Journal of Advanced Trends in Basic and Applied Science
Vol.1, No.1:160-165, 2017
(Print ISSN: 2537-0537, Online ISSN:2537-0618)

www.JATBAS.com

Simmondsia chinensis

Jojoba tree

Waleed F. Abobatta

Citrus, Department, Horticulture Research Institute, Agriculture Research Center, Egypt

Abstract

This review presents general information about Hohoba commonly as jojoba. It is the sole species of the family Simmondsiaceae. Jojoba plants have currently received exceptional attention, since, its seeds contain a unique liquid wax commonly called jojoba oil, that is very similar to that obtained from Whale sperm.
Jojoba is considered a promising crop for arid and marginal areas; the plant also has probable value in combatting desertification and soil degradation in dry areas. Although the plant is known for its high-temperature and high-salinity tolerance growth ability, jojoba considered as a new plant for arid and marginal areas.The plant is grown for its seed which contains a liquid wax with a high melting point. This oil is used in a variety of products including pharmaceuticals, cosmetics, lubricants and bio-fuel. Several aspects of the crop agronomy is reviewed including a botanical description, propagation methods from seed and cuttings, This review is intended to afford a reference to scientists and growers in the agronomy and management of jojoba.
Keywords: *Simmondsia chinensis*, stem cuttings, combat desertification, jojoba oil.

Introduction

Jojoba *Simmondsia chinensis* (Link) Schneider is a precious, drought resistant shrub. Jojoba is mostly a woody, evergreen, perennial shrub that produces small seeds, which contains liquid wax very similar to whale sperm in value.
The oil is used mostly in the pharmaceutical industry, cosmetics, weight reduction in livestock, also as bio degradable lubricants in the motor industry, moreover, jojoba oil is used for bio-fuel production, and it is a new solution of fuel in coming era.
Plants are extremely tolerant of drought [1] and their foliage is a source of nutritious forage for sheep, goats, and cattle, as well as for wild ungulates and smaller browsers such as rabbits.
In arid and marginal lands there are only a few crops being grown mainly for survival purposes. These areas lack cash crops which are drought tolerant.
In recent decades, there has been considerable interest in using multipurpose crops which can tolerate stress conditions such as jojoba (*Simmondsia chinensis*) [2 &3].

Native Jojoba is found in Sonoran desert climatic, this area receive annual precipitation of 80-450 mm and temperatures ranging from 9-54^{o}C [4].

Jojoba grows naturally on soils of marginal soil fertility, fertilization of field plots with nitrogen and phosphorus improved plant growth and increase seed production.Jojoba plant is drought resistant, also jojoba appears to tolerate soil salinity, and Jojoba needs little water for survival (a third or less of the moisture required by crops like citrus or cotton). Also, treated sewage water and saline water could be used to irrigate Jojoba.
For that, Jojoba offers promise for agriculture in harsh environments where many conventional crops cannot survive, however, where annual rainfall is less than 350 mm, supplementary irrigation is necessary especially in the initial growth stages (12-15 months) for proper root establishment [5]), and for sustained high yields especially in desert areas.
Economic consideration dictates that irrigation is essential for a healthy and profitable crop in many dry areas.From other side, it would seem that jojoba can grow with little water. The best jojoba plants observed with (254 to 380 mm) of annual rain.

Jojoba is a promising cash crop; it has a potential use for rehabilitation in marginal land and dry areas, and the important usage to combat and prevent desertification in different regions of the world. Moreover, this review suggests future research opportunities such as a promising biorefinery using Jojoba oil as main raw material.

Jojoba common names:

The name Jojoba was derived from the Indian name jojowi and the plant has many more names like buck nut, coffee nut, goat nut, wild hazel, pig nut and lemon leaf [3]

Origin and distribution:

Jojoba *Simmondsia chinensis* plants originated in the Sonoran desert of Northern Mexico and the United States (South West Arizona and Baja California) [4,6].

Now, due to its high economic value, it is cultivated as a commercial plant in different parts of the world like Argentina, Australia, India, Egypt, Israel, Mexico, Peru, Kenya, Brazil, South Africa, Costa Rica, Haiti, Paraguay, Chile and Iran, jojoba has extraordinary characteristics as a desert shrub [4],it is a characteristic plant of marginal and dry lands [5].

Botanical:

Jojoba is a perennial evergreen dioecious plant, woody, wind-pollinated, shrub or small multi-stemmed tree and has condensed crown [3].

Leaves opposite, oval, 2-3 cm long and 1.0 -1.5 cm broad, leathery, oblong, grey green or bluish-green, also, jojoba has a deep rooting habit, the roots can penetrate to a depth of 15-25 m [7], and this extensive root structure enables the plant to survive in the arid conditions.

In its natural habitat *Simmondsia. chinensis* tolerates high temperatures and drought and may be classified as a true xerophyte [8].

Flowering:

Jojoba is dioecious with male and female plants, flower bud formation is mainly associated with new vegetative growth [9]), occurring during the warm season in late summer or early fall after the harvesting previous crop.

Generally male seedlings flower earlier than female seedlings, with male flowering beginning to occur during the second year of growth [10].

The flowers are small, greenish-yellow, with 5-6 sepals and no petals, the female ones are usually borne singly at alternate nodes, also, light green with long pedicles and there are no female petals or scent to attract insects. Meanwhile, the male flowers are borne in clustered at the nodes [11].

The Jojoba Fauna:

A number of insects frequent jojoba. The more harmless include katydids, grasshoppers, darkling beetles, and leaf-chewing larvae. Wood borings have been found in old stems and a bostrychid beetle, Amphicerus simplex (Horn), hollows out [12].

Soil type:

Jojoba grows on rough, light and medium textured well drained sandy or gravelly soils, with a pH of 5-8.5 [13], jojoba prefers very sandy soils with low organic matter [14], and it tolerates saline environments.

Drainage is critical factor; hence, water-logged clay sites should be avoided since jojoba will die if flooded for a short period.

Climate:

Jojoba naturally grows in marginal areas with rainfall ranging between 220-400 mm yr-1. Jojoba is planted when soil temperatures are 20°C, Jojoba tolerates high temperatures ranging, with an optimum between 27-33°C[15]. Frosts below (-3°C) especially during flowering can damage the plant, in this regard, frost damage in the early flowering stages may not be as harsh as at later stages; given enough time, a new crop of flowers will replace the damaged one. Although, excessive cold during early seedling development may kill whole plantations, however, mature bushes are able to withstand cold better than the seedlings and frost may not endanger their survival to the same degree but it may reduce yields.

Propagation:

Jojoba may be propagated through seed, stem cuttings, grafting and tissue culture.

1. Seed propagation method:

It is an easier and cheapest method but produce male and female plants, with a slight tendency to produce more male plants, (normally 1:1 or even up to 5:1 male to female) in seeded fields. This may create a problem in field regarding position and regularity of male and female plants, at least 50% of the plants are nonproducing males, and many of the females are low-yielding or are undesirable, which leads to low productivity in seeded plantation [4]. Also, seed plantation of jojoba has genetic heterogeneity [11], which considered as negative points of seed propagation, but still, can be circumvented by over planting; a grower can remove extra males and a large number of poorer female plants from the field after flowering.

2. Vegetative Propagation methods:

Vegetative propagation solve the problem of high male to female ratio in the field since fewer male are required

compared to females, and use only desirable plants, also, these methods allow growers to plant according to planting plans.

There are different asexual methods used for jojoba propagation, like stem cuttings [15], air-layering [16], grafting [17] and tissue culture [18], also, vegetative seedlings had earlier seed production which mean earlier return of initial establishment and maintenance costs.

2.1. Stem cuttings

The use of stem cuttings becoming the favorite method for propagating jojoba, for this reason, commercially stem cuttings use to produce female seedlings to improve the ratio of female to male plants, also, reducing the expense of removing male plants in seeded fields, the use of cuttings also improved the growth rate of the female plants, which no longer needed to compete with faster growing male plants for nutrients and water.

Rooting of stem cuttings, is the most commonly used as vegetative propagation method, and become the most commonly adopted methods.

For better rooting of cuttings, preferable taken during the dormant stage, when they have high carbohydrate to nitrogen (C/N) ratio, also, the use of rooting hormones on jojoba cuttings promotes quickly root formation,

The advantages of using vegetative propagation methods in commercial jojoba plantations are that they afford uniform and expected plant growth and yield [19]and can be sexed earlier before flowering.

2.2. Rooted cuttings:

This method has not been used commercially because of lack of mother plants as sources of cuttings; in addition, production of cuttings proceeds slowly and requires considerable controlled greenhouse facilities.

Vernalization:

Flower induction in jojoba request 15 days to 1 month at 15-20°C to as chilling requirement for induction and break flower dormancy [20].

Flowering and fruiting:

Jojoba flowering occurs in March through May in response to cold climate and winter rains. New flower buds are mainly dormant and do not open without exposure to cool period with enough cold units for the fulfillment of their chilling requirements [20].

Jojoba is dioecious and depends on wind for successful pollination [21], however, it requires at least, one month at 15-20°C to.

Jojoba flowers, greenish yellow, inconspicuous, and without petals, are borne in the axils of the leaves, the male flowers are yellow and grow in clustered at the nodes [22]., while, the female flowers are regularly greenish and almost borne singly.

The fruits are corn-shaped ovoid, three-angled capsule 1-2 cm long, partly enclosed at the base by the sepals, which turn gradually from green to brown color on maturation.

Seeds are different in shape, size, color and weight, according to management, are elongated, slightly spherical and pointed [7].

The mature seed is a hard oval, dark brown in color and contains oil (liquid wax) content of 40 - 50% approximately.

Under commercial planting conditions, jojoba seedlings usually begin producing seeds the second or third year after planting [15&20], while jojoba seeds ripen during the summer.

- **Seed collection, cleaning, and storage:**

Seeds have main commercial value due to the quantity and quality of their waxes [23], Seeds of jojoba are most readily collected manually or by vacuuming machine after they have fallen to the ground, but where rodents are active, seeds do not remain on the ground for long period [24].

- **Stand establishment:**

Most of the direct seeded commercial jojoba seeds were planted with commercially available planters on raised beds.Preferable using large seed in planting because it is expected to produce large-seeded plants and more vigorous seedlings than small seed during the first 2 to 3 months of growth; however, this advantage disappears later. After planting on dry beds, seed is irrigated up.

- **Time of Planting:**

For quicker emergence, plantings should be during the warm months of the year, when soil temperatures of 21o C (70 o F) or higher, and depth of planting should not more than 2 to 3 cm (1 1/2 inches), however, low soil temperature may delay emergence from 20 days up to 3 months approximately. The recommended ratio is 1:10 (male to female) in order to obtain highest yields ha-1 [25& 26].

Irrigation should be applied as needed during the first 8 to 12 weeks to preserve enough moisture near to the surface of the raised bed to insure good germination and root establishment. Later, irrigations may be applied at monthly intervals between September and January to supply the field with minimum water requirement, overwatering jojoba raised beds or may be disastrous to seedling emergence and survival [15].

Now, almost new Commercial plantations have been established from high yielding vegetative clones giving a more constant seed yield which has given rise to probability that

stabilized supplies of seeds will motivate additional plantations and markets [٢7], also, using seedlings for establishment of plantations increased growth and gives jojoba a head start over weeds [7].

• Expected yield:

Jojoba generally does not produce an economically viable yield until at least the fourth year after planting [28]. The seed production per tree around 2-3 kg per year which means 2 to 3 metric tons per hectare, The amount of produced jojoba seed oil equate with the quantity produced by 124 whales [29]. The seed yield can reach 4-5 kg per bush with improved selection and management, from other side, there have been considerable yield differences between clonal varieties developed world wide, also, the total yield may be fluctuated depending on local conditions and management.

• Oil Content:

Jojoba oil is a fixed oil of seeds, which contain about 40-50% of the light yellow, odorless oil referred as jojoba oil and consists of a long series of esters instead of a mixture of triglycerides, which gives jojoba oil unique characteristics [30].

Jojoba oil mainly composed of straight chain monoesters in the range of C40–C44 [31]. Most of the wax content is esters of high molecular weight monounsaturated fatty acids and alcohol in addition to many sterols and vitamins [32]. However, few flavonoids were isolated and biologically evaluated for their hepato protective and antioxidant activity from the methanol extract of Jojoba pericarp.

• Physico-chemical properties of Jojoba oil:

Jojoba oil contains no cholesterol or triglycerides and is not broken down by normal metabolic pathways, this oil can be used as an anti-foam agent in antibiotic production and as a cure for skin disorders [33], also, this oil has brilliant qualities for many industrial and medicinal uses.

The oil has a peculiar molecular structure in comparison with the rest of conventional plant oils, chemically it is a liquid wax and by hydrogenation is easily transformed to a hard white wax [34].

Jojoba oil considered a mixture of monounsaturated C20 and C22 alcohols and acids where the double bond is placed at each side of the ester bond; this composition is unique among the rest of the vegetable oils because of the almost complete absence of glycerine [35]. In addition, Jojoba oil is a unique source of straight monounsaturated alcohols such as 11-eicosenol, 13-docosenol and 15-tetracosenol, which they are classified as high-added value products.

For all this unique properties and characteristics which are very valuable, jojoba oil used for fine chemical industry and for the production of pharmaceuticals. In addition, Jojoba oil can be an excellent source of fatty acid alkyl esters or biodiesel after the transesterification process and the purification steps [36].

• USES:

Jojoba considered multipurpose crops, and is a promising cash crop as well as provision of income to the poor communities, Jojoba used to combat and prevent desertification in the Thar desert in India [37] and 6 October desert in Egypt [7].

The applications of jojoba oil are numerous in pharmaceuticals or cosmetics and it can be used in many different reactions such as hydrogenation, halogenation or sulfuration to obtain high-added value products.

In cosmetics industry Jojoba oil is used in a number of skin care products, mainly as a moisturizer, also in hair conditioners and as lubricant [38].

In pharmaceuticals jojoba oil, wax and extracts obtainable promising activity for a number of skin and scalp disorders (39)., skin emollient (40), anti-acne, anti-psoriasis [41],anti-inflammatory [42]anti-hypercholesterolemia [43], antioxidant [44] and wound healing properties and it could be used as a remedy for skin infections [45].

Jojoba is used as a bio diesel fuel as well as biodegradable lubricants. It is a new solution of fuel in coming days [36].

However, the research of Jojoba oil has been mainly focused on the alcoholysis of this oil and NOx, CO and CO2 emissions related to the use of different blends of Jojoba oil and conventional fuel in a diesel engine [30&46].

The mixture of long monounsaturated alcohols (11-eicosenol, 13-docosenol and 15-tetracosenol) produced after crystallization has a high value in the market because of its pharmaceutical properties against enveloped viruses whereas the co-product might be used for energy purposes, which could be the starting point for a biorefinery implementation.

Jojoba used in cosmetics, pharmaceuticals, waxes, animal feed supplement (20-30% protein content of oil less meal), and as ornamental plant [7].

The seed meal (plant material after extracting the oil) is rich in protein 29–30%, in addition to simmondsin which toxic for livestock [47], these toxicants could be broken [48] and the meal could be used as livestock feed ingredient [49].from other side Simmondsin have insecticidal, antifeedant and antifungal activities [50].

Conclusion:

In summary, the establishment of commercial plantations of jojoba does not require agricultural methodology or specialized equipment, although jojoba is not demanding of soil fertility, water quality and altitude, it is expected that the cultivation of Jojoba plant will grow

exponentially together with the search of synthetic ways to obtain similar waxy products in the next era to achieve the lack of natural resources which provide long monounsaturated esters. In addition, researchers have shown a growing concern in the possible uses of Jojoba meal, such as removal of contaminants or insecticides, in order to take advantage of the waste generated after extraction.

Therefore, Jojoba has a promising future because it offers a bunch of opportunities in chemical and environmental sectors, although several drawbacks linked to its cultivation, oil extraction and products purification after transesterification should be dealt with before its general exploitation.

However, the main factor to the widespread adoption of the crop and the development of sustainable markets for jojoba oil is a yield that is stable and predictable, which can be achieved through vegetative propagation of adapted clonal produced for each region/country.

Alternatively, the production of jojoba-type waxes from transgenic canola may provide a means of large scale production and the establishment of new markets. Like all other new crops, the number and importance of pests and diseases of the crop is not well documented, but the crop does seem to have relatively few pests that threaten its production in any country.

References

1. Al-Ani, H. A., Strain, B. R., Mooney, H. A. 1972. The physiological ecology of diverse populations of the desert shrub *Simmondsia chinensis.* Journal of Ecology 60: 41-57.
2. Thagana, W. M., Riungu, T. C., Inoti, S. K., Omolo, E. O., Ndirangu, C. M., Nyakwara Z.A., Waweru, J.K. and Arama, P. 2004. Introduction and status of Jojoba [*Simmondsia chinensis* (Link). Schneider] production in Kenya. Proceedings of the 9th KARI scientific conference held at KARI Headquarters. Kaptagat road, Loresho, Nairobi.Nov. 8-12. pp. 28-32.
3. Weiss E. A. (Ed.). 1983. Oilseed crops. London, New York: Longman. Pp. 507-527.
4. Gentry, H. S. 1958. The natural history of Jojoba (*Simmondsia chinensis*) and its cultural aspects. Economic Botany. 12 (3): 261-295.
5. Forster, K.E., Wright, N.G. 2002. Constraints to Arizona agriculture and possible alternatives. Office of arid land studies. University of Tucson, Arizona, USA, pp: 13-25.
6. Phillips, S.J., Comus., P.W., 2000. In: Phillips, S.J., Comus, P.W. (Eds.), A Natural History of the Sonoran Desert. University of California Press, Berkeley and Los Angeles, CA, pp. 256–257.
7. Abobatta, W. F. 2016. *Simondsia chinensis* " الجوجوبا- شجرة الذهب الاخضر" Noor Publishing - Germany. https://www.morebooks.de/fr/search?utf8=%E2%9C%93&q=978-3-330-79952-3
8. Adams J. A., Johnson, H. B., Bingham, F. T. and Yermanos, D. M. (1977). Gaseous exchange of *Simmondsia chinensis* (Jojoba) measured with a double isotope porometer and related to water stress, salt stress and nitrogen deficiency. Crop Sci. 17: 11-15.
9. Ince, A.G. and Karaca, M. 2011. Early determination of sex in jojoba plant by CAPSassay. The Journal of Agricultural Science 149(3): 327-336.
10. Forster, K.E., and Wright, N.G. 2002. Constraints to Arizona agriculture and possible alternatives. Office of arid land studies. University of Tucson, Arizona, USA, pp: 13-25.
11. Inoti, S. K., Chamshama, S.A.O., Dodson, R., Thaganam W. M. and Lulandala, L. L. L. 2015. Studies on Seed Size and Storage on Germinability and Performance of young Jojoba (*Simmondsia Chinensis* L.) Seedlings in Semi-arid Areas of Kenya. Journal of Biology, Agriculture and Healthcare. 5 (12): 10- 17.
12. Pinto, J. D., Fromer, S. I. and Manweiler, S.A. 1987. The insects of jojoba, *Simmondsia chinensis*, in natural stands and plantations in south western north America. The Southwestern Entomologist. Vol. 12 (4): 287-298.
13. El-Baz, E. E.T., El-Dengawy, E. F., El-Shahat, S.E.S. and El-Hassan, E. M. 2009. Studies on some morphological aspects of jojoba [*Simmondsia chinensis* (Link). Schneider] under Egyptian conditions. Journal of Agricultural Sciences Mansoura University 34(11): 10575-10586.
14. Yermanos, D. M. 1979. Jojoba, a crop whose time has come. California Agriculture 33:4-11.
15. Cao, B. and Gao, H. D. 2003. Technology of Cutting Propagation of *Simmondsia chinensis* (Link) Schneider. Journal of Nanjing- Forestry University, 27(4): 62-66.
16. Palzkill, D. A. and Feldman, W. R. 1993. Optimizing rooting of Jojoba stem cuttings: effects of basal wounding, rooting medium and depth of insertion in medium. Journal of the American Oil Chemists, Society, 70(12): 1221-1224.
17. Singh, K. J., Nayyar, H., Dutta, A. and Dhir,K.K. 2003.Rhizogenetic studies of Jojoba: hormone effect, rooting medium and seasonal variation. Indian – Forester. 129 (11): 1405-1411.
18. Llorente, B. E. and Apóstolo , N. M. 1998. Effect of different growth regulators and genotype on in vitro propagation of jojoba. New Zealand Journal of Crop and Horticultural Science. 26: 55-62.
19. Lee, C. W., and Paskill, D. A. 1984. Propagation of Jojoba by single node cuttings. Hort Sci. 19, 841-842.
20. Nord, E. C. and Kadish, A. 1974. *Simmondsia chinensis* (Link.) C. K. Schneider., jojoba. In: Schopmeyer CS, tech. coord. Seeds of woody plants in the United States. Agric. Handbk. 450.Washington, DC: USDA Forest Service: 774-776. (20)
21. Hogan, L., Lee, G.W., Palzkill, D.A. and Feldman, W.R. 1980. Jojoba: A new horticultural crop for arid regions. Hort science 15(2): 1-14.
22. Niklas, K. J. and Buchmann, S. L. 1985. Aerodynamics of wind pollination in *Simmondsia chinensis* (Link) Schneider. American Journal of Botany 72: 530–539.

23. Abobatta, W.F.R., El Ghadban, E.A.E. and Mahmud, G.F.2015. Chemical studies on grown jojoba oils under Egyptian conditions. Glob. J. Agric. Food Safety Sci., Vol.2 (3): 270 – 283.
24. Castellanos, A. E. and Molina, F. E. 1990. Differential survivorship and establishment in Simmondsia chinensis (jojoba). Journal of Arid Environments 19: 65-76.
25. Undersander, D.J., Oelke E.A., Kaminski, A.R., Doll, J.D., Putnam, D.H., Combs, S.M. and Hanson, C.V. 1990. Alternative field crop manual. University of Wisconsin-Madison and Minnesota, St. Paul, USA. 48pp.
26. ARJP 2001. Association of the Rajasthan Jojoba Plantation. Research Project. Proceedings of national seminar on production, marketing and processing of jojoba. Highlights and recommendations. Held at Jaipur, Rajasthan, India. Feb.19-20.32pp.
27. Hogan, I. and Bemis, W.P. 1983. Buffalo gourd and jojoba: Potential new crops for arid lands. Advances in Agronomy 36: 317-349.
28. Milthorpe, P. L., and Dunstone, R. L. 1989. The Potential of Jojoba (*Simmondsia chinensis*) in New South Wales. 1. Growth and Yield. Aust. J. Exp. Agric. 29, 383-387.
29. Ward, K. 2003. A little about Jojoba and saving the whales. KSA Jojoba Experimentation and Research. Northridge, California.
30. Al-Hamamre, Z. 2013. "Jojoba is a Possible Alternative Green Fuel for Jordan". Energy Sources, Part B: Economics, Planning, and Policy. 8 (3): 217 – 226.
31. Vrkoslav, V., Urbanovi, R. and Cvaika, K. J., 2010. Analysis of wax ester molecular species by high performance liquid chromatography/atmospheric pressure chemical ionisation mass spectrometry. J. Chromatogr. A 1217: 4184–4194.
32. Miwa, T.K., Structural determination and uses of jojoba oil. J Am Oil Chem. Soc., 1984. 61(2): 407-410.
33. Benzioni, A., and Forti. M. 1989. Jojoba. Pages 448-461 in Oil Crops of the World. G. Robbelen, R.K. Downey, and A. Ashri (eds.) McGraw-Hill Publishing Company; New York. 553 pages.
34. PATEL, N. K. 2017. Chemical properties and uses of Hohoba. International Research journal of Chemistry (IRJC). Vol 18:15- 18.
35. Sánchez, M., Marchetti, J. M., El Boulifi, N., Aracil J. and Martínez, M. 2015. Kinetics of Jojoba oil methanolysis using a waste from fish industry as catalyst. Chem. Eng. J. 262:640–647.
36. Sánchez, M., Avhad, M. R., Marchetti, M. J., Martínez, M. and Aracil, J. 2016. Jojoba oil: A state of the art review and future prospects. Energy Conversion and Management. 129:293–304.
37. Alsharhan, A. S., Fowler, A., Goudie, A.S, Abdellatif, E .M. and Wood, W. W. 2003. Desertification in the third millennium. Lisse: Balkema, pp.151-172.
38. Jaime, W., 1994. Potential uses of jojoba oil and meal. Ind. Crop. Prod. 3, 43–68.
39. El-Shamy, A. M., Shehata, A. H., Sanad, O. A., El-Halawany, A. M. and Abd El-Latif, H. A. 2001. Biologically active flavonoids from *Simmondsia chinensis* (Link) Schneider growing in Egypt. Bull Fac. Pharm Cairo Univ. 39(2): 55-63.
40. Brown, J., Arqette, J. and Reinhardt, J. 1994. Jojoba esters; A new family of cosmetic emollients, in Proceedings of 9th international conference on Jojoba oil and its uses and of the 3rd international conference on new crops and products, L.H. Princen and C. Rossi, Editors. 1994, A the association for the advancement of industrial crops: Catamarca, Argentina. p. 100-103.
41. Mosovich, B. 1985. Treatment of acne and psoriasis, in Proceedings of the 6th international conference on Jojoba oil and its uses, J. Wisniak and J. Zabicky, Editors. 1985, Ben Gurion University: The Negev, Beer Sheva, Israel. p. 393-397.
42. Habashy, R.R., Abdel-Naim, A. B., Khalifa, A. E. and Al-Azizi, M. M., 2005. Anti-inflammatory effects of jojoba liquid wax in experimental models. Pharmacol. Res. 51(2): 95-105.
43. Farag, R. S., Farag, M. M. and Ali, R. F. M. 2008. Use of sunflower oil mixed with jojoba and paraffin oils in deep-fat frying process. Int. J. Food Sci. Technol. 43(7): 1306-1315.
44. Ibrahim, H.M., Abou-Arab, A. A. and Abu Salem, F. M., 2011. Antioxidant and antimicrobial effects of some natural plant extracts added to lamb patties during storage. Grasas Y Aceites 62:139–148.
45. Ranzato, E., Martinotti, S. and Burlando, B., 2011. Wound healing properties of jojoba liquid wax: an in vitro study. J. Ethnopharmacol. 134, 443–449.
46. Wisniak, J. 1994: Potential uses of Jojoba oil and meal a review. Ind. Crops Prod. 3: 43 - 68.
47. Bellirou, A., Bouali, A., Bouammali, B., Boukhatem, N., Elmtili, B.N., Hamal, A. and El- Mourabit, M., 2005. Extraction of simmondsin and oil in one step from jojoba seeds. Ind. Crop. Prod. 21, 229–233.
48. Verbiscar, A.V., Banigan, T.F., Weber, C.W., Reid, B.L., Trei, J.E., Nelson, E.A., Raffauf, R.F. and Kosersky, D., 1980. Detoxification of jojoba meal. J. Agric. Food Chem. 28, 571–578.
49. Abbott, T. P., Holser, R. A., Plattner, B. J., Plattner, R. D. and Purcell, H.C., 1999. Pilot-scale isolation of simmondsin and related jojoba constituents. Ind. Crop. Prod. 10:65–72.
50. Abbassy, M. A., Abdelgaleil, S. A. M., Belal, A. S. and Rasoul, M. A. A., 2007. Insecticidal, antifeedant and antifungal activities of two glucosides isolated from the seeds of *Simmondsia chinensis*. Ind. Crop. Prod. 26, 345–350.