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FATTY ACID PROFILES IN GERMINATING *MANIHOT ESCULENTA**

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Key Word Index—*Manihot esculenta*; Euphorbiaceae; cassava; seeds and seedlings; fatty acids.

Abstract—The fatty acid composition of the storage lipids of cassava seeds was analysed by GLC. Linoleate (61·6%), oleate (22·4%) and palmitate (10·3%) occurred as major components, with myristate, palmitoleate, stearate and linolenate as minor components. A trace of arachidate occurred during early germination. The overall fatty acid composition of total lipids in dark- and light-grown seedlings remained relatively constant and indicated that no specific fatty acids were preferentially metabolized during seed germination and growth.

INTRODUCTION

THE CASSAVA plant is widely cultivated in tropical and subtropical countries as a source of dietary and industrial carbohydrates derived from its large tuberous roots. Although cassava tuber products form a major staple food in several developing countries,[1,2] cassava seeds do not appear to have achieved any nutritional or economic value. Recently, it was reported that cassava seed kernels contain 34% proteins and 47% lipids.[3,4] Consequently, it was suggested that the seeds may represent a nutritionally and an economically useful asset in the developing countries where the plant is under extensive cultivation. The present paper is a report on the fatty acid composition of total and neutral storage lipids of cassava seeds as well as changes in fatty acid profiles during seed germination and growth. The possible nutritive and industrial values of cassava lipids are discussed in relationship with other useful oilseeds.

RESULTS AND DISCUSSIONS

Electron microscopic studies have revealed that both the endosperm and cotyledon of mature cassava seed contain proteins and lipids as major reserves. When total storage lipids of seed kernels were analysed into lipid classes by TLC, it was found that triglycerides constituted 98%, while phospholipids, glycolipids and steroids formed only 2%.[4]

GLC[5] analyses of methyl esters[6] of total lipids revealed the presence of seven fatty acids, while the triglyceride fraction contained only five fatty acids, ranging from $C_{14:0}$ to $C_{18:3}$. Table 1 shows the fatty acid composition of the total lipids and the triglyceride fraction of cassava seed kernels. It is noticed from Table 1 that cassava seed fats are characterized by

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a high content of linoleic, oleic and palmitic acids which occur mainly as triglycerides. Among the Euphorbiaceae, this profile of seed fatty acids relates cassava more to *Hevea* than to *Ricinus*.[7] It is of nutritional significance that the concentrations of the major fatty acids of cassava seeds are nearly identical with those of soya beans,[7] one of the major sources of edible and industrial vegetable oils. Furthermore, the three fatty acids constitute *ca.* 80% of the total fatty acids in all commercial fats.[8] Thus the results of these investigations show that cassava seed fats may well be utilized as a source of dietary and industrial vegetable oil.

TABLE 1. FATTY ACID COMPOSITION OF TOTAL STORAGE LIPIDS AND TRIGLYCERIDES OF *Manihot esculenta* SEEDS

Fatty acid	% Composition in Total lipids	% Composition in Triglyceride fraction	Fatty acid	% Composition in Total lipids	% Composition in Triglyceride fraction
$C_{14:0}$ (Myristate)	0·07	n.d.	$C_{18:1}$ (Oleate)	22·40	23·00
$C_{16:0}$ (Palmitate)	10·34	9·90	$C_{18:2}$ (Linoleate)	61·60	62·00
$C_{16:1}$ (Palmitoleate)	0·09	n.d.	$C_{18:3}$ (Linolenate)	1·40	1·20
$C_{18:0}$ (Stearate)	4·10	3·90	$C_{20:0}$ (Arachidate)	n.d.	n.d.

n.d.—not detected.

Cassava seeds do not contain free fatty acids. However, on germination, free fatty acids and diglycerides accumulate, followed by a rapid decrease in total lipids and an overall conversion of storage fats to carbohydrates.[4] Furthermore, the rate of lipid mobilization and utilization in light-grown seedlings is twice as much as that in dark-grown seedlings. The analyses of fatty acid profiles in light- and dark-grown seedlings showed that the overall composition of fatty acids did not undergo significant qualitative and quantitative variations, except that myristate and palmitoleate disappeared after 25 days germination, while a trace of arachidate appeared at the beginning of seed germination. Table 2 illustrates the relative percentage composition of the fatty acids in the total lipids of seedlings as a function of growth condition and period.

TABLE 2. NET CHANGES IN THE FATTY ACID COMPOSITION OF *Manihot esculenta* SEEDLINGS

Fatty acid	% Composition Age of seedlings, day* 3 Dark (49·2)	9 Dark (43·8)	13 Dark (41·0)	13 Light (35·7)	17 Dark (37·2)	17 Light (28·5)
$C_{14:0}$	0·04	0·10	t.	n.d.	n.d.	t.
$C_{16:0}$	10·20	11·60	11·80	10·20	11·00	12·50
$C_{16:1}$	0·05	0·11	t.	t.	t.	t.
$C_{18:0}$	4·10	5·10	4·60	3·40	4·10	4·60
$C_{18:1}$	21·80	22·70	23·00	21·60	21·60	22·60
$C_{18:2}$	62·20	59·20	58·70	63·30	60·20	58·70
$C_{18:3}$	1·60	1·30	2·00	1·60	3·00	1·60
$C_{20:0}$	0·11	t.	n.d.	n.d.	n.d.	n.d.

*All seeds were germinated in the dark. After 9 days germination, samples of uniform seedlings were exposed to a light–dark regime.[4] Figures in parentheses represent per cent lipids in dry plant materials. t.—trace; n.d.—not detected.

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It is seen from Table 2 that only small variations in the relative concentrations of the fatty acids occurred in both types of seedlings over a growth period of 17 days. Thus although both types of seedlings rapidly lost storage lipids, no specific fatty acids appeared to be metabolized preferentially to any large extent. A non-preferential utilization of fatty acid components of storage lipids appears to be general for germinating oilseeds.[8] However, exceptions have been noted for germinating peanuts which metabolize saturated fatty acids preferentially,[9] and for watermelon seedlings which metabolize oleic acid preferentially.[10]

EXPERIMENTAL

Cassava seeds were kindly provided by the Crops Research Institute, Kumasi, Ghana. Seed germination and the isolation and TLC analyses of total lipids and triglycerides were performed as previously described.[4]

GLC of total lipids and triglycerides. Methyl esters of total lipids and isolated triglycerides were prepared in BF_3–MeOH[6] and analysed by GLC[5] with Beckman GCM and GC4 instruments with FIDs using 0·3 × 180 cm steel columns packed with 15% DEGS on Chromosorb W. The instruments were connected to recorders with disc integrators and calibrated with quantitative standard mixtures of methyl esters. Quantitative results were obtained by calculations from the integrator measurements of peak areas. Samples were run isothermally at column temp. of 175°, detector temp. of 240°, injection temp. of 230°. The following flow rates were employed: He 38–40 ml/min, air 250 ml/min, H_2 40 ml/min.

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