrate metabolism of corms and cormels of two local varieties of *C. esculenta* was investigated.

MATERIALS AND METHODS

Corms and cormels of local *C. esculenta*, var. white and pink were harvested unbruised from a nine-month-old plantation. After storage for four weeks, they were planted in plastic buckets containing sterilized top forest soil and kept in a greenhouse at 28 ± 3°C and r.h. 50–80%. They were watered once daily. At each sampling, three buckets were randomly selected and harvested. Corms and cormels were washed and immediately deep-frozen. They were then peeled, sliced, dried at 80°C for three days, and powdered.

A 1-g powdered sample was exhaustively extracted in a Soxhlet extractor for 6 h with boiling 80% ethanol. The extract was purified, concentrated and separated on Whatman No. 54 paper according to the method described by Fasidi (1980). The identified sugars were eluted with water from an unsprayed chromatogram and quantitatively determined by using titrimetric method (Somogyi, 1937).

The starch content of the ethanol-insoluble residue was determined by the diastase-hydrolysis method of Shriner (1932) and Barnell (1936).

RESULTS AND DISCUSSION

The corms and cormels of the white and pink varieties of *C. esculenta* store starch, glucose, fructose and sucrose in varying quantities. Starch was the most abundant of these carbohydrates (Table 1; Figs 1 and 2). This finding agrees with those of Coursey (1968)

Table 1. Starch and sugars expressed as percentages of total carbohydrates during sprouting

	Pink variety				White variety			
	Corm		Cormel		Corm		Cormel	
	Starch	Sugar	Starch	Sugar	Starch	Sugar	Starch	Sugar
At planting	90·14	9·86	94·42	5·58	83·5	16·5	78·79	21·21
Leaf flush	53·95	46·1	54·63	45·4	63·08	36·9	64·02	36·0
After leaf flush	52·55	47·5	67·01	33·0	63·42	36·8	69·50	30·5

and Onwueme and Sinha (1991). Coursey (1967) and Oyenuga (1968) have reported similar findings for *Dioscorea* species, *Ipomoea batatas* and *Manihot utilissima*. Ketiku and Oyenuga (1973), from their investigation on *D. rotundata*, identified maltose, sucrose and fructose as the free sugars in the tubers and found starch as the most abundant of the carbohydrates.

In the corms and cormels of both varieties, the starch contents decreased steadily from planting to leaf flush and increased thereafter. In the pink corms and cormels, the starch contents dropped to 53·95 and 54·63%, respectively, and in white corms and cormels they fell to 63·08 and 64·02% at leaf flush (Table 1). In contrast, glucose, fructose and sucrose contents of the corms and cormels increased from planting and reached a peak before leaf flush (Table 1; Figs 1 and 2). Adesuyi (1975) reported that the total sugar in the sprouting tubers of *D. rotundata* increased from 4.2 to 7.4%, whereas starch decreased from 65·0% to 16·8% from the first to the eighth week. The steady depletion of the starch content reported in this investigation is primarily due to its hydrolysis to glucose to supply respiratory energy and carbon skeletons to the new sprout.

The increase in sugar contents before leaf flush may be due to starch hydrolysis (Coursey, 1968), conversion of fat to sugar, and a lower rate of sugar utilization than production (Table 1). Just before and during leaf flush, there was a noticeable drop in the levels of starch and sugars in the corms and cormels of the two varieties. This may be due to hydrolysis of starch to sugar and the utilization of free and hydrolyzed sugars for the supply of energy and structural components for the growth of the new sprout. The ultimate increase in starch and sugar contents of the corms and cormels is due to the production of photosynthate as a result of the inception of photosynthesis by the new leaves (Figs 1 and 2).

From the time of planting until after leaf expansion, glucose was invariably the least abundant of the three sugars. This is not surprising, because glucose is readily utilized for energy supply and building of structural components for new cells. This explains the low glucose level obtained from planting to leaf expansion.

The white and pink varieties of *C. esculenta* did not show any difference in the metabolism and distribution of starch, glucose, fructose and sucrose in the corms and cormels. However, the pink corms sprouted and produced foliage leaves earlier than the cormels (Fig. 1(A) and (B)). This may be due to a higher activity of the hydrolases in the pink corms than in the cormels.

Sprouting in *C. esculenta* commenced with gradual depletion of starch and accumulation of sugars in the corms and cormels until leaf flush. At leaf flush, the

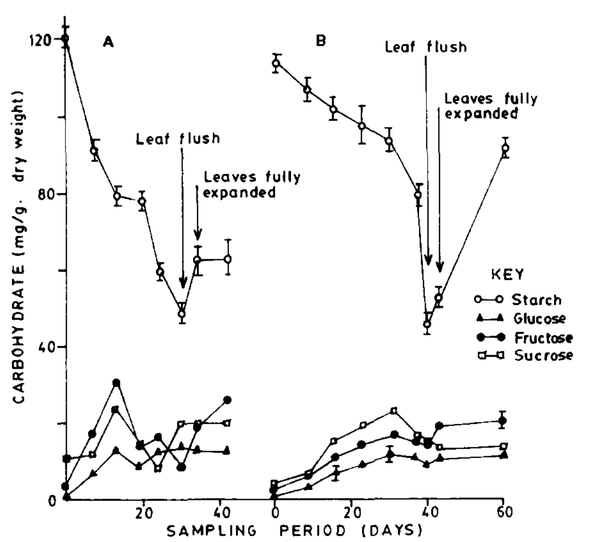

Fig. 1. Carbohydrate contents of pink corms and cormels of *C. esculenta* during sprouting.

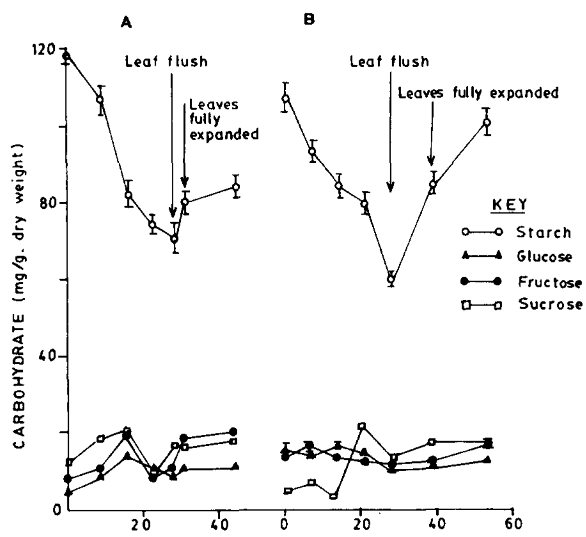

Fig. 2. Carbohydrate contents of white corms and cormels of *C. esculenta* during sprouting.

sugars were highly utilized, after which starch and sugars increased. It thus appears that the metabolism of carbohydrates in corms and cormels of *C. esculenta* during sprouting is based primarily on starch.

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