Original Article

Fatty Acid Composition of Seed Oils from Five Medicinal Plant Species

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Received: 13/2/2026
Accepted: 10/3/2026

DOI: https://doi.org/10.53796/nsj512

Abstract

Seed oils from medicinal plants are important sources of bioactive lipids with nutritional, pharmacological, and chemotaxonomic value. This study comparatively evaluated the fatty acid composition of seed oils from *Adansonia digitata*, *Balanites aegyptiaca*, *Lawsonia inermis*, *Ziziphus spina-christi*, and *Trigonella foenum-graecum* using gas chromatography–mass spectrometry (GC-MS). Fatty acid methyl esters were prepared and analyzed to determine qualitative and quantitative profiles. All oils were dominated by unsaturated fatty acids (81.7–100%), mainly oleic and linoleic acids. *A. digitata* and *T. foenum-graecum* were rich in oleic acid (61.10% and 49.93%), whereas *L. inermis* and *B. aegyptiaca* contained higher proportions of linoleic acid (59.00% and 54.77%). *B. aegyptiaca* was distinguished by the exclusive presence of petroselinic acid (45.23%) and the absence of saturated fatty acids. Pairwise similarity analysis showed a high affinity between *A. digitata* and *T. foenum-graecum* (99.17%). The predominance of nutritionally valuable unsaturated fatty acids supports the potential use of these oils in food, cosmetic, and pharmaceutical applications, while distinctive fatty acids such as petroselinic acid highlights their chemotaxonomic relevance.

Keywords: Fatty acids; Seed oils; GC-MS; Chemotaxonomy; Oleic acid; Linoleic acid; Petroselinic acid

Introduction

Seed oils of medicinal plants are increasingly valued as sources of essential fatty acids that contribute to human nutrition, therapeutic efficacy, and industrial utility.(1) Beyond their functional roles, fatty acid profiles can serve as biochemical fingerprints useful in chemotaxonomy, reflecting evolutionary relationships and adaptive strategies among plant taxa. The present study focuses on five medicinally important species widely used in traditional medicine and adapted to arid and semi-arid environments: *Adansonia digitata* (Bombacaceae), *Balanites aegyptiaca* (Balanitaceae), *Lawsonia inermis*(Lythraceae), *Ziziphus spina-christi* (Rhamnaceae), and *Trigonella foenum-graecum* (Fabaceae). Although taxonomically unrelated, these species produce seed oils that may share or differ in fatty acid composition due to ecological adaptation and metabolic specialization.

Previous studies have reported that baobab seed oil is rich in oleic and linoleic acids, conferring both nutritional and oxidative stability. *B. aegyptiaca* seed oil is known for containing unusual fatty acids, whereas *T. foenum-graecum* seeds are recognized for their health-promoting lipid fraction. However, comparative studies addressing the chemotaxonomic significance of their fatty acid profiles remain limited [1-13]. This study aimed to (a) characterize the fatty acid composition of seed oils from five medicinal plants using Gas Chromatography–Mass Spectrometry (GC-MS). (b) compare their nutritional and industrial potential, and (c) evaluate the usefulness of fatty acid profiles as chemotaxonomic markers.

Materials and Methods

Plant materials:

Seed oils of *A. digitata* (Tebaldi), *B. aegyptiaca* (Hejleej), *L. inermis* (Henna), *Z. spina-christi* (Sedder), and *T. foenum-graecum* (Helba) were purchased from Omdurman Market, Khartoum State, Sudan, in June 2014. Botanical identification was confirmed by Prof. H. H. El-Kamali.

The experimental work was conducted at the Department of Botany, Faculty of Science and Technology, Omdurman

Islamic University, Sudan, and at the Department of Chemistry , Ministry of Science and Technology, Central Laboratory , Khartoum , Sudan for the Gas Chromatography–Mass Spectrometry (GC-MS) facilities, between June and August 2014.

Preparation of fatty acid methyl esters:

Seed oils were subjected to saponification and methylation following standard procedures. Briefly, oil samples were treated with methanolic NaOH, followed by methylation using boron trifluoride in methanol. Fatty acid methyl esters (FAMEs) were extracted with heptane, dried over anhydrous sodium sulfate, and used for GC-MS analysis [14].

GC-MS analysis

FAMEs were analyzed using a Hewlett-Packard 5890 Series II gas chromatograph coupled with an HP-5971 mass selective detector and an HP-5 capillary column (30 m × 0.25 mm × 0.25 µm). The oven temperature was programmed from 60 to 240 °C at 3 °C/min. Helium was used as the carrier gas (1 mL/min). Identification of fatty acids was based on retention indices and mass spectral comparison with of fragmentation patterns with those found in the library of the mass spectrometer and with reference standards [15].

Results

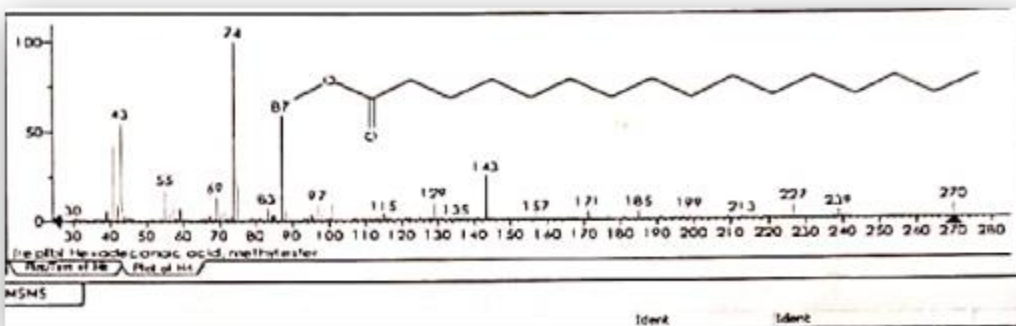
Table 1. Fatty acid composition (%) of seed oils from the studied species

Fatty acid	Saturation	*Adansonia digitata*	*Trigonella foenum-graecum*	*Balanitesa egyptiaca*	*Ziziphus . Spina-christi*	*Lawsonia . Inermis*
Hexadecanoic acid (palmitic)	Saturated	18.23	0.7803	-	7.420	1.040
Linoleic acid	Unsaturated	19.74	48.56	54.77	39.62	59.00
9-octadecenoic acid (.oleic acid.)	Unsaturated	61.10	49.93	-	46.46	38.45
Octadecenoic acid (Stearic acid)	Saturated	0.7304	0.5993	-	6.496	0.6116
7-Hexadecenoic acid	Unsaturated	0.1323	-	-	-	-
Eicosanoic acid (arachidonic acid)	Unsaturated	0.0631	-	-	-	-
Linolenic acid	Unsaturated	-	0.1262	-	-	-
6-Octadecenoic acid (peteroselinic acid)	Unsaturated	-	-	45.23	-	-

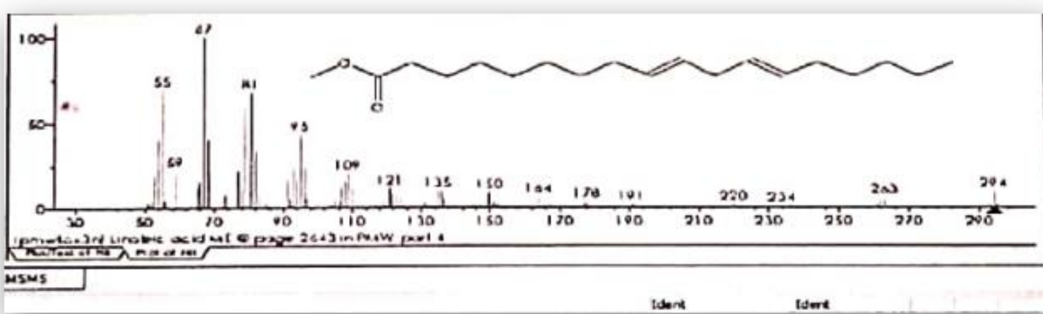
Values represent percentage composition of total fatty acids determined by GC/MS analysis of fatty acid methyl esters. The symbol (-) indicates that the compound was not detected.

Figure 1 represents an Electron Impact (EI) mass spectrum (MS) of some fatty acids methyl ester obtained from fixed oils of studied five plant species.

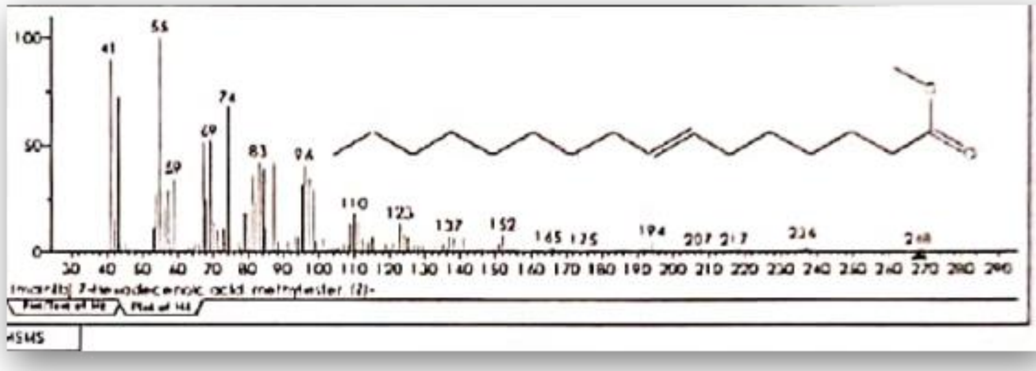
Adansonia digitata



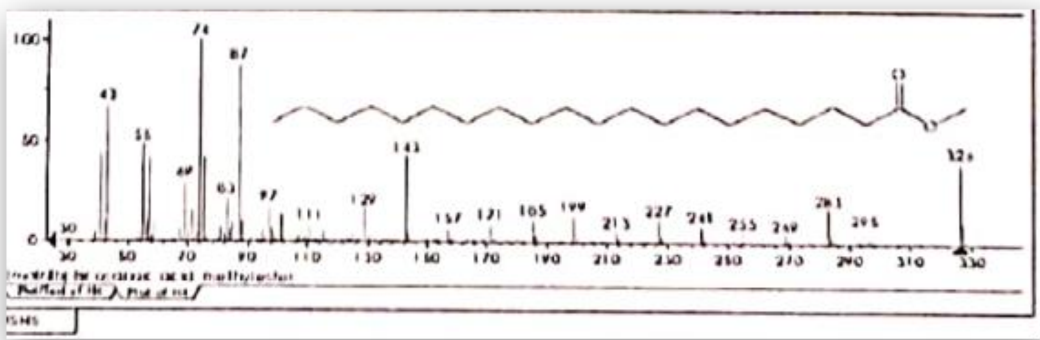
Palmitic acid ME (Molecular Ion (m/z) = 270 in GC/MS (EI mode/70 eV)



Linoleic acid ME (Molecular Ion (m/z) = 294 in GC/MS (EI mode/70 eV)

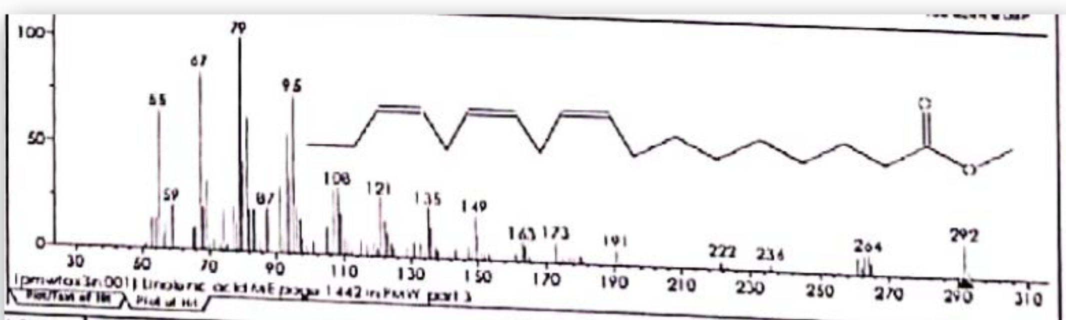


Oleic acid ME (Molecular Ion (m/z) = 296 in GC/MS (EI mode/70 eV)



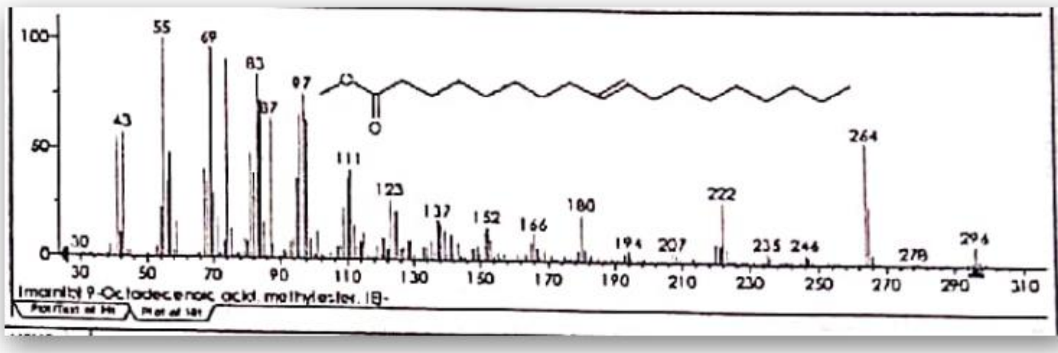
Stearic acid ME (Molecular Ion (m/z) = 298 in GC/MS (EI mode/70 eV)

Trigonella foenum-graecum



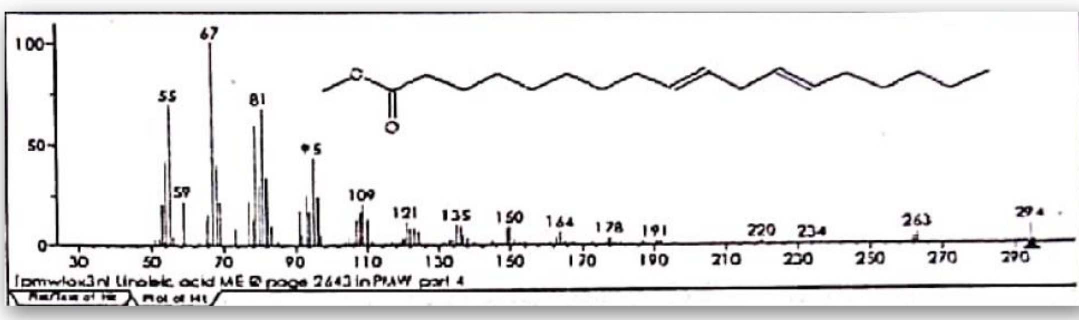
Linolenic acid ME (Molecular Ion (m/z) = 292 in GC/MS (EI mode/70 eV)

Lawsonia inermis

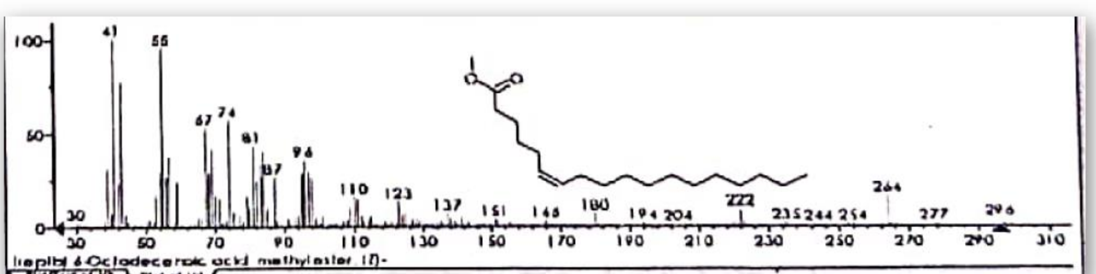


Oleic acid ME (Molecular Ion (m/z) = 296 in GC/MS (EI mode/70 eV)

Balanites aegyptiaca



Linoleic acid ME (Molecular Ion (m/z) = 294 in GC/MS (EI mode/70 eV)



Petroselinic acid ME (Molecular Ion (m/z) = 296 in GC/MS (EI mode/70 eV)

Figure 1. Electron Impact (EI) mass spectrum (MS) of some fatty acids methyl ester obtained from fixed oils of studied five plant species.

Table 2. Pairwise Similarity Matrix of Five Plant Species Based on Fatty Acid Composition

	Adansoniadigitata	*Trigonellafoenum graecum*	*Balanitesaegyptiaca*	*Ziziphusspina-christi*	*Lawso Lawsoniainermis niainermis*
Adansoniadigitata	100	99.17	37.26	96.29	60.36
Trigonellafoenum-Graecum		100	51.69	92.33	99.07
Balanitesaegyptiaca			100	47.20	57.14
Ziziphusspina-christi				100	92.18
Lawsoniainermis					100

Table 3. Total Saturated and Unsaturated Fatty Acids (%) in the studied seed oils

Plant species	**Total saturated fatty acids**	**Total unsaturated fatty acids**
Adansonaidigitata	18.9	81.70
Trigonellafoenum- graecum	1.4	98.6
Balanitesaegyticia	-	100
Ziziphusspina–Christi	13.9	86.0
Lawsoniainerims	1.04	98.06

Discussion:

Fatty acid composition of seed oils

GC-MS analysis revealed that all studied seed oils were dominated by unsaturated fatty acids, accounting for 81.7–100% of total fatty acids. Oleic and linoleic acids were the principal components across species, confirming their nutritional relevance.

Adansonia digitata oil contained six fatty acids, with oleic acid (61.10%) as the major component, followed by linoleic (19.74%) and palmitic acids (18.23%). This composition suggests good oxidative stability and suitability for culinary and cosmetic uses [16,17].

Trigonella foenum-graecum oil showed a nearly balanced profile of oleic (49.93%) and linoleic acids (48.56%), consistent with its recognized health benefits. *Balanites aegyptiaca* exhibited a unique profile consisting exclusively of unsaturated fatty acids, dominated by linoleic (54.77%) and petroselinic acids (45.23%). The absence of saturated fatty acids and the presence of petroselinic acid distinguish this species from the others [18, 19].

Ziziphus spina-christi oil comprised mainly oleic (46.46%) and linoleic acids (39.62%), with moderate levels of saturated fatty acids, particularly stearic acid. *Lawsonia inermis* oil was rich in linoleic acid (59.00%), followed by oleic acid (38.45%), indicating high nutritional value but increased susceptibility to oxidation [20,21].

Nutritional and functional implications

Unsaturated fatty acids, particularly oleic (omega-9) and linoleic (omega-6) acids, are associated with cardiovascular protection, anti-inflammatory effects, and maintenance of skin integrity. Oils rich in oleic acid, such as those from *A. digitata,* exhibit greater oxidative stability, whereas linoleic-rich oils provide essential fatty acids important for human health but require careful handling to prevent oxidation [17, 21-23].

Chemotaxonomic significance

Fatty acid profiles can serve as chemotaxonomic markers by highlighting biochemical similarities and distinctions among plant species. In this study, oleic acid predominated in *A. digitata*, *T. foenum-graecum*, and *Z. spina-christi*, whereas linoleic acid was dominant in *L. inermis* and *B. aegyptiaca*. The exclusive detection of petroselinic acid in *B. aegyptiaca* represents a distinctive chemotaxonomic feature of this species.

Pairwise similarity analysis demonstrated a high affinity between *A. digitata* and *T. foenum-graecum* (99.17%), suggesting convergent lipid biosynthesis despite taxonomic differences. Such biochemical convergence may reflect adaptation to similar environmental conditions.

Conclusion

The comparative GC-MS analysis of seed oils from five medicinal plants revealed a predominance of nutritionally valuable unsaturated fatty acids, especially oleic and linoleic acids. Oils from *A. digitata* and *T. foenum-graecum* exhibited high oleic acid content and greater oxidative stability, while *L. inermis* and *B. aegyptiaca* were characterized by high linoleic acid levels. The unique occurrence of petroselinic acid in *B. aegyptiaca* underscores its chemotaxonomic and industrial significance.

Overall, fatty acid profiling proved useful not only for assessing nutritional and industrial potential but also for supporting chemotaxonomic classification. These findings encourage further exploration of underutilized medicinal plant oils for functional food, cosmetic, and pharmaceutical applications.

References

1. Hankey, A. (2004). *Adansoniadigitata L.*PlantZAfrica. Retrieved from https://pza.sanbi.org/adansonia-digitata

2.**Caluwé, E. D., Halamová, K., & Van Damme, P. (2010).** Baobab (*Adansoniadigitata* L.): A review of traditional uses, phytochemistry, and pharmacology. *Afrika Focus, 23*(1), 51–84. https://doi.org/10.21825/af.v23i1.5037

3. **Otto, W. (1989).**Encyclopaedia Americana (Vol. 11, p. 44). Grolier Incorporated.

4. Ojo, O. O., Nadro, M. S., &Tella, I. O. (2006). Protection of rats by extracts of some common Nigerian trees against acetaminophen-induced hepatotoxicity. African Journal of Biotechnology, 5(9), 755–760. (International Scholars Journals)

5. Hardman, R., &Sofowora, E. A. (1971). Biosynthesis of diosgenin in germinating seeds of *Balanitesaegyptiaca*. *Planta Medica, 20*(5), 193–198. https://doi.org/10.1055/s-0028-1099691

6. Maydell, H.-J. von. (1986). *Trees and shrubs of the Sahel: Their characteristics and uses*. Deutsche GesellschaftfürTechnischeZusammenarbeit (GTZ).

7. Adzu, B., Amos, S., Amizan, M. B., &Gamaniel, K. (2003). Evaluation of the antidiarrhoeal effects of *Zizyphusspina-christi* stem bark in rats. *ActaTropica, 87*(2), 245–250. https://doi.org/10.1016/S0001-706X(03)00114-1

8. KhairElseed, A. S., &Shakak, M. A. S. (2016). Determination of physico-chemical properties of *Ziziphusspina-christi* (Nabag) seed crude oil. *IJRDO-Journal of Agriculture and Research*, 2(4), 22–35. https://doi.org/10.53555/ar.v2i4.37

9. Allen, O. N., & Allen, E. K. (1981). *The Leguminosae: A source book of characteristics, uses and nodulation*. University of Wisconsin Press.

10. Kamath, S. H., &Sohonie, K. (1959). Nutritive value of proteins of green vegetables. *Indian Journal of Medical Research, 47*, 93–101.

11. El-Sebaiy, L. A., & El-Mahdy, A. R. (1983). Lipid changes during germination of fenugreek seeds (*Trigonellafoenum-graecum*). *Food Chemistry, 10*(4), 309–319. https://doi.org/10.1016/0308-8146(83)90086-9

12. Vasudevan, T. N., &Laddha, K. S. (2003). *Herbal drug microscopy* (1st ed., pp. 68–69). Yucca Publishing House.

13. Chetty, K. M. (2008). *Flowering plants of Chittoor* (1st ed., pp. 132–133). Andhra Pradesh.

14. Morrison, W. R., & Smith, L. M. (1964). Preparation of fatty acid methyl esters and dimethylacetals from lipids with boron fluoride–methanol. *Journal of Lipid Research, 5*(4), 600–608. https://doi.org/10.1016/0022-2275(64)90088-6

15. Ichihara, K., Shibahara, A., Yamamoto, K., & Nakayama, T. (1996). **An improved method for rapid analysis of the fatty acids of glycerolipids by one-step methylation.***Lipids, 31*(5), 535–539. https://doi.org/10.1007/BF02522648

16. Simopoulos, A. P. (2002). **Omega-3 and omega-6 fatty acids: Essential nutrients for health.***American Journal of Clinical Nutrition, 70*(3 Suppl), 560S–569S. https://doi.org/10.1093/ajcn/70.3.560s

17. Lin, T.-K., Zhong, L., & Santiago, J. L. (2018). **Anti-inflammatory and skin barrier repair effects of topical application of some plant oils.***International Journal of Molecular Sciences, 19*(1), 70. https://doi.org/10.3390/ijms19010070

18.Zacharia, J., &Lifa, S. (2020). Fatty acids composition of *Adansoniadigitata* (baobab) seed oil from Tanzania. *Journal of Humanities & Social Science (JHSS)*, *9*(2), 45–53. https://doi.org/10.56279/jhss.v9i2.57

19.Khalil, M. I., & Khalil, I. M. I. (n.d.). **Comprehensive and comparative study of fatty acid composition, physicochemical properties, and thermal stability of Kurdufan (Sudan) baobab (*Adansoniadigitata* L.) seed oil** [Preprint]. *Sci-Hub (republished copy).* Retrieved from https://sci-hub.org

20. Dauk, M., Lam, P., Kunst, L., & Smith, M. A. (2001). **Accumulation of ricinoleic, lesquerolic and densipolic acids in *Arabidopsis***

thaliana* expressing fatty acid hydroxylase and acyltransferase genes from castor (*Ricinuscommunis* L.) and *Lesquerellafendleri* (Gray) Wats.Plant Physiology and Biochemistry, 39*(7–8), 593–603. https://doi.org/10.1016/S0981-9428(01)01276-5

21. Christie, W. W. (2003). **Lipid analysis: Isolation, separation, identification and structural analysis of lipids** (3rd ed.). Bridgewater, England: The Oily Press. https://doi.org/10.1201/9781482272773

22. Firestone, D. (Ed.). (2006). **Physical and chemical characteristics of oils, fats, and waxes** (2nd ed.). Champaign, IL: AOCS Press. https://doi.org/10.1201/9781439832022

23. Liu, Q., Wu, M., Zhang, B., Shrestha, P., Petrie, J., Green, A. G.,& Singh, S. P. (2017). Genetic enhancement of palmitic acid accumulation in cotton seed oil through RNAi down-regulation of *GhKAS2* encoding β-ketoacyl-ACP synthase II (KASII)**.***Plant Biotechnology Journal, 15*(1), 132–143. https://doi.org/10.1111/pbi.12598