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Lipid Metabolism in Seeds of *Citrullus Vulgaris* During Germination

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Studies have been carried out on *Citrullus vulgaris* Schrad, variety Sugar baby for the determination of moisture, lipid content, lipid classification into neutral and polar lipids and fatty acid composition ($C_{12:0}$- $C_{20:0}$) of lipid fractions of primary roots and the respective cotyledons at various stages (10 mm-30 mm root length) of germination. Several workers [1-6] have studied *Citrullus vulgaris* with respect to germination from different aspects. But detailed study about the variation and composition of each lipid class during germination has not been discussed so far. An effort is made to study minutely the changes in each lipid class and its fatty acid composition of cotyledons and primary roots of *Citrullus vulgaris* seeds when germinated at 30°C in the dark. The studies at different stages of germination help to understand the biosynthesis of lipids and the natural pathway of the formation of fatty acids and their changes prior to the maturation of seeds.

The lipid content of primary roots (10, 20, and 30 mm) and the respective cotyledons were determined according to Folch's method [7,8] (Table 1) and the lipids were classified into neutral and polar lipids by TLC [9,10] using different solvent systems (Table 2). The methyl esters of each lipid class were prepared with boron-trifluoride-methanol reagent [11] and the fatty acid compositions of each lipid class of cotyledons (Table 3) and primary roots (Table 4) were determined by gas chromatography.

The lipid content on dry weight basis decreased (15.38 - 8.46%) in primary roots as the root length increased from 10 mm to 30 mm, showing that there was a rapid utilization of

Table 1. Lipid, Dry Wt. and Moisture Contents of Cotyledons and Roots at Different Germination Stages.

Root length (mm)	Cotyledons						Roots					
	Wt. (g)	Dry Wt.	Moisture	Moisture (%age)	Lipids	Lipids (%age)	Wt. (g)	Dry Wt.	Moisture	Moisture (%age)	Lipids	Lipids (%age)
10	5.06	2.32	2.74	54.95	0.52	22.41	1.13	0.13	1.00	88.49	0.02	15.38
20	5.23	1.80	3.43	65.58	0.41	22.77	1.45	0.11	1.34	92.41	0.01	9.09
30	4.97	1.15	3.82	76.93	0.26	22.91	2.46	0.13	2.33	94.76	0.11	8.46

Table 2. Percentage of Lipid Fractions at Various Roots Lengths.

Lipids		R_f value	Cotyledons			Primary roots		
			10 mm	20 mm	30 mm	10 mm	20 mm	30 mm
Hydro carbons	(HCN)	0.96	1.3	1.0	0.9	1.1	0.9	0.7
Wax esters	(WE)	0.90	2.1	1.7	1.6	2.0	1.7	1.4
Triglycerides	(TG)	0.59	68.2	57.8	52.4	68.8	58.5	50.5
Free fatty acids	(FFA)	0.40	4.5	10.8	12.3	3.4	9.8	14.8
1:3-Diglycerides	(1:3 DG)	0.33	5.2	4.9	4.5	4.9	4.3	4.0
1:2-Diglycerides	(1:2 DG)	0.30	2.0	1.7	1.6	1.8	1.7	1.3
Alcohols	(Al)	0.24	0.7	1.2	1.3	0.6	0.7	1.0
Sterols	(S)	0.21	2.3	3.0	3.5	2.1	2.6	3.0
2-Monoglycerides	(2MG)	0.18	1.8	2.8	2.5	1.7	1.5	1.2
1-Monoglycerides	(1MG)	0.13	3.5	3.4	3.6	4.5	5.6	5.9
Monoglactosyl diglycerides	(MGDG)	0.78	2.4	4.1	4.8	2.6	4.3	5.3
Phosphatidyl ethanolamines	(PE)	0.65	1.5	2.1	2.4	1.9	2.5	3.1
Phosphatidyl cholines	(PC)	0.53	1.7	2.3	2.8	2.1	2.9	3.5
Lysophosphatidyl ethanolamines	(LPE)	0.46	1.6	2.2	2.4	1.5	1.8	2.0
Lysophosphatidyl cholines	(LPC)	0.42	0.9	1.3	1.6	1.0	1.4	1.9
Phosphatidyl inositols	(PI)	0.17	1.3	1.9	2.8	1.6	2.3	2.9

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TABLE. 3. FATTY ACID (%) COMPOSITION OF COTYLEDON LIPIDS AT DIFFERENT ROOT LENGTHS.

Lipids	10 mm											20 mm											30 mm										
	12:0	12:1	14:0	14:1	16:0	16:1	18:0	18:1	18:2	18:3	20:0	12:0	12:1	14:0	14:1	16:0	16:1	18:0	18:1	18:2	18.3	20:0	12:0	12:1	14:0	14:1	16:0	16:1	18:0	18:1	18:2	18:3	20:0
WE	-	-	8.6	9.8	21.2	8.3	11.9	12.6	21.5	4.5	3.6	-	-	9.0	7.5	21.7	7.8	12.9	12.7	20.6	4.1	3.7	-	-	9.1	6.9	23.2	7.3	13.9	12.0	19.9	3.9	3.8
TG	2.1	0.6	2.9	2.8	22.8	-	9.7	15.6	43.5	-	-	2.1	0.3	3.5	2.5	23.0	-	10.7	14.9	43.0	-	-	1.5	0.2	4.6	2.3	23.6	-	11.2	14.5	42.1	-	-
FFA	0.5	0.7	0.8	3.0	20.7	2.9	14.5	11.7	41.7	3.5	-	0.3	-	1.7	2.1	23.1	2.8	16.1	10.9	40.7	2.3	-	0.4	-	3.2	1.9	25.6	1.7	18.9	9.9	37.1	1.3	-
1:3DG	2.9	-	7.1	-	25.3	-	17.8	11.7	35.2	-	-	2.0	-	7.5	-	26.7	-	18.8	10.8	34.2	-	-	1.4	-	8.1	-	27.1	-	19.3	10.4	33.7	-	-
1:2DG	1.1	-	3.0	-	23.0	-	14.5	12.1	46.3	-	-	0.5	0.3	6.9	-	24.7	-	16.5	12.0	39.1	-	-	0.2	-	7.5	-	25.6	-	17.9	11.5	37.3	-	-
2-MG	5.4	0.3	8.1	0.6	25.1	-	20.5	4.9	35.1	-	-	3.1	-	9.1	0.3	26.4	-	22.1	5.7	33.3	-	-	0.9	-	10.1	-	27.9	-	23.5	6.9	30.7	-	-
1-MG	6.1	-	7.3	4.2	17.9	-	16.1	15.3	33.1	-	-	3.2	-	8.7	1.9	19.3	-	18.7	15.5	32.7	-	-	0.5	-	9.8	0.2	20.9	-	20.1	16.0	31.0	1.5	-
MGDG	5.9	-	9.4	3.2	18.9	1.5	14.3	11.0	35.8	-	-	2.3	-	13.7	0.5	22.3	-	17.3	10.9	33.0	-	-	1.2	-	14.5	-	23.3	-	18.1	10.9	32.0	-	-
PE	5.2	1.7	12.3	2.3	19.7	4.3	13.1	10.7	28.2	2.5	-	3.1	-	13.4	0.6	22.6	1.1	15.9	11.0	27.1	5.2	-	1.9	-	15.2	-	23.2	-	16.7	10.9	26.1	6.0	-
PC	4.8	-	14.3	3.4	18.7	3.9	11.0	12.5	29.1	2.3	-	4.7	-	15.0	2.0	22.1	1.2	12.0	11.1	28.7	3.2	-	4.5	-	16.0	1.0	23.1	-	13.4	10.9	26.2	4.9	-
LPE	6.9	-	10.3	-	29.5	-	8.0	13.9	31.4	-	-	5.1	-	12.5	-	29.5	-	9.5	12.6	30.8	-	-	4.8	-	12.9	-	30.1	-	10.0	11.9	30.3	-	-
LPC	9.0	-	6.9	5.2	21.9	-	11.7	6.7	34.1	4.5	-	7.9	-	10.5	2.9	25.5	-	13.0	5.7	33.0	1.5	-	6.9	-	11.9	-	29.1	-	15.7	4.0	32.4	-	-
Pl	9.3	-	11.3	5.7	22.3	2.0	5.1	8.9	35.4	-	-	8.1	-	13.5	2.7	25.9	-	9.3	7.6	32.9	-	-	7.1	-	14.6	1.0	29.5	-	10.7	6.8	30.3	-	-

TABLE 4. FATTY ACID (%) COMPOSITION OF PRIMARY ROOT LIPIDS AT DIFFERENT ROOT LENGTHS.

Lipids	10 mm										20 mm										30 mm									
	12:0	12:1	14:0	14:1	16:0	16:1	18:0	18:1	18:2	18:3	12:0	12:1	14:0	14:1	16:0	16:1	18:0	18:1	18:2	18:3	12:0	12:1	14:0	14:1	16:0	16:1	18:0	18:1	18:2	18:3
WE	4.6	0.3	9.1	2.7	19.9	5.3	13.5	12.5	28.9	3.2	3.7	-	10.9	1.5	23.8	3.7	14.7	12.9	27.5	1.3	2.5	-	12.0	0.6	24.1	2.9	16.7	12.9	27.0	1.3
TG	1.7	-	2.4	0.7	26.8	-	10.2	14.9	43.3	-	1.5	-	3.7	-	28.6	-	10.2	14.7	41.3	-	0.9	-	4.3	-	31.2	-	11.1	13.5	39.0	-
FFA	4.7	-	7.5	1.3	22.7	1.4	14.1	11.9	33.6	3.1	3.1	-	8.9	0.7	24.8	-	15.0	11.7	32.7	3.1	2.8	-	9.5	-	26.4	-	16.3	11.5	31.9	1.6
1:3DG	7.9	-	4.9	1.0	30.7	-	18.7	15.4	21.4	-	6.8	-	6.5	-	32.5	-	19.7	14.0	20.5	-	6.2	-	7.1	-	33.2	-	20.1	13.8	19.6	-
1:2DG	7.6	0.9	6.9	-	22.9	-	13.5	10.9	37.3	-	7.0	-	8.1	-	24.9	-	14.6	9.9	35.5	-	6.0	-	9.9	-	26.1	-	15.3	9.4	33.3	-
2-MG	6.0	-	2.5	3.8	26.9	1.0	20.8	9.5	29.5	-	5.0	-	4.0	1.2	28.9	0.5	23.1	9.3	28.0	-	4.7	-	4.5	0.5	30.9	-	23.9	8.7	26.8	-
1-MG	9.0	0.7	6.9	0.2	27.7	3.0	12.9	8.9	29.1	1.6	8.1	-	9.0	-	29.7	1.5	14.1	8.1	28.0	1.5	7.0	-	9.5	-	31.2	0.7	15.6	7.2	27.0	1.8
MGDG	9.2	-	10.1	4.1	21.9	3.9	9.1	10.8	29.2	1.7	8.1	-	12.4	3.2	24.6	2.1	10.3	10.0	28.2	1.1	7.4	-	12.9	2.5	26.7	1.0	11.5	9.0	27.0	2.0
PE	7.2	1.0	10.5	1.2	27.1	-	8.1	9.7	34.1	1.1	6.2	0.5	11.1	0.7	29.9	-	9.4	9.0	32.9	0.3	5.3	-	12.0	0.3	35.9	-	9.5	8.5	28.5	-
PC	10.5	-	16.7	1.5	23.4	-	8.3	8.9	28.8	1.9	8.7	-	18.1	0.9	29.5	-	9.8	7.0	25.5	0.5	7.5	-	19.2	-	35.7	-	10.0	6.8	20.8	-
LPE	7.3	-	9.1	-	28.1	-	11.7	15.8	28.0	-	6.4	-	9.9	-	33.9	-	13.0	13.1	23.7	-	5.9	-	11.3	-	37.9	-	13.3	11.5	20.1	-
LPC	7.0	-	10.7	2.1	27.9	0.3	14.5	6.9	30.6	-	5.4	-	11.9	1.0	32.5	-	17.6	5.1	27.5	-	4.1	-	12.0	-	37.1	-	18.1	5.0	23.7	-
Pl	10.2	-	13.9	-	34.7	-	10.4	7.3	23.5	-	8.2	-	14.8	-	39.5	-	11.9	5.4	20.2	-	7.0	-	15.3	-	41.1	-	12.1	5.0	19.5	-

lipids as energy source but slight increase (22.41 - 22.91%) in cotyledons could be due to their biosynthesis and the preferential utilization of non lipid components. The relative amount of triglycerides decreased while the free fatty acid fraction and the polar lipids increased continuously with the increase of root length. Saturated fatty acids increased whereas lauric acid and the unsaturated fatty acids decreased gradually during germination. The metabolic system of the plant showed the interconversion of unsaturated fatty acids to saturated fatty acids which was supported by previous workers [12].

Key words: *Citrullus vulgaris*, Germinations, Lipids.

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