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Review

Use of vegetable oils in dermatology: an overview

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Summary

Vegetable oils have been used for a wide variety of purposes since time immemorial; however, their principle use remains as skin moisturizers, especially in neonates and children. Because of their considerable efficacy and a low side effect profile and bearable cost, these oils are hugely popular as moisturizers among the common people in countries such as India. A wide variety of oils have been used, and newer ones are coming up with each passing day. This article focuses on the different types of vegetable oils and their varied uses in dermatology.

Introduction

Vegetable oils have been used as skin moisturizers for a very long time, their first use probably dating back to China, around the 2nd century BC.[1] Although these oils have been used to moisturize and smoothen skin of any age, their most widespread use continues to be in neonates and infants, as their skin is much more delicate and prone to trauma and infections than their adult counterparts due to certain differences in their properties. However, all oils are not equally effective; some like almond oil and mustard oil might even be harmful to the skin to a certain degree.[2] Due to the rising popularity and widespread use of these oils, especially in countries like India, dermatologists need to be aware of their various properties**.** This article focuses on the different types of vegetable oils commonly available, their wide gamut of uses in dermatology, and some of their harmful effects.

Chemical nature of vegetable oils

Vegetable oils are produced by plants as a source of energy, the highest concentration being present in seeds and fruits. About 95% of each vegetable oil is composed primarily of triglycerides with meager amounts of mono and bi-glycerides. The triglycerides are principally triesters of polyol glycerin with long chain monocarboxylic fatty acids; the latter may be saturated or unsaturated in nature. Coconut oil and palm oil contain mainly saturated fatty acids, while other oils largely contain unsaturated fatty acids (oleic acid, linoleic acid, and linolenic acid). The remaining 5% of each vegetable oil is composed of different substances in varying proportions viz. phospholipids, glycolipids, sulpholipids, sphingolipids, waxes (saponifiable fraction) and hydrocarbons like squalene, pigments in the form of carotenoids and chlorophyll, vitamin E, phytosterols, polyphenols, and triterpene alcohols (non-saponifiable fraction). The non-saponifiable fraction is mainly responsible for the anti-inflammatory and antioxidant effects of vegetable oils. Squalene, which is a well-known component present in many of the newer synthetic formulations like lipid emulsions and nano-structured lipid carriers, is hydrogenated to produce squalane to impart a less oily and more pleasant feel.[3,4]

It is important here to note the distinction between vegetable oils and essential oils, both being sourced from plants. While vegetable oils are typically "oily", essential oils are colorless, pleasant smelling liquids with a high refractive index. They are usually volatile at room temperature, concentrated, potent, and are purported to have rejuvenative properties and other health benefits.[5]

Table 1 Commonly used vegetable oils in dermatology

Type of oil	Constituents	Functions
Corn oil	Linoleic acid, oleic acid, palmitic acid, linolenic acid	Emulsion and moisturizer in emulsions, as a vehicle to dissolve lipo soluble active ingredients like retinol
Coconut oil/ cocoa butter	95% saturated fat Lauric, myristic, caprylic, capric, palmitic acid	Sebum reconstitution properties
Palm kernel oil	Lauric, myristic, oleic and palmitic acids	Similar to coconut oil
Palm oil	Oleic and palmitic acid	Bulk quantities
Soybean oil	Oleic, linoleic, palmitic, stearic and linolenic acid. Tocopherol, phytosterols	Highly susceptible to oxidation
Rapeseed oil	Oleic, linoleic and linolenic acid, Tocopherol, phytosterol	Same as soybean oil
Sunflower seed oil	Linoleic acid, tocopherols Glyceryl trioleate a polar lipid	Emollient, repair process
Olive oil	Oleic70-80%, linoleic, palmitoleic, palmitic and stearic acid squalene	Sebum restitutive, emollient, repair process stimulation
Sweet almond oil	Unsaturated fatty acid> saturated fatty acid; Oleic > linoleic> palmitic acid	Soften the chapped skin, soothing effect on mucous membranes
Avocado oil	Oleic, linoleic, palmitic, palmitoleic acid branched chain hydrocarbons, phytosterols, terpene alcohol, avocatine, vitamin E	Stimulates fibroblasts, inhibits collagenase used in anti-aging
Borage oil	Linoleic, oleic, gamma-linolenic, palmitic and stearic acid	Antioxidant
Evening primrose oil	Linolenic acid, linoleic acid, polyphenols	Antioxidant
Shea butter	Oleic, stearic, linoleic, palmitic, linolenic and arachidic acid, triterpene alcohols, cinnamates, tocopherols	Superb moisturizer, healing properties (contains vitamin A), anti-aging properties.
Argan oil	Oleic > Linoleic> Palmitic> Stearic acid, Vitamin E, phenols, Carotene, squalene, epicathecin etc.	Powerful antioxidant action, mainly used as cosmetic oil for skin and hair.

Vegetable oils commonly used in dermatology

Some of the commonly used vegetable oils have been tabulated in Table 1.

There are several uses of vegetable oils in dermatology, some of the important ones being: neonatal and infantile skin care (oil massage), treatment of various skin diseases like atopic dermatitis,[6,7] xerosis, other eczematous conditions, psoriasis,[8] etc. Recently, vegetable oils have been found to be effective in the treatment of tinea pedis[9] and are known to have antimicrobial action. They are also used as a part of rejuvenation and treatment in alternative medicine systems like Ayurveda.[10] Some vegetable oils like Argan oil have also become popular as ingredients of hair and skin cosmetics. Many oils like coconut oil are used as hair moisturizers traditionally in certain societies.[11] The various uses of vegetable oils are discussed in detail here.

Neonatal and infantile skin care

One of the most important roles of vegetable oils is related to neonatal and infantile massage. The custom of oil massaging has been practiced in countries like India since time immemorial. The benefits of massage can be attributed to the oil application itself as well as the tactile kinesthetic stimulation during the massage.[12]

Benefits of oil application

The benefits due to oil application range from strengthening the skin barrier function to improvement of thermoregulatory properties.[12] Above all, it serves as an effective emollient to nourish and moisturize the fragile skin. Darmstadt *et al.* observed that these oils may lead to increased fat absorption through the pre-term skin, thus enhancing nutrition and improving skin barrier function. It has been proposed that increased absorption of the oils through the skin increases triglyceride levels and that increased vagal activity following oil massage results in faster weight gain.[13]

Although a wide variety of oils can be used for this purpose, vegetable oils are most widely used in countries such as India due to their easy availability and low cost. Studies have shown that the widely available coconut oil is a very good option for this purpose. Coconut oil, a saturated fat without any cholesterol, is a blend of both short and medium chain fatty acids, primarily lauric (44%) and myristic (16.8%) acids. It has been reported by Sankaranarayanan *et al.* that coconut oil massage leads to greater weight gain and faster length gain when compared with other mineral oils and placebo.[14] They found that there was a greater benefit on massaging with coconut oil, over and above the benefits of tactile kinesthetic stimulation. Contrary to popular belief, mustard oil happens to be inferior to coconut oil, as it may occasionally lead to contact dermatitis (irritant reaction more common than allergic dermatitis; characterized by eczematous and/or vesicular dermatitis) due to the presence of the allyl isothiocyanate antigen.[15,16] However, despite the widespread use of mustard oil for massaging the baby skin, only a few cases of contact dermatitis have been reported in Indian population. Thus, we may opine that mustard oil contact hypersensitivity is

relatively uncommon in India. Studies have also shown that the widely popular olive oil is inferior to sunflower oil in terms of providing nourishment to newborn skin. While sunflower oil has been shown to enhance the integrity of stratum corneum and hydration of skin, olive oil has detrimental effects on the neonatal skin (impairing skin barrier, enhancing chance of atopic dermatitis, production of erythema).[17] Sunflower oil massage has also led to reduced mortality among pre-term neonates in developing countries, proposedly by enhancing maturation of skin and by helping in faster weight and length gain.[18] The use of essential fatty acid (EFA) rich safflower oil and saturated fat rich coconut oil may lead to increased nutrition of the neonatal and infantile skin, owing to the transcutaneous absorption of these oils.[19]

Benefits of oil massage

Recently, studies have shown that aside from the nature of oil used, the very act of oil massaging has several beneficial effects on infantile skin. These effects are related to the tactile kinesthetic stimulation due to massage.[12] There are several beneficial effects of massage ranging from weight gain, better sleep-wake cycle, enhanced neuromotor development, emotional bonding, and lower rates of nosocomial infections in both term and pre-term babies.[20] Darmstadt *et al.*[21] eventually went on to show that lubricant oil massage is more effective than dry massage.

Technique of oil massage

One must be acquainted with the proper technique of oil massage to derive the maximal benefits. Moderate pressure massage with passive movement (flexion and extension) of the limbs has been shown to provide the maximum benefit viz. weight gain, enhanced bone growth, etc. (Fig. 1, 2). Overzealous and vigorous massage should be avoided as it may lead to physical injuries, also enhancing the chance of infection. Recently it has been shown that kinesthetic stimulation during moderate pressure massage may lead to increased vagal activity, gastric motility, and insulin-like growth factor 1 levels, which in turn lead to better weight gain of the child.[22]

Role of vegetable oils in the treatment of several dermatological disorders

Aside from its role as a natural moisturizer in neonates and infants, which has its own share of benefits, these oils find use as an adjuvant form of treatment in several dermatological disease processes due to their remarkable properties as emollients and humectants. In many cases, solitary use of these oils may suffice, thus paving the way for low cost of therapy, especially useful in resource-poor countries like India. These oils are remarkably useful in conditions where the skin becomes excessively dry and there is excessive transepidermal water loss (TEWL) viz. atopic dermatitis,[6,7] other eczematous conditions like psoriasis,[8] and virtually all other conditions presenting with dry skin. It has been found that coconut oil is superior to olive oil and other mineral oils in this regard.[23]

Recent studies show that coconut oil may have broad-spectrum activity against *Staphylococcus aureus* and other bacteria, viruses, and fungi, and thus may play a proactive role in the treatment of atopic dermatitis.[7,21]

Role of vegetable oils as effective antimicrobial agents

Several studies have demonstrated the broad-spectrum antimicrobial activity of coconut oil against bacteria, viruses, and fungi.[7,21] There are not many reports on the antimicrobial activity of the other commonly available vegetable oils. However,

Figure 1 Proper technique of massaging oil, flexion of lower limbs

Figure 2 Proper technique of massaging oil, gently over the lateral part of body

Delaquis *et al.* have stressed upon the antibacterial effect of essential oils like coriander oil, Eucalyptus oil, dill, and cilantro oil on *Staphylococcus aureus* and other Gram-positive and Gram negative bacteria.[24]

Role of vegetable oils in Ayurveda

Vegetable oils form an important part of the therapeutic regimens in Ayurveda, an alternative system of medicine widely popular in India. Ayurveda recommends "Abhyanga" meaning anointing the whole body with oil, for maintenance of health and as a treatment for various disorders. The common oils used for Abhyanga include sesame oil, mustard oil, almond oil, corn oil, coconut oil, and sunflower oil, which may be used as such or in combination with other herbs depending on the specific condition. As per Ayurvedic teachings, the choice of oil for Abhyanga depends on the "prakrithi" (constitution) of the patient, "vikrithi" (current condition) of the patient, the external environment, and the preponderance of the 'Doshas' in one's constitution. Ayurveda identifies thridoshas (3 Doshas) in a person's constitution, which have to be pacified: Vata (airy element), Pitta (fiery element or bile), and Kapha (watery element). Therefore, the choice of oil is governed by the preponderance of these doshas.

The procedure for Abhyanga

Abhyanga is done preferably in the early morning with slightly warm oil. Sesame oil and coconut oil are the most commonly used oils for this procedure. The patient lies or sits on a traditional wooden table called "Dhroni" which drains away the excess oil. (Fig. 3, 4) The classic sequence of the 7 positions with Abhyanga are sitting, supine (lying on back), left lateral, prone (lying on stomach), right lateral, supine (lying on back), and finally return to sitting. Long, medium-to-firm strokes are used, away from the navel, predominantly in repeats of seven.[10,25]

Benefits of Abhyanga

A pilot study investigating the benefits of Abhyanga found that the subjects showed statistically and clinically significant reduction in subjective stress experience.[25] Another study done on the effect of Abhyanga on hair found that there was a significant reduction in pruritus and scaling of scalp and improvement in texture of hair, though no change was found on the graying of hair.[26] Ayurveda purports many other benefits for Abhyanga including improving the complexion, luster, and softness of skin. It is also thought to rejuvenate the tissues, improve strength and stamina, and retard the aging process. However, the scientific evidence regarding these benefits is limited.

Vegetable oils as moisturizers for hair

One of the newer uses of vegetable oils is as moisturizer for hair, which can be of two main types: humectants and emollients. Vegetable oils fall into the category of emollients. They do not actually supply moisture to the hair but rather form films/coatings on the surface of the hair, which seals the cuticle and traps the moisture inside. They are lubricants and

Figure 3 The traditional "Abhyanga" Ayurvedic oil massage being practiced in an Ayurvedic center in Kerala, South India

Figure 4 A patient undergoing Abhyanga on the prone position by trained Ayurvedic practitioners

provide increased slip between adjacent hair strands, which helps in detangling and smoothens and flattens the cuticle surface, thus improving the health and appearance of the hair strands.[11] They also fill the gap between cuticle cells and prevent penetration of aggressive substances like surfactants into the follicle.

Additionally, some vegetable oils may also have a role in preventing hair protein loss.[27] In a comparative study among three oils, Rele and Mohille found that only coconut oil was able to prevent protein loss in both damaged and undamaged hair. Coconut oil, because of its low molecular weight and straight linear chain, is able to penetrate inside the hair shaft. Mineral oil and sunflower oil is not able to penetrate the fiber, resulting in no favorable impact on protein loss.[28]

Argan oil: The new arrival

Argan oil, a vegetable oil extracted from the fruit of the Argan tree (Arganiaspinosa [L]) found in Morocco, deserves special mention as a widely popular cosmetic oil for hair and skin due to its excellent antioxidant properties. During the past 15 years, Argan oil has emerged as a very important ingredient of many cosmeceutical products. Three main types of Argan oil exist – the edible Argan oil, the beauty Argan oil, and the cosmetic Argan oil.

Edible argan oil is the oldest type and is prepared by a traditional process involving coldpressing the slightly roasted kernels of the argan tree. The high content of unsaturated fatty acids is thought to contribute to the purported cardio-protective and hepato-protective benefits of edible argan oil.[29,30] Beauty argan oil is the cold-pressed argan oil that is produced from unroasted kernels. It is golden in color and is odorless. It is meant to be directly applied on the skin/hair. Cosmetic argan oil is not a cold-pressed oil, rather prepared by the solvent extraction of crushed argan kernels. It is used exclusively in the composition of creams/shampoos/body lotions.[31]

Argan oil of edible or beauty grade is composed of 99% acylglycerides (primarily triglycerides), which are mainly oleic and linoleic acid. The high oleic acid content in this oil is found to have regulatory effect on sebum secretion and is found to be useful in treatment of acne; the high linoleic acid content is thought to contribute to its traditional indication as a cure for skin inflammation. Unsaponifiable matter, which represents the remaining one percent, is composed of carotenes, tocopherols, triterpene alcohols, sterols, and xanthophylls. The exceedingly high concentration of tocopherol 620 mg/kg, compared to 320 mg/kg in olive oil, gives it strong antioxidant and free radical scavenging properties. Therefore, it is also used as an anti-aging product, thought to have a role in reducing facial wrinkles. Recently, oral/topical Argan oil has been shown to hydrate the postmenopausal skin, thus maintaining its elasticity.[32–34] To summarize the effects of argan oil on skin and hair, it is thought to have moisturizing, sebostatic, anti-acne, wound healing, and anti-aging properties. Much of these are based on traditional claims and are yet to be proven conclusively.

Adverse effects of vegetable oils

There are few reported adverse effects of vegetable oils, which have occurred sporadically, but their incidence is extremely low when compared to the widespread use of vegetable oils. There are a few reports of contact dermatitis due to mustard oil[15,16] and almond oil[2,35] application. A pityriasis rosea-like eruption due to mustard oil has been reported by Zawar *et al*.[36] Another condition called Mudi-chood is commonly seen in Southern India; it was first described by Sugathan and Nair in 1972.[37] It is a lichenoid dermatitis seen on the nape of the neck and upper back, thought to be caused by contact with residual coconut oil and other Ayurvedic herbal oils in the hair. It has also been shown that olive oil exerts detrimental effects on the neonatal skin.[17] Argan oil has also been implicated to cause contact dermatitis in infants in some studies.[38] Some researchers have also cautioned that vegetable oils like olive oil may encourage *Malassezia* overgrowth, and the excessive unsaturated fatty acids produced by the digestion of fat by these yeasts may augment inflammation in seborrheic dermatitis and other dermatoses linked with *Malassezia*.[39] Increased systemic absorption of evening primrose oil may rarely lower the blood pressure[40] and lead to prolonged bleeding time.[41] Palm oil and palm kernel oils have been reported to cause deranged lipid profiles, reproductive toxicities, and also toxicities of the kidney, lung, liver, and heart.[42] Based on all the studies, coconut oil, sunflower oil, and safflower oil have been found to be most efficacious for dermatological use with minimal incidence of adverse effects.

Conclusion

Vegetable oils are a relatively inexpensive modality of skin care for the nourishment of infantile skin and furthermore, as an adjuvant treatment for several dermatological conditions which present with dry and damaged skin. Aside from their dermatological function, the proper application of these oils has also been shown to aid in the growth and development of infants. However, erroneous selection of oil or faulty massage technique may sometimes result in detrimental effects. Therefore, proper education of mothers in this regard is vital. The use of either coconut oil or sunflower oil is found to have superior efficacy along with safety in this regard and is recommended by the authors.

Thus, as we can see, despite the flooding of market by a wide plethora of commercial moisturizers, vegetable oils still play a very important role in resource poor settings due to their proven efficacy, low cost, easy availability, and a commendable safety profile.

Questions (answers provided after references)

1 What is the major constituent of vegetable oils?
- a Phospholipids
- b Triglycerides
- c Hydrocarbons
- d Carotenoids

2 Which among the following vegetable oils is preferred for neonatal and infantile skin care?
- a Olive oil
- b Mustard oil
- c Sesame oil
- d Sunflower oil

3 Which among the following vegetable oils is known to have antimycotic action?
- a Coriander oil
- b Olive oil
- c Coconut oil
- d Almond oil

4 The act of anointing the whole body with oil, as practiced by Ayurveda, is known as:
- a Marma
- b Dosha
- c Abhyanga
- d Prakrithi

5 Which of the following is used as an emollient for hair?
- a Propylene glycol
- b Glycerin
- c Vegetable oils
- d Sorbitol

6 Argan oil is extracted from the fruits of the Argan tree found in:
- a Morocco
- b Mexico
- c Nigeria
- d Algeria

7 High concentration of which substance is responsible for the strong antioxidant and free radical scavenging properties of Argan oil?
- a Carotenes
- b Tocopherol
- c Xanthophylls
- d Sterol

8 The site affected in "Mudi-chood", a lichenoid dermatitis caused by contact with oils, is:
- a Chest
- b Nape of neck and upper back
- c Lower abdomen
- d Thigh

9 Pityriasis rosea-like eruption has been reported with which vegetable oil?
- a Coconut oil
- b Argan oil
- c Sunflower oil
- d Mustard oil

10 As per the review, which of the following oils have been found to be most efficacious in dermatological use with minimal adverse effects?
- a Coconut oil
- b Almond oil
- c Mustard oil
- d Olive oil

References

1 Kulkarni A, Kaushik JS, Gupta P, *et al.* Massage and touch therapy in neonates: the current evidence. *Indian Pediatr* 2010; **47**: 771–776.

2 Sarkar R, Basu S, Agrawal RK, *et al.* Skin care of the newborn. *Indian Pediatr* 2010; **47**: 593–598.

3 Wolosik K, Knas M, Zalewska A, *et al.* The importance and perspective of plant-based squalene in cosmetology. *J Cosmet Sci.* 2013; **64**:59–66.

4 Huang ZR, Lin YK, Fang JY. Biological and pharmacological activities of squalene and related compounds: potential uses in cosmetic dermatology. *Molecules* 2009; **23**: 540–554.

5 Ali B, Wabel NA, Shams S, *et al.* Essential oils used in aromatherapy: a systemic review. *Asian Pac J Trop Biomed* 2015; **5**: 601–611.

6 Evangelista MT, Abad-Casintahan F, Lopez-Villafuerte L. The effect of topical virgin coconut oil on SCORAD index, transepidermal water loss, and skin capacitance in mild to moderate pediatric atopic dermatitis: a randomized, double-blind, clinical trial. *Int J Dermatol* 2014; **53**: 100–108.

7 Verallo-Rowell VM, Dillague KM, Syah-Tjundawan BS. Novel antibacterial and emollient effects of coconut and virgin olive oils in adult atopic dermatitis. *Dermatitis.* 2008; **19**:308–315.

8 George R. Treatment plan of juvenile psoriasis. *Ind J Ped Derm* 2012; **13**: 9–11.

9 Beikert FC, Anastasiadou Z, Fritzen B, *et al.* Topical treatment of tineapedis using 6% coriander oil in unguentumleniens: a randomized, controlled, comparative pilot study. *Dermatology* 2013; **226**: 47–51.

10 Roshy Joseph C, Anu C, Joseph CT. Role of Abhyanga (oil massage) to lead a healthy life. *Ayur Pharm Int J Ayur Alli Sci* 2012; **1**: 163–167.

11 Carson J, Gallagher KF. Emollient esters and oils. In: Schueller R, Romanowski P, eds. *Conditioning Agents for Hair and Skin.* New York, Marcel Dekker Inc, 1999: 111–138.

12 Dhar S, Banerjee R, Malakar R. Oil massage in babies: Indian perspectives. *Ind J Ped Derm* 2013; **14**: 1–3.

13 Darmstadt GL, Dinulos JG. Neonatal skin care. *Pediatr Clin North Am* 2000; **47**: 757–782.

14 Sankaranarayanan K, Mondkar JA, Chauhan MM, *et al.* Oil massage in neonates: an open randomized controlled

study of coconut versus mineral oil. *Indian Pediatr* 2005; **42**: 877–884.
15 Pasricha JS, Gupta R, Gupta SK. Contact hypersensitivity to mustard khal and mustard oil. *Indian J Dermatol Venereol Leprol* 1975; **51**: 108–110.
16 Gaul LE. Contact dermatitis from synthetic oil of mustard. *Arch Dermatol* 1964; **90**: 158–159.
17 Danby SG, AlEnezi T, Sultan A, *et al.* Effect of olive and sunflower seed oil on the adult skin barrier: implications for neonatal skin care. *Pediatr Dermatol* 2013; **30**: 42–50.
18 Darmstadt GL, Saha SK, Ahmed AS, *et al.* Effect of skin barrier therapy on neonatal mortality rates in preterm infants in Bangladesh: a randomized, controlled, clinical trial. *Pediatrics* 2008; **121**: 522–529.
19 Solanki K, Matnani M, Kale M, *et al.* Transcutaneous absorption of topically massaged oil in neonates. *Indian Pediatr* 2005; **42**: 998–1005.
20 Mathai S, Fernandez A, Mondkar J, *et al.* Effects of tactile-kinesthetic stimulation in preterms: a controlled trial. *Indian Pediatr* 2001; **38**: 1091–1098.
21 Darmstadt GL, Mao-Qiang M, Chi E, *et al.* Impact of topical oils on the skin barrier: possible implications for neonatal health in developing countries. *Acta Paediatr* 2002; **91**: 546–554.
22 Field T, Diego M, Hernandez-Reif M. Preterm infant massage therapy research: a review. *Infant Behav Dev* 2010; **33**: 115–124.
23 Agero AL, Verallo-Rowell VM. A randomized double-blind controlled trial comparingextra virgin coconut oil with mineral oil as a moisturizer for mild to moderate xerosis. *Dermatitis* 2004; **15**: 109–116.
24 Delaquis PJ, Stanich K, Girard B, *et al.* Antimicrobial activity of individual and mixed fractions of dill, cilantro, coriander and eucalyptus essential oils. *Int J Food Microbiol* 2002; **74**: 101–109.
25 Basler AJ. Pilot study investigating the effects of ayurvedic abhyanga massage on subjective stress experience. *J Altern Complement Med* 2011; **17**: 435–440.
26 Perke BM. Evaluation of the role of Shirobhyanga with reference to Keshaswasthya (health of normal hair). *Int Res J Pharm* 2013; **4**: 125–127.
27 Trüeb RM. Pharmacologic interventions in aging hair. *Clin Interv Aging* 2006; **1**: 121–129.
28 Rele AS, Mohile RB. Effect of mineral oil, sunflower oil, and coconut oil on prevention of hair damage. *J Cosmet Sci* 2003; **54**: 175–192.
29 Charrouf Z, Guillaume D. Argan oil and other argan products; use in dermocosmetology. *Eur J Lipid SciTechnol* 2011; **113**: 403–408.
30 Charrouf Z, Guillaume D. Argan oil: occurrence, composition and impact on human health. *Eur J Lipid SciTechnol* 2008; **110**: 632–636.
31 Monfalouti HE, Guillaume D, Denhez C, *et al.* Therapeutic potential of argan oil: a review. *J Pharm Pharmacol* 2010; **62**: 1669–1675.
32 Guillaume D, Charrouf Z. Argan Oil. *Alternative Medicine Review* 2011; **16**: 275–279.
33 Dobrev H. Clinical and instrumental study of the e%cacy of a new sebum control cream. *J Cosmet Dermatol* 2007; **6**: 113–118.
34 Boucetta KQ, Charrouf Z, Aguenaou H, *et al.* The effect of dietary and/or cosmetic Argan oil on postmenopausal skin elasticity. *Clin Interv Aging* 2015; **10**: 339–349.
35 Guillet MH. Percutaneous sensitization to almond oil in infancy and study of ointments in children with food allergy. *Allerg Immunol (Paris)* 2000; **32**: 309–311.
36 Zawar V. Pityriasisrosea-like eruptions due to mustard oil application. *Indian J Dermatol Venereol Leprol* 2005; **71**: 282–284.
37 Sugathan P, Nair MB. Mudichood: a new dermatological entity. In: Marshall J, ed. *Essays on Tropical Dermatology*. vol. **2**. Amsterdam: ExcerptaMedica, 1972: 183–188.
38 Barrientos N, Moreno de Vega M, Dominguez J. Allergic contact dermatitis caused by Argan oil in an infant. *Contact Dermatitis* 2014; **71**: 316–317.
39 Siegfried E, Glenn E. Use of olive oil for the treatment of seborrheic dermatitis in children. *Arch Pediatr Adolesc Med* 2012; **166**: 967.
40 Engler MM. Comparative study of diets enriched with evening primrose, black currant, borage or fungal oils on blood pressure and pressor responses in spontaneously hypertensive rats. *Prostaglandins Leukot Essent Fatty Acids* 1993; **49**: 809–814.
41 Ford I, Cotter MA, Cameron NE, *et al.* The effects of treatment with [alpha]- lipoic acid or evening primrose oil on vascular hemostatic and lipid risk factors, blood flow, and peripheral nerve conduction in the streptozotocin-diabetic rat. *Metabolism* 2001; **50**: 868–875.
42 Edem DO. Palm oil: biochemical, physiological, nutritional, hematological and toxicological aspects: a review. *Plant Foods Hum Nutr* 2002; **57**: 319–341.

Answers to questions

1 b
2 d
3 a
4 c
5 c
6 a
7 b
8 b
9 d
10 a