Composition of Phospholipids in Seed Oil of *Jojoba* (*Simmondsia chinensis* [Link], Schneider)

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Phospholipids from *Jojoba* oil were isolated in amounts of 0.16%. The following phospholipids were identified: phosphatidylcholine 45%, phosphatidylethanolamine 38%, phosphatidylinositol 10% and phosphatidylglycerol 7%. The fatty acid composition is similar in all individual phospholipids. Palmitic acid and oleic acid are the dominating fatty acids.

Introduction

Jojoba seeds consist of more than 50% of wax esters [1–3]. The homologous series of isomeric wax esters results from a combination of unsaturated fatty acids and alcohols containing double bonds exclusively in position ω 9 of the alkane chains [4]. In *Jojoba* plants wax esters located in the cotyledons are the storage lipids for germinating seeds, comparable to triglycerides in other plants [5–7]. In all plant seeds additional phospholipids are found, which mostly occur in amounts of less than 2% of the total lipids [8, 9]. In the present study we have analysed the composition of phospholipids in the seed oil of *Jojoba*.

Materials and Methods

Jojoba fruits were sampled in August 1981 in their native habitat near Tonto National Monument, Arizona, USA. The collected seeds were dipped in hexane several times for a total of 9 min in order to obtain the cuticular waxes [10]. Seeds were homogenised in a mixer and then extensively extracted with hot chloroform/methanol (2:1).

Determination of phospholipids:

1. qualitatively with phospholipid-reagent [11]
2. quantitatively according to Debuch et al. [12] with Fiske-Subbarow-reagent [13].

Total and individual phospholipids were methanolysed with 5% HLC in anhydrous methanol by refluxing for 2 h. TLC: TLC plates silica gel 60 (Merck) Solvent system:

1. benzene for separation of wax esters and phospholipids
2. chloroform/methanol/water (70:30:4) or
3. chloroform/methanol/acetic acid (65:25:8) for separation and identification of the individual phospholipids.

GLC: Hewlett-Packard Model 5830 with FID and GC-Terminal 18850 A; 12 m glass capillary column FFAP; split rate 1:8 N_2; Temp.program: 140 °C–220 °C; 4 °C/min.

Results and Discussion

In *Jojoba* seed oil phospholipids occur in amounts of 0.16%. The concentration of phospholipids in this seed oil is low in contrast to most other oil plants with less than 2% of the total seed lipid [8, 9]. Phospholipids (R_f 0.01) were isolated from wax esters (R_f 0.6) by TLC on plates of silica gel with benzene as solvent. The phospholipid fraction obtained by this manner was fractionated once more on silica gel plates with more polar solvents to isolate

Table I. Composition of phospholipids in *Jojoba* seed oil.

	% of PL	% of seed oil
PG	7	0.01
PI	10	0.02
PE	38	0.06
PC	45	0.07
PL	62 µg/40 mg oil = 0.16%	

Table II. Composition (peak area %) of fatty acids from phospholipids of *Jojoba* seed oil.

No. of C-atoms	PL	PC	PE	PI	PG
16:0	14.3	11.3	18.1	27.5	58.7
16:1	1.0	+	+	+	+
16:3	0.5	+	+	+	+
18:0	+	+	+	+	+
18:1	79.0	84.2	79.1	71.0	41.3
18:2	2.2	2.2	2.2	1.5	+
18:3	1.0	1.0	+	+	+
20:1	1.3	1.3	0.7	+	+

Abbreviations: PL, phospholipids; PC, phosphatidylcholine; PE, phosphatidylethanolamine; PG, phosphatidylglycerol; PI, phosphatidylinositol.

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the individual phospholipids. They could be identified with authentic samples of phospholipids and a special reagent for phospholipids [11]. In addition to this qualitative analysis the phospholipid fraction as well as the separated individual components were determined by quantitative analysis according to Debuch *et al.* [12]. Results are summarized in Table I. Phosphatidylcholine and phosphatidylethanolamine are the dominating phospholipids representing of 45% and 38%. In lower concentrations are identified also phosphatidylinositol (10%) and phosphatidylglycerol (7%).

The fatty acid composition of the phospholipids is shown in Table II. Fatty acids with a chain length of C_{16} and C_{18} are dominating, especially palmitic acid and oleic acid. Phosphatidylcholine, phosphatidylethanolamine and phosphatidylinositol have nearly the same composition of fatty acids, namely palmitic acid (11%–28%) and oleic acid (71%–84%). There is another acid pattern in phosphatidylglycerol, in which palmitic acid increases to 59%. These analyses show quite a different composition of fatty acids which are derived from phospholipids of *Jojoba* seed oil as compared to those derived from *Jojoba* seed wax esters. In wax esters eicosenoic acid in amounts of about 70% is dominating [1]. These data suggest that different biosynthetic pathways exist for phospholipids and for wax esters. In view of the different patterns of fatty acids a common precursor is unlikely. The absence of *Δ*3-*trans*-hexadecenoic acid in the phosphatidylglycerol of *Jojoba* seed oil is also remarkable and confirms that this acid is characteristic for phosphatidylglycerol from chloroplasts of green leaves [14].

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