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Distribution of food reserves in *Dioscorea dumetorum* (Kunth) Pax tubers during sprouting

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The distribution of starch, ethanol-soluble sugars, lipid and protein in the tubers of *Dioscorea dumetorum* var. funfun (white variety) and *D. dumetorum* var. pupa (deep yellow variety) was investigated during sprouting. The distribution patterns of the food reserves were the same in the two varieties. There were variations in the distributions of food reserves in the 'head', 'middle' and 'tail' regions of the tubers, but physiological dominance was not observed. Starch and lipid decreased from planting to leaf flush, whereas ethanol-soluble sugar increased from planting and reached a peak just before sprout initiation. Similarly, protein increased until after sprout initiation and then decreased. The food reserves increased after leaf flush. At planting, starch was the most abundant food reserve. This was followed in order by protein, lipid and sugar. During sprouting, protein was the most abundant. These findings are discussed in relation to sprouting in *D. dumetorum* tubers.

INTRODUCTION

Yams, the tubers of *Dioscorea* species are of major importance as a food item in Nigeria and many of the tropical and subtropical countries of the world (Coursey, 1967).

Sprouting in yam tubers is an important physiological process that sets in motion tremendous metabolic activity that terminates dormancy. An understanding of the mechanism of sprouting is the key either to prolongation of the shelf-life of yam or increase in the number of crops per year. Despite its importance to yam storage, sprouting has not been fully understood. Onwume (1973) and Ikediobi (1985) reported that sprouting induces active cell division of the meristematic cells beneath the tuber skin. Coursey (1967), Onwume (1973) and Passam (1977) have shown that the whole tubers tended to sprout earlier than bisected tubers, and the proximal half of bisected tubers sprouted earlier than the distal half. Ikediobi & Oti (1983) reported a sharp increase in the biosynthesis of proteins after sprouting, while Adesuyi (1975) showed that sprouting reduces starch reserves. In the present work, the effect of sprouting was investigated on the distribution of food reserves in two local varieties of *D. dumetorum* tubers.

MATERIALS AND METHODS

Whole tubers of *D. dumetorum* var. funfun (white variety) and *D. dumetorum* var. pupa (deep yellow variety) were purchased from the market at Ibadan and planted in ridges made in the departmental garden. The ridges were regularly watered and whole tubers were harvested at regular intervals, washed and deep-frozen. Thereafter, they were peeled and divided into 'head', 'middle' and 'tail' pieces. Each portion was sliced into thin pieces, dried at 80°C to a constant weight and powdered.

Ethanol-soluble sugars

Sugars extracted in boiling 80°C ethanol for 6 h in a Soxhlet extractor were quantitatively estimated using the phenol–sulphuric acid method of Dubois *et al.* (1956).

Starch

The ethanol-insoluble residue was refluxed with 10% HCl for 4 h in a Soxhlet extractor. The resulting hydrolysate was neutralised with 10% NaOH and quantitatively estimated by the anthrone–sulphuric acid method (Carroll *et al.*, 1956). The value of glucose was multiplied by 0·9 to obtain the starch value (Hassid & Neufield, 1964).

Protein

Powdered sample was extracted in 2% NaCl at 60°C for 30 min. Protein precipitated from the resulting solu-

tion by 3% copper acetate monohydrate (Osborne & Voogt, 1978) was centrifuged and dissolved in 0·1 M NaOH solution. The quantity of protein was estimated by the folin–phenol method of Lowry *et al.* (1951).

Lipid

Powdered sample was extracted for 4 h in light petroleum in a Soxhlet extractor. The lipid extract was quantified according to the method of Mukiibi (1973). Each determination was done in triplicate.

RESULTS AND DISCUSSION

Starch was the most abundant food reserve at the time of planting and the white variety contained the greater amount (Fig. 1; Table 1). Starch was reported as the most abundant carbohydrate in *Colocasia esculenta* (Fasidi, 1993) and *D. rotundata* (Ugochukwu *et al.*, 1977). The starch content of the tubers in both varieties decreased gradually from planting to leaf flush and increased slightly thereafter (Fig. 1). This result agrees with the findings of Fasidi (1993) on *C. esculenta* and of Adesuyi (1975) and Booth (1974) on *D. rotundata* during sprouting. Starch was presumably hydrolysed to glucose to provide respiratory energy and structural carbon for the new sprout. Izundu (1988) reported a sharp increase in amylase activity during the sprouting of *D. dumetorum* tubers. The increase in starch content after leaf flush is due to commencement of photosynthesis.

The sugar content of the deep yellow variety was higher than that of the white variety. This perhaps explains the sweeter taste of and preference for the deep yellow variety. The sugar contents of both varieties increased from planting and reached a peak just before

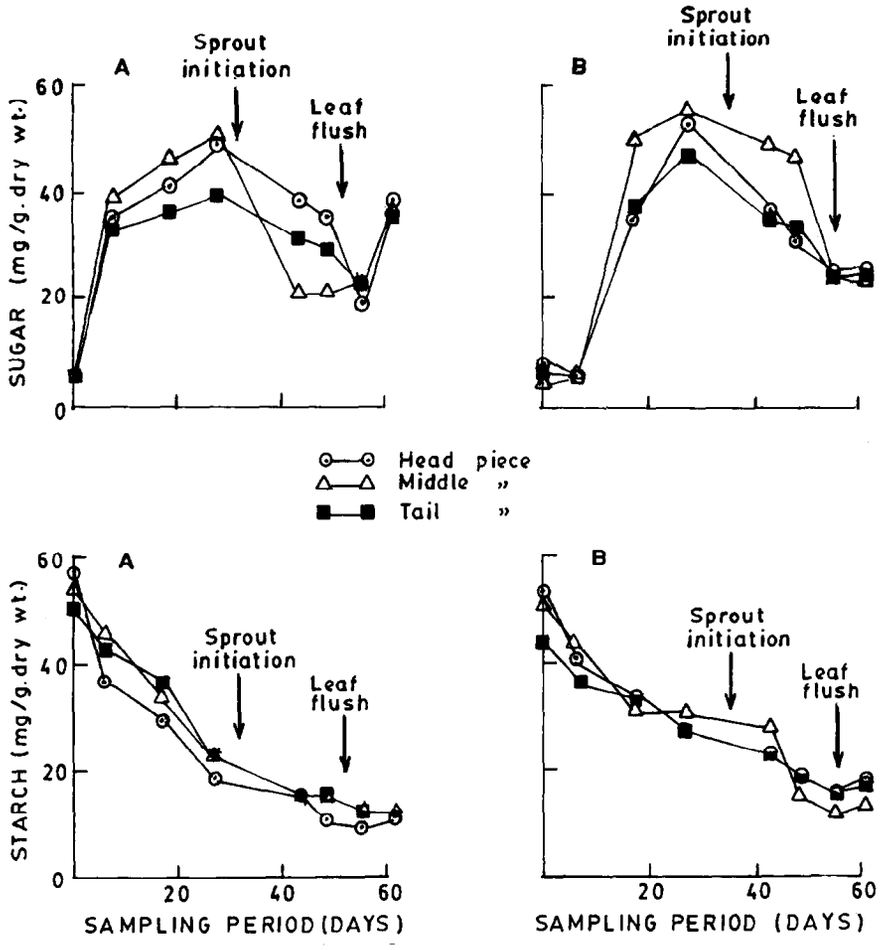

Fig. 1. Distribution of sugars and starch in 'head', 'middle' and 'tail' portions of tubers during sprouting. A: White variety; B: Deep yellow variety.

Table 1. Starch, ethanol-soluble sugars, lipid and protein contents of tubers expressed as percentage of total food reserves during sprouting

	Deep yellow variety				White variety			
	Starch	Sugars	Lipid	Protein	Starch	Sugars	Lipid	Protein
At planting	52·4	3·5	13·1	31·0	53·5	2·6	9·9	34·1
Sprout initiation	28·2	23·6	3·0	45·2	26·6	27·4	5·7	40·4
Leaf flush	29·6	27·8	2·3	40·3	18·5	19·8	4·3	57·3

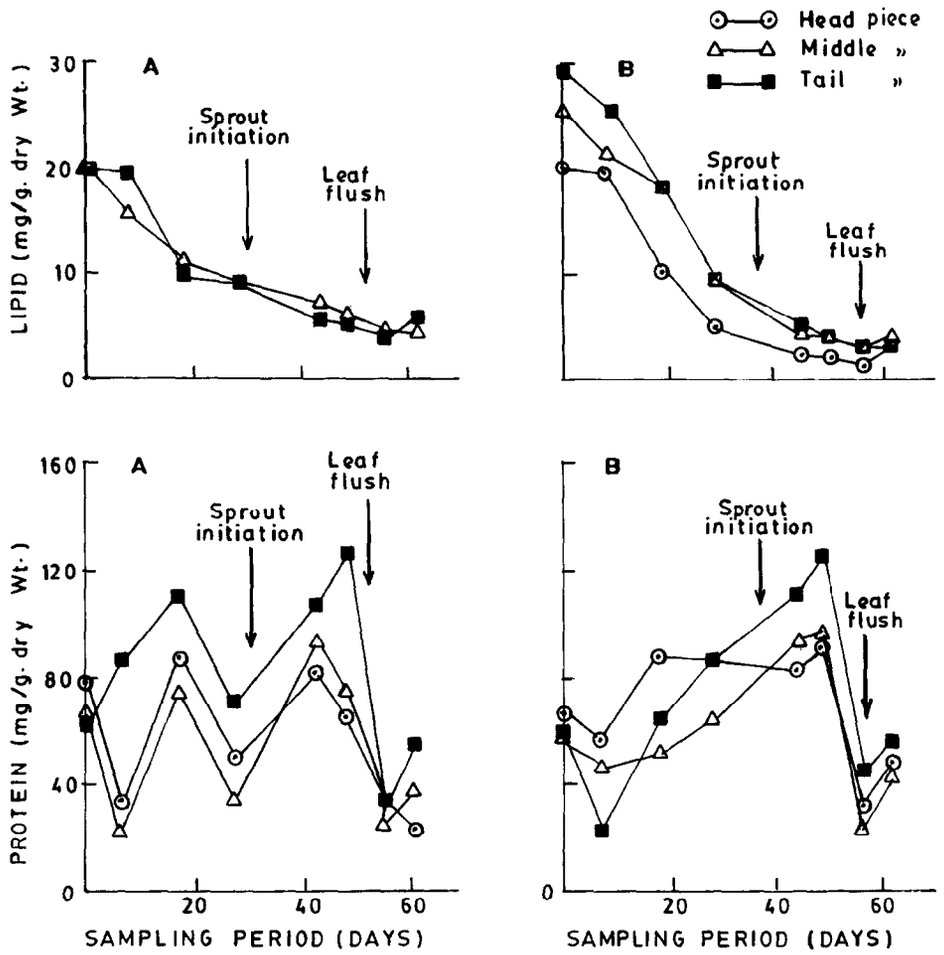

Fig. 2. Distribution of lipid and protein in 'head', 'middle' and 'tail' portions of tubers during sprouting. A: White variety; B: Deep yellow variety.

sprout initiation and then decreased. The sugar contents increased again after leaf flush (Fig. 1). The initial increase is due to hydrolytic production of sugars (from starch) that could be utilised immediately by the tuber tissues. The decrease in sugar content after sprout initiation is due to its utilisation for respiratory energy and carbon skeleton production for the new sprout. The sugar contents of the tubers at sprout initiation were more than five times the amount at planting (Table 1). This explains why sprouted tubers are sweeter than dormant ones.

The dormant white variety of *D. dumetorum* stored an amount of protein greater than that of the deep yellow variety (Table 1). The protein contents of both varieties increased from planting and reached a peak just before leaf flush (Fig. 2). Perhaps sprouted tubers of *D. dumetorum* are to be preferred nutritionally to dormant ones because of their high protein and sugar contents. The increase in protein content may be due to conversion of carbohydrate and lipid into proteoplasmic protein for the new shoot. Ikediobi & Oti (1983) reported a sharp increase in protein biosynthesis during sprouting of *D. rotundata* tubers.

There were differences in the distribution of food reserves in the 'head', 'middle' and 'tail' regions of the white and deep yellow tubers of *D. dumetorum*. However, no tuber region appeared to exert physiological dominance throughout the period of sprouting (Figs 1 and 2). Ologhobo (1985) observed that the 'head', 'middle' and 'tail' regions of the yam tubers did not differ significantly in their protein contents. Similarly, Martin & Thompson (1971) reported that, except for the peel, the various parts of the yam did not differ significantly. In contrast, Ugochukwu & Anosike (1985) and Izundu & Fasidi (1991) reported that the 'head' region of the yam tuber is superior to other regions in enzyme activities.

During the sprouting of *D. dumetorum* tubers, protein and sugar increased, whereas lipid and starch were depleted. In dormant tubers, starch accounted for more than 50% of total food reserves and a large percentage of this was degraded during sprouting (Table 1). It appears, therefore, that the metabolism of *D. dumetorum* during sprouting is based primarily on degradation of starch.

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