Composition and Characteristics of Safflower Seed and Oil

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ABSTRACT

Safflower (*Carthamus tinctorius*) seeds were brought from the Agriculture Experimental Station at Geran (S.P.L.A.J.). Composition of seeds along with physical and chemical properties of oil is reported. Neutral fats were separated by silicic acid column and thin layer chromatography. The methyl esters were quantitated by GLC analysis.

The seeds contain 5.036% moisture; their chemical composition on a dry basis is: crude fat 31.58%; crude protein 17.44%; crude fibre 24.28%; ash, 3.65% and total nitrogen 3.06%. The characteristics of the seed oil are: specific gravity at 25°C, 0.9322; refractive index at 25°C, 1.4713; saponification value, 199.22; iodine value, 143.56; Reichert Meissl value, 0.57; Polenske value, 3.76; free fatty acids, 0.16; TBA number, 0.31; acid value, 0.32; and viscosity 69.322 (Cp. at 20°C).

The distribution of principal fatty acids in neutral fat is: linoleic, 57.2%; oleic, 23.3%; Palmitic, 12.1%; stearic, 4.8%; and arachidic, 1%. The linolenic acid is in traces.

INTRODUCTION

The safflower oil is extracted from the seeds of *Carthamus tinctorius*. Although this plant has been used since ancient times its commercial importance has been realised only in recent years (4,10). The figures regarding the total world production of safflower seeds are not available, however, there is a substantial increase in the area of safflower crop cultivation in United States, India, Mexico, Spain, Portugal and Australia (4). The world production of this oilseed is expected to rise in the near future. Depending on climate and other environmental factors seeds contain 25–40% oil on dry basis and linoleic acid content in triglycerides may be as high as 81%. The saturated and unsaturated fatty acids are about 10% and 90% respectively (5,9,12).

According to AOCS (14) standards, the characteristics of safflower oil are: specific gravity at 25°/25°C, 0.191–0.924; refractive index, at 25°C, 1.472–1.475; iodine value, 140–150; saponification value, 186–197. The data of the characteristics of this oil reported by other workers (2) also fall within the above ranges.

The high quality of safflower oil both for edible and industrial uses is due to its high linoleic and low linolenic acids. In spite of its standing as a premium edible oil, the advantages claimed in surface coating application include excellent odour, good drying properties, more uniform polymer structure, and lack of after-yellowing (10,14).

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High-quality safflower seeds (40% oil content) were imported from the U.S.A. by the Libyan Council of Food Affairs and Marine Wealth in 1977. The crop thrived well under the local conditions and results suggest that the introduction of this oilseed crop in Libyan Jamahiriya is technically feasible and economically viable (7).

The present study was undertaken to investigate the chemical composition of safflower seed and oil produced at local Agricultural Research Stations, at Geran (S.P.L.A.J.).

MATERIALS AND METHODS

Safflower seeds grown at the Agriculture Experimental Station at Geran were used in this study. The seeds were stored at room temperature and subjected to different analysis. For each test six replicates were prepared.

Composition of seed

The determination of moisture, crude fat, protein and ash was carried out according to AOCS methods (1). The extraction of total lipids from the oven-dried and ground seed samples was achieved by petroleum ether (60–70 BP) diethyl ether or chloroform-methanol (2:1 v/v) with Soxhlet apparatus. The solvent was removed by rotary evaporator, under vacuum.

Physico-chemical properties of oil

The crude oil as extracted above, was stored under nitrogen cover. The specific gravity (density) refractive index, viscosity, acid value, iodine value, saponification value, Reichert Meissl value and Polenske value were determined according to the Official and Tentative Methods of AOCS (1). The free fatty acids were determined by the methods of Doris (3). The thiobarbituric acid (TBA) was determined spectrophotometrically at 532 nm by using Bechaman Spectrophotometer Model 26 (11).

Fatty acid composition

The separation of neutral fat was done on silicic acid column and thin layer chromatography as described by Stahl (13). One g of neutral fat fractioned on silicic acid column was dissolved in 20 ml chloroform and 0.2 ml aliquot of this stock solution was spotted on silica gel coated plates. The neutral lipids were developed first with solvent system; 1: diethylether:benzene:ethanol acetic acid (40:50.2:0.2), air dried and redeveloped in the same direction with solvent system II: n-Hexanol/diethylether (96:4). The lipids were detected with iodine vapours. The resulting triglycerides were scraped from the plates and used for the preparation of methyl esters. These were prepared by transesterification with born trifluoride (8). The methyl esters were assayed by gas chromatography (Pye-Unicam model 104) equipped with flame ionization detectors, automatic temperature programming, and a 250 cm × 0.5 cm ID glass column containing 8% polyethylene-glycol-adipate (PEGA) was used. The column temperature was held constant at 170°C and injection temperature was 210°C and samples were analyzed isothermally with a nitrogen flow rate 50 ml/min. and recorded chart speed 0.5 cm/min. The fatty acids were identified on the basis of retention time with known standards.

Table 1 Composition of safflower seeds

Constituent	Amount (%)
Crude fat	31.58 ± 0.77
Protein	17.49 ± 0.40
Carbohydrates	22.99 ± 1.72*
Crude fibre	24.29 ± 0.28
Ash	3.65 ± 0.07
Total	100.00%

*Carbohydrate calculated by difference.

RESULTS AND DISCUSSION

The fresh seeds were found to have 5.04% moisture content. The percentage of each component of the seed is an average of six replicate samples on dry weight basis. The composition is as follows: crude fat, 31.58%; protein, 17.49%; crude fibre, 24.29%; ash 3.65%; and the carbohydrates are 22.99% (Table 1).

These results closely agree with those reported by Libyan Jamahiriya Council of Food Affairs and Marine Wealth (7). Looking at the yield of oil and protein from the safflower seeds large scale cultivation of this crop in Libyan Jamahiriya seems feasible.

Oil samples in triplicate extracted from a representative sample of safflower seeds produced in Geran were found to have the following average characteristics: specific gravity at 25°C 0.9322; refractive index at 25°C, 1.4713; saponification value 198.22; iodine value 143.56; Reichert Meissl value, 0.57; Polenske value, 3.76; viscosity (Cp. at 20°C), 69.322; acid value, 0.32; TBA number 0.31; and free fatty acids 0.16% (Table 2). These physical characteristics of Libyan safflower oil fall within the range reported by AOCS (14), and other researchers (2).

The principal fatty acids are approximately: linoleic (C18:2) 57%; oleic (C18:1) 23%; palmitic (C16:0) 12%; stearic (C18:0) 5%. The arachidic acid is 1% and each of the other minor fatty acids is less than 0.1% and none is more than 0.5%. The total unsaturated and saturated fatty acids are about 80% and 20% respectively (Table 3). This is evident from the results that safflower oil maintains its typical properties even under changed environment. A typical GLC spectrum of safflower neutral lipid is shown in Fig. 1.

Safflower oil is characterized by the presence of high linoleic (up to 81%) and negligible linolenic acids. According to the present study the fatty acid distribution is

Table 2 Physical and chemical constants of safflower oil

Constants	Values
Specific gravity at 25°/25°C	0.9322 ± 0.0004
Viscosity (in centipoise at 20°C)	69.32 ± 0.37
Refractive index at 25°C	1.4713 ± 0.0002
Richert-Meissl value	0.57 ± 0.28
Polenske value	3.76 ± 0.32
Acid value	0.32 ± 0.04
Free fatty acids (%)	0.16 ± 0.02
Saponification number	189.2 ± 5.08
Iodine value	143.56 ± 3.95
TBA number	0.31 ± 0.003

Table 3 Fatty acid distribution of safflower oil.

Fatty acid	Weight percent
C10:0	0.1
C12:0	0.1
C14:0	0.5
C14:1	0.1
C15:0	0.1
C16:0 (Iso)	—
C16:0	12.1
C16:1	0.2
C17:0	0.1
C17:1	—
C18:0	4.8
C18:1	23.3
C18:2	57.2
C18:3	0.4
C20:0	1.0
C20:1	—

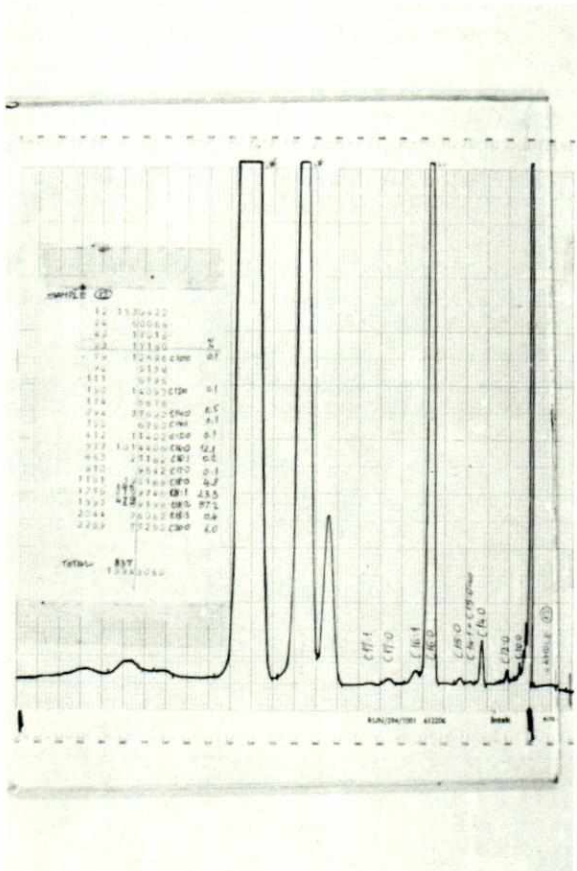

Fig. 1. GLC spectrum of safflower neutral lipids.

Table 4 Ranges of fatty acid distribution tentatively adopted for safflower oil by the Food And Agriculture Organization Codex Alimentarius Committee on Fats and Oils (12).

Fatty acid	Weight percent
<14	<0.1
14:0	<1.0
16:0	2–10
16:1	<0.5
18:0	1–10
18:1	>7–42
18:2	55–81
18:3	<1.0
20:0	<0.5
20:1	<0.5
22:0	<0.5

within the ranges adopted for safflower oil by the FAO/WHO Codex Alimentarius Committee on Fats and Oils (Table 4). The results are also in general agreement with other researchers (2,4,7,14). The linoleic acid content of safflower oil produced in Geran (S.P.L.A.J.) is about 57% which is towards the lower range relatively. Several past studies have indicated that the composition of vegetable oil varies as a function of geographic locations, variety, climatic and soil conditions (4,5). The increasing worldwide demand for safflower oil is the consequence of its high linoleic acid and negligible linolenic acid contents. The linolenic acid in the sample under study is 0.4%, which is quite low (Table 3). The low or negligible content of this polyunsaturated acid in safflower oil has led to its wide-spread use in alkyd resin coatings with good resistance to yellowing (10,14). The results of our studies strongly recommend the large-scale cultivation of safflower crop in the Jamahiriya, because of its commercial importance.

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دراسة الخواص والتركيب الكيمائى لبذرة وزيت القرطم

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المستخلص

ان بذور القرطم المعده من اجل هذه الدراسه قد تم الحصول عليها من محطة التجارب بالغيران . وقد حللت العينات والزيت المستخلص منها لتقدير المكونات الاساسيه للبذور مع الخواص الطبيعية والكيمائية للزيت . ووجد ان البذور تحتوى على ٣٦ر٥ رطوبه والمكونات الاساسية الاخرى على اساس الوزن الجاف وجدت كالاتى :-

هن ٥٨ر٣١/ ، بروتين ٤٤ر١٧/ ، الياف ٢٨ر٢٤/ ورماد ٦٥ر٣/

اما بالنسبه للخواص الطبيعية والكيمائيه للزيت المستخلص من البذور كانت كالاتى :-

لكثافه النسبيه (٢٥م°) ٩٣٢٢ر٠ ، معامل الانكسار (٢٥م°) ١ر٤٧١٣ ، رقم التصبن ٢٢ر١٩٩ ،رقم اليودى ٥٦ر١٤٣ والاحماض الدهنيه الحره ١٦ر٠٠

بخصوص الاحماض الدهنية وتوزيعها فى الجلسريدات كانت كالاتى :-

حامض لينوليك ٢ر٥٧/ ، حامض الوليك ٣ر٢٣/ ، حامض البالميتك ١ر١٢/

حامض الاستيرك ٨ر٤/ ، حامض الاراكيديك ١/ وحامض الينولنييك ٤ر٠ / ٠