

Study of Jojoba (*Simmondsia chinensis*) Oil by Gas Chromatography

Ahmed K Al-Ghamdi^{1*}, Thanaa A Elkholy², Shahd Abuhelal³, Hatem Alabbadi⁴, Dina Qahwaji⁵, Hanaa Sobhy⁶, Nahlaa Khalefah⁶ and Mohammad Abu Hilal⁷

¹Department of Medical Laboratory Technology, Faculty of Applied Medical Sciences, King Abdulaziz University, Jeddah 21589, Saudi Arabia

²AlAzhar University, Cairo, Egypt

³Institute of Pharmaceutical Science, King's College London, Waterloo, London, SE1 9NH, UK

⁴King Abdulaziz University, University Hospital, KFMRC, Jeddah, Saudi Arabia

⁵Department of Clinical Nutrition, Faculty of Applied Medical Sciences, King Abdul-Aziz University, Jeddah, Saudi Arabia

⁶Head of Pharmacology Unit, Biochemical and Toxicology and Food Deficiency, King Abdul-Aziz University, Jeddah, Saudi Arabia

⁷Consultant Hepatobiliary and Pancreatic Surgery, Southampton University Hospital, Southampton SO16 6YD, UK

*Corresponding author: Al-Ghamdi AK, Department of Medical Laboratory Technology, Faculty of Applied Medical Sciences, King Abdulaziz University, Jeddah 21589, Saudi Arabia, Tel: +966 58 023 2426; E-mail: aalghamdi@kau.edu.sa

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Abstract

The oil of *Simmondsia chinensis* (Link) CK Schneid (*Simmondsiaceae*) has been traditionally used in ethno-medicine because of its unique chemical constituents. This study aims to analyze the components of Egyptian Jojoba Oil (JO) and assess the differences between the Egyptian JO and that found in other parts of the world. The fatty acids and sterols profiles will also be determined by Gas Chromatography (GC). Jojoba seeds were subjected to hot extraction by solvent (hexane) followed by cold pressing extraction.

Our results showed that the fatty acid Behenic acid methyl ester (C22:0) and Cis-13, 16 Docosadienoic acid methyl ester (C22:2) were in higher percentages within the Egyptian oil compared to JO found in other parts of the world. On the other hand, Egyptian oil was found to have lower percentage of the fatty acids; Eliadic acid, Y-Linolenic acid, Cis-8,11,14 Eieosatrienoic acid, and Lingocernic acid. Heneicosanoic acid was in much higher percentages within the Egyptian oil and the Egyptian JO does not contain Arachidic, Arachidonic Caprylic, Capric, lauric, Tridecanoic, Myristicor Palmitoleic acid. This study reports novel results clarifying the components of JO cultivated in Egypt under different environmental conditions to our knowledge such results have not been report before.

Keywords: Jojoba oil; Gas chromatography; Fatty acids

Introduction

Simmondsia chinensis, is the sole member the *Simmondsiaceae*'s family. It is known as Jojoba, which originates from the deserts of USA. However, it is now planted in many other deserts across the world. In Egypt, it is known to be cultivated in the Ismailia desert.

S. chinensis is unique plant in many ways [1] and its importance was early noted by the by Native Americans.

Jojoba seeds are known to produce a colorless, odorless oil or liquid wax. This oil has a unique chemical structure within the plant world. Nearly 97% of the wax is composed of a straight chain monoester of C-20 and C-22 acids and alcohols with two double bonds.

The acids have been identified as a mixture of cis-11-eicosenoic (C-20) and cis-13-docosenoic (C-22, erucic). The alcohols have been identified as mixtures of cis-11-eicosenol, cis-13-docosenol and cis-15-tetracosenol (C-24). Sterols and stanols (around 0.5% total) are mainly represented by; campesterol, stigmaterol, sitosterol, cholesterol and avenasterol [2-4] along with some traces of triglyceride [5] and different tocopherols, such as α -tocopherol [4].

Furthermore, groups of nitrile glycosides known as *simmondsin*'s compounds (10-20%) have also been identified [5,6]. Those

simmondsins are considered as strange nitrile glycosides and cannot be compared to most nitrile glycosides found in plants [7]. It also contains phospholipids [2] and oligosaccharides [8].

Of more than 250,000 identified plant species, Jojoba is the only plant which produces significant quantities of liquid wax esters like the natural restorative esters produced by human sebaceous glands (sebum). Hence, it can be used as natural emollient for all skin types and hair. The wax is stable and resistant to both oxidation and rancidity [9]. Therefore, JO is used as a carrier substance for oxidation sensitive substances such as vitamin A [10]. In addition, Jojoba liquid wax is useful in the stabilization of penicillin products. In fact, JO, has been shown to be the finest liquid wax for this purpose [11]. Moreover, JO is used as carrier oil for essential oils in aromatherapy and massage therapy [12]. All this has attracted huge research interest leading to a number of quantitative and qualitative analyses performed interested researchers [4].

The purpose of this work is to study the chemical constituents of Jojoba wax, Egyptian cultivated *S. chinensis*. To our knowledge, this is the first work investigating similar parameters of the JO in Egypt.

Materials and Methods

Materials

Jojoba oil: Three heaps of Jojoba seeds (season 2015) from different sites were kindly supplied by the farm affiliated to the Egyptian Natural Oil Co., Cairo, Egypt (season 2015).

Authentic samples: Standard sterols (campe, stigma, b-sito, iso-fuco-, 7-stigma-and avena-sterols); fatty acids methyl esters (C16-C24 saturated and unsaturated) and cetyl alcohol were purchased from Sigma Company.

Gas Chromatography analysis (GC): [(GC; HP Hewlett Packard 5890 series II-USA, MS; Mass selective detector HP Hewlett Packard 5972 series-USA) and Wiley Registry of Mass Spectral Data (Chemical data library) (1995)-Wiley-UK] was carried out in the environmental instrument lab and environmental labs testing division at the RSC.

Methods

Preparation of jojoba oil: After a complete removal of all seed's teats, cold pressing technique was used for extracting the liquid wax and other related compounds. This method is based on a hydraulic presser machine designed specifically for this purpose in the Jojoba's cold-pressing unit.

Gas Chromatography (GC) for fatty acids analysis: For determination of fatty acids in JO, obtained from the seeds by hot reflux and cold pressing extraction methods, a previously reported and validated method was used (International Olive Council). The method (stated below) describes a procedure for determining the individual and total fatty acids content of by capillary column gas chromatography [13] through preparation of the fatty acids methyl esters from JO by:

1. Seeds extracts were dissolved in a chloroform methanol saline mixture of (8:4:3), while final concentration was 0.33 g/ml.
2. Extracts were homogenized in the solvent mixture. However, in some cases oil was dissolved in methanol up to 0.1 g/ml, then the concentration was adjusted by chloroform to 0.33 g/ml.
3. Extraction was performed up to three times to remove all the lipids.

Methylations reaction [14] was performed by adding; 1.5 ml methanol, 150 micro-litter Methanolic-HCL 8%. The reaction was left to complete over 14-16 hours at 45°C. GC samples were dissolved in hexane and 1 µl was injected for analysis using GC instrument model HP5942, Column HP-5: 30 m × 0.25 nm × 0.20 nm, Carrier gas nitrogen 1 ml/sec, Injector temp: 260°C, Detector temp: 260°C, samples were ran for 45 minutes total run time. Heating was programmed at 140°C for 5 minutes then was increased to 260°C at a velocity of 3°C per minute. Results were compared with a standard using chemi-station program.

Results and Discussion

Gas Chromatography (GC) for fatty acids

The results are shown in Table 1. The procedure was performed in triplicate.

The results, based on GC analyses of previously studied Jordanian JO [4] indicated that the oil contains fatty acids of carbon atoms from

14°C to 24°C (saturated and unsaturated). Furthermore, the main fatty acids identified in the JO were Heneicosanoic acid (21:0), Behenic acid (22:0), Cis-13 and 16 Docosadienoic acid (22:2). This is in line with previous reports [4,15].

It was also noticed that the fatty acid Cis-11 Eicosaenoic acid (20:1) was in higher concentrations within the Egyptian wax compared to JO from around the world. In contrast, the fatty acids heptadecanoic acid (17:0), Eliadic acid (18:1n9t), Cis-8,11, 14 Eieosatrienoic acid (20:3) and Lingocernic acid (24:0) were in lower concentration within the Egyptian oil compared to JO from around the world. This became clear after comparing our results for Egyptian JO with studies testing Jordanian JO [4,15].

Fatty acids	Concentration (µg/ml)
C4:0	2.57650e ⁻²
C6:0	7.516622e ⁻¹
C8:0	-----*
C10:0	-----
C11:0	-----
C12:0	-----
C13:0	-----
C14:0	-----
C14:1	-----
C15:0	-----
C15:1	3.78618e ⁻²
C16:0	3.48415e ⁻²
C16:1	-----
C17:0	1.4872e ⁻²
C17:1	8.0024e ⁻²
C18:0	5.78082e ⁻²
C18:1n9t	1.00307e ⁻²
C18:1n9c	4.29783e ⁻¹
C18:2n6t	2.35591
C18:2n6c	4.13070
C20:0	-----
C20:3n6	1.13692e ⁻¹
C18:3n6	1.02111e ⁻²
C22:2	13.1111219
C20:1	24.28284
C18:3n3	2.07436e ⁻²
C21:0	19.24169
C20:2	8.78022e ⁻²
C22:0	13.54594

C22:1n9	4.70928e ⁻²
C20:3n3	5.686364
C23:0	3.94414
C20:4n6	-----
C24:0	1.14591
C20:5n3	2.76868e ⁻¹
C24:1	-----
C22:6	7.9140e ⁻¹
*concentration was not detected	

Conclusion

Egyptian JO is different from other JO, it is a rich source of fatty acids and triglycerides and have great potentials to be used in different fields such as the cosmetic and pharmaceutical industry.

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References

- Howard Scott G (1958) The Natural History of Jojoba (*Simmondsia chinensis*) and its cultural aspects. *Econom Bot* 12: 261-295.
- Léon F, Van Boven M, de Witte P, Busson R, Cokelaere M (2004) Isolation and identification of molecular species of phosphatidylcholine and lysophosphatidylcholine from jojoba seed meal (*Simmondsia chinensis*). *J Agric Food Chem* 52: 1207-1211.
- Tada A, Jin ZL, Sugimoto N, Sato K, Yamazaki T, et al. (2005) Analysis of the Constituents in Jojoba Wax Used as a Food Additive by LC/MS/MS. *J Food Hyg Soc* 46: 198-204.
- El-Mallah MH, El-Shami SM (2009) Investigation of Liquid Wax Components of Egyptian Jojoba Seeds. *J Oleo Sci* 58: 543-548.
- Van Boven M, Holser RA, Cokelaere M, Decuyper E, Govaerts C, et al. (2000) Characterization of Triglycerides Isolated from Jojoba oil. *JAOCS* 77: 1325-1329.
- Laszlo Joseph A, Compton David L, Liang LX (2006) Feruloyl esterase hydrolysis and recovery of ferulic acid from jojoba meal. *Indus Crops and Prod* 23: 46-53.
- Allen Joselyn J (1997) Application of colorimetric assay for the determination of cyanide in deoiled jojoba meal. Master's Theses in Nutritional Science, The Faculty of Nutrition and Food Science, San Jose State University, USA.
- Hantus S, Pauly M, Darvill AG, Albersheim P, York WS (1997) Structural characterization of novel L-galactose-containing oligosaccharide subunits of jojoba seed xyloglucans. *Carbohydr Res* 304: 11-20.
- Mishra AK, Mishra A, Chattopadhyay P (2011) Herbal Cosmeceuticals for Photoprotection from Ultraviolet B Radiation: A Review. *Tropical J Pharmaceu Res* 10: 351-360.
- Gruenwald Joerg G (1998) PDR for Herbal Medicine. (1st edn), USA, Medical Economics Company.
- Daugherty PM, Sineath HH, Wastler TA (2012) Industrial raw materials of plant origin (IV) A survey of *Simmondsia chinensis* (Jojoba). *Econ Bot* 12: 296-304.
- Buckle Jane B (2007) Clinical Aromatherapy. (2nd edn), China, Churchill Livingstone.
- Folch J, Lees M, Stanley GHS (1957) Increased cholesterol content of erythrocyte and brain membranes in ethanol-tolerant mice. *J Biol Chem* 226: 497-509.
- Nelson GJ (1991) Analyses of Oils and Fats. American Oil Chemists' Soc., Champaign, pp: 20-59.
- Al-Qizwini H, Al-Khateeb E, Mhaidat NM (2014) Study of Jordanian Jojoba (*simmondsia chinensis*) liquid wax by GC and GC/MS. *Europ Sci J* 10: 1857-7881.