EDITORS: Dr. DAMJAN JANEŠ and Dr. NINA KOČEVAR GLAVAČ

MODERN COSMETICS

INGREDIENTS OF NATURAL ORIGIN

A SCIENTIFIC VIEW

VOLUME 1

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The main purpose of this book is to inform laypeople and the professional public about the possibilities offered by cosmetic ingredients of natural origin, to present findings from the latest research and to describe traditional practices. The book does not describe diseases and symptoms, and is not intended for self-treatment. Some (skin) diseases should not be subject to self-treatment, as only trained medical practitioners may make the proper diagnosis and prescribe the appropriate treatment after thorough examination. Typographical errors may appear in the book, despite a thorough review. The authors, editors and publisher shall not be held liable for any damage arising from the use of this book.

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MODERN COSMETICS

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VOLUME
1

The pursuit of a natural way of life is one of the ideals of modern society. Cosmetics represent just one area where this tendency can be strongly felt. It is evident in both a sharp increase in the use of natural cosmetics and in an ever growing awareness of our relationship with nature, which can be seen at the individual level and at the level of society as a whole.

This book aims to build and establish a concept of modern cosmetics that derives from these values. Our concept is based on the meshing of the physiological needs of the skin, ecologically and physiologically acceptable cosmetic ingredients, and modern approaches of cosmetology.

Modern Cosmetics is a book about natural cosmetic ingredients that are gentle to the skin. It is a book of traditional and contemporary knowledge that is supplemented in certain sections by the authors' critical point of view. Finally, its well-articulated content weaves a rich web of picturesque images of the natural world and original portraits of cosmetics. We invite you to discover this world!

Dr. Nina Kočevar Glavač and Dr. Damjan Janeš

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VEGETABLE BUTTERS AND OILS

Nina Kočevar Glavač

INTRODUCTION

Vegetable butters and oils have become one of the main interests of natural cosmetics, from the perspective of manufacturers and users. The reasons are numerous: they can be found extensively throughout the plant world, their medicinal and cosmetic use is based on experience of thousands of years and, last but not least, they are a valuable source of biologically active substances. Moreover, the trend of returning to nature has contributed significantly and added an exotic touch to the popularity of vegetable butters and oils.

Numerous misleading facts and even lies related to vegetable butters and oils can be found too often in non-scientific literature, particularly in advertisements and promises made on cosmetic products. Therefore, remember that vegetable butters and oils are not sources of physiologically important enzymes, water-soluble vitamins and minerals, do not function as suitable sunscreens, and do not possess miraculous beneficial and nutritional properties, or exceptional antioxidative and regenerative properties. Vegetable butters and oils may, however, be a reasonable and excellent substitute for a number of cosmetic ingredients if used correctly. Therefore, be critical and invest in knowledge – because you're worth it!

Vegetable butters and oils are complex substances rich in various lipid compounds and suitable for a broad cosmetic application. They are considered the most unique cosmetic ingredients, in terms of their physiological, technological and functional characteristics. To explain, vegetable butters and oils exhibit biological and cosmetic effects on the skin, and are the basic constituents of numerous cosmetic products, thereby defining their physical characteristics.

The first (and true) masters in the production and use of vegetable butters and oils were the ancient Egyptians. As part of a religious ceremony, various cosmetic accessories were placed in the tomb of a dead pharaoh to empower the soul after death. In Tutankhamun's tomb, for example, cosmetic jars were found containing the remains of vegetable oils used to remove mascaras, lipsticks and eye shadows.

The chemical composition of vegetable butters and oils has been researched in detail. They consist of triglycerides that usually represent 98 to 99% of all compounds. In chemistry terms, triglycerides are esters of glycerol with medium-chain or long-chain fatty acids. The main element of triglycerides in vegetable butters is represented by saturated fatty acids, therefore, they are solid or semi-solid at room temperature and melt at body temperature. In contrast, vegetable oils consist mainly of monounsaturated and polyunsaturated fatty acids, and are therefore usually liquid at room temperature. Triglycerides are responsible for the physical and chemical properties, as well as the biological effects of vegetable butters and oils. In addition, an important role has been attributed to phospholipids and other accompanying substances (i.e. unsaponifiable matter), e.g. phytosterols, squalene, phenols, terpenoids, carotenoids and vitamin E.

In general, vegetable butters are chemically stable due to their high content of saturated fatty acids in triglycerides, and can therefore be stored for longer periods. Vegetable oils, especially those predominantly containing polyunsaturated fatty acids such as linoleic or linolenic acid, are unstable, as they are prone to relatively rapid oxidative changes, which result in their rancidity. Oxidative changes are the result of free radical reactions, i.e. lipid peroxidation, and lead to the formation of lipid radicals, aldehydes and other reactive compounds. The oxidative degradation of unsaturated chains is high in the presence of oxygen, metal ions, high temperatures and ultraviolet radiation. In terms of cosmetology, these unstable oils are termed active oils. Active oils for skin care should be available in small glass containers and stored in a cool and dark place (e.g. refrigerator) for only a short period of time. To protect them against oxidation (i.e. rancidity) and thus to extend their stability, they may be combined with vitamin E or other antioxidants, e.g. rosemary or sage extract, or with more stable oils to prepare skin care oil mixtures. Exposure to direct sunlight should be avoided after skin care using pure active oils, which is best practiced in the evening.

While the chemical composition of vegetable butters and oils has been studied in detail, very little scientific research has been done to examine their mechanism of action. It is still largely unknown what effects at the cellular level are expressed following the application of vegetable butters and oils to the skin, and which processes are consequently activated or inhibited. The effects of long-term use are likewise largely unknown.

A welcome step in addressing the aforementioned problem was made on the scope of research work published in 2012, which studied the penetration of three vegetable oils (avocado, almond and soybean oils), jojoba wax, paraffin oil and petrolatum into the skin, as well as their emollient and occlusive effects. What were the results? The applied substances remained on the skin surface and formed a thin layer. Significant penetration into deeper parts of the skin was excluded. Soybean and almond oils showed the best penetration properties. However, they were only capable of penetrating the surface, i.e. the first upper layers of the *stratum corneum*. All substances except jojoba wax significantly decreased transepidermal water loss.

Vegetable butters and oils effectively express their emollient properties and thereby indirectly improve skin moisturisation. Based on the current level of knowledge, no significant effects can be expected in the deeper layers of the *stratum corneum*. There is also no information on the extent of the enzymatic degradation of triglycerides to individual fatty acids (free fatty acids, together with ceramides and cholesterol, are the basic lipids of the *stratum corneum*). The most important role of vegetable butters and oils is therefore their emollient, moisturising and protective function in close combination with the function of the hydro-lipid mantle (p. 24). The hydro-lipid mantle is mainly composed of diglycerides, triglycerides, free fatty acids, waxes and squalene, with minor parts of cholesterol and cholesterol esters. Also very important are two lipophilic antioxidants, vitamin E and coenzyme Q_{10}, which provide protection from the harmful effects of ultraviolet radiation.

In terms of research and evaluation, the effects of vegetable butters and oils expressed on the skin are even harder to explain when they are incorporated into cosmetic products. In such cases, their mechanisms of action cannot be generalised, as additional ingredients strongly affect the overall effects. One example is emulsifiers, which are surfactants.

To conclude, further scientific research is needed to address the following issues: discovering the connection between the effects of vegetable butters and oils and their chemical composition, discovering the individual cosmetically active ingredients of vegetable butters and oils, and studying their mechanisms of action. Furthermore and even more important in terms of their application to the skin, reliable data is needed to prove that the long-term use of vegetable butters and oils is safe and beneficial.

Some recent studies focused on the effects of olive oil (p. 127) applied to the skin of adults suffering from atopic dermatitis. Olive oil caused a significant reduction in *stratum corneum* integrity and induced a mild erythema. As none of the mentioned skin damaging effects were observed after the application of sunflower oil, it is assumed that a high triglyceride content of oleic acid is responsible for the disruption of the lipid barrier. Oleic acid is known as a skin penetration enhancer that decreases the order of *stratum corneum* lipids. Moreover, oleic acid may replace linoleic acid in acylceramides (linoleic acid is a functional component of acylceramides), resulting in an impaired skin barrier function. Based on the presented findings, the regular long-term use of olive oil and other vegetable oils rich in oleic acid should be discouraged in the care of dry skin, especially in infants. The caution applies to the use of pure oils with a high content of oleic acid, not to the use of oil mixtures and emulsions.

MONOGRAPHS OF VEGETABLE BUTTERS AND OILS

The following pages include descriptions of the most important vegetable butters and oils used as ingredients in (natural) cosmetics. Data on mechanism of action and use are primarily based on the results of scientific *in vitro*, *in vivo* and clinical studies, and on the functions defined in the CosIng database. Unfortunately, reliable studies on the cosmetic use of vegetable butters and oils are very scarce. It is also not possible to directly transfer the *in vitro* effects to effects on our skin; these may only be considered potential effects. In many cases, only data on traditional use is available.

The monographs of vegetable butters and oils place a special emphasis on their composition and characteristics. The fatty acid composition of triglycerides is presented as a proportion of individual fatty acids (in %) and the composition of unsaponifiable matter in mg/kg. The content of individual components is based on the results of scientific research listed in the reference section at the end of the chapter. It is reasonable to expect that the results differ from study to study, as plant metabolism is highly affected by various environmental factors. Oxidative stability has been assessed according to triglyceride composition, i.e. the proportions of saturated and unsaturated fatty acids, and is not based on definite values, as there is no such scientific data available for the majority of vegetable butters and oils for cosmetic use. The vegetable butters and oils described in this chapter were defined as very stable, stable, unstable and very unstable. Additionally, individual vegetable butters and oils have been studied for their chemically related relatives and may be considered as possible substitutes.

The triglyceride composition of a vegetable butter or oil extracted from a specific plant species growing in different locations cannot be completely the same due to different origins. A plant is an integral organism capable of responding to numerous factors. This results in differences in plant metabolism and, ultimately, in differences in the composition of the corresponding plant metabolites. In general, the chemical composition is mainly affected by the soil and the climate, both depending on geographical position. However, other factors are also very important, e.g. weather conditions, time of seed collection, extraction process, etc. Differences in the triglyceride composition are expected to range from 5 to 10%, and rarely more.

The following table presents the main components of vegetable butters and oils: fatty acids, phytosterols, ɣ-oryzanol, phospholipids, terpenoids, lignans, phenols, vitamins and carotenoids, and the most important associated scientifically proven effects observed in *in vitro* and *in vivo* laboratory studies, and after application to the skin or hair.

The most important individual components of vegetable butters and oils, and their scientifically proven properties. [1]The properties apply to the isolated compound. [2]The properties apply to the isolated compound as part of a cosmetic product. [3]The properties apply to the isolated compound as part of a vegetable butter or oil.

Fatty acids*	Properties
Lauric acid (C_{12} : 0)	antimicrobial[1], prevention of protein loss in hair[3]
Palmitoleic acid (C_{16} : 1, ω-7)	antimicrobial[1], skin penetration enhancement[2]
Oleic acid (C_{18} : 1, ω-9)	regenerative[1], skin penetration enhancement[1, 2]
Linoleic acid (C_{18} : 2, ω-6)	anti-inflammatory[1], regenerative[1]
α-Linolenic acid (C_{18} : 3, ω-3)	regenerative[1]
ɣ-Linolenic acid (C_{18} : 3, ω-6)	anti-inflammatory[1]
Punicic acid (C_{18} : 3, ω-5)	antioxidative[1]
Stearidonic acid (C_{18} : 4, ω-3)	anti-inflammatory[1]
Phytosterols	antioxidative[1], photoprotective[2]
ɣ-Oryzanol	antioxidative[1]
Phospholipids (lecithin)	moisturising[2]
Terpenoids (squalene)	antioxidative[1], antitumour[1]
Lignans (sesamin and sesamolin)	antioxidative[1]
Phenols	antioxidative[1]
Vitamin A	antioxidative[1, 2], regenerative[1, 2]
Vitamin E	antioxidative[1, 2]
Vitamin K	decrease of pigmentation[1]
Carotenoids	antioxidative[1], photoprotective[1]

*The number beside the carbon atom (C) indicates the number of carbon atoms comprising the fatty acid chain, while the numbers 0, 1, 2, 3 and 4 following the carbon atoms indicate the number of double bonds in the fatty acid chain.

GENTLY for skin and hair

Every skin or hair, irrespective of the type, may benefit from the use of vegetable butters and oils. This may not, however, be a general rule, as everyone must determine for themselves whether such care meets their needs. At the end of each monograph, useful advice is given on how to prepare skin or hair care mixtures using the presented vegetable butters and oils. As a general rule, follow the recipe of 70 to 80% of a base butter or oil and 20 to 30% of an active oil. In the case of problematic skin, e.g. irritated or inflamed skin, pure active oils may also be used. The base part of an oil mixture may be prepared by combining different butters or oils (the latter should always be oxidatively stable oils). The proportion of butters regulates the consistency of a mixture: a semi-solid mixture contains a larger proportion of a butter. The most popular of the base oils are oils from avocado, babassu, Chilean hazel, coconut, hazelnut, macadamia, marula, moringa, oil palm, olive and white meadowfoam. The active part of a mixture may also be prepared by combining different active oils.

In terms of wider ecological awareness, the use of natural unrefined vegetable butters and oils of organic origin should be encouraged. The refining process is easily recognised by the lack of colour and odour. Refining undoubtedly results in the significantly higher stability of a vegetable butter or oil, while at the same time removing cosmetically active ingredients.

ABYSSINIAN KALE · Abyssinian kale oil

Scientific name: *Crambe hispanica* subsp. *abyssinica* (Hochst. ex R. E. Fr.) Prina
Family: Brassicaceae (mustard family)
Other names: Abyssinian crambe
Plant part: seed
INCI: *Crambe Abyssinica Seed Oil,* CosIng: *hair conditioning, skin conditioning*

Description

Abyssinian kale is a herbaceous annual plant that grows 1 to 1.5 m in height. It is native to the Mediterranean. From there it has spread through Southwest Asia and Western Europe. It grows today in many parts of the world.

Botanical characteristics: stem branched with approximately 30 side stems; inflorescence racemose, flowers numerous, small, white, tetramerous; fruits small, with 1 seed; seeds round, greenish white, 1 to 3 mm in diameter.

Composition and characteristics

Fatty acid	
Palmitic acid (C_{16} : 0)	1%
Oleic acid (C_{18} : 1, ω-9)	15%
Linoleic acid (C_{18} : 2, ω-6)	13%
Arachidic acid (C_{20} : 0)	1%
Gondoic acid (C_{20} : 1, ω-9)	2%
Behenic acid (C_{22} : 0)	2%
Erucic acid (C_{22} : 1, ω-9)	64%
Nervonic acid (C_{24} : 1, ω-9)	1%
Phytosterols	β-sitosterol (52% of total phytosterols)
Vitamin E	137 mg/kg (ɣ-tocopherol: 125 mg/kg)

Abyssinian kale seeds contain approximately 30% oil. The fatty acid composition of triglycerides is defined by a high content of long-chain C_{20-24} fatty acids, i.e. gondoic, behenic, erucic and nervonic acids. Abyssinian kale oil is stable against oxidation. The oil has a light-yellow colour and a weak nutty odour.

Given its fatty acid composition, there is no suitable substitute for Abyssinian kale oil among other vegetable oils. It is classified into a special group of vegetable oils defined by long-chain fatty acids, together with broccoli, meadowfoam and rapeseed oils.

Abyssinian kale oil is considered a natural substitute for synthetic silicones due to its high content of long-chain fatty acids, which are supposed to provide a silky feeling on the skin and hair, as the fatty acid chains slide easily side by side.

Mechanism of action and use

Long-chain fatty acids give Abyssinian kale oil its good slip and spreadability, which makes it a suitable cosmetic ingredient for the cleansing and care of the hair, which in turn should become shiny, easy to comb and manageable. Abyssinian kale oil has good potential for use in decorative cosmetics, particularly in lip products, where slip and spreadability properties are also desired. The oil may also be incorporated into skin care products for its emollient function.

GENTLY for soft and shiny hair

Add some drops of Abyssinian kale oil to your shampoo, mix and wash your hair. You will probably find it manageable.

AÇAI · açai oil

Scientific name: *Euterpe oleracea* Mart.
Family: Arecaceae (palm family)
Plant part: pericarp
INCI: *Euterpe Oleracea Fruit Oil,* CosIng: *skin conditioning*

Description
Açai is a 15 to 25 m tall palm of the Amazon rainforest. Açai fruit is one of the most important export products of the Brazilian food industry. The global trade of açai fruit began flourishing around 2000, although it has been used traditionally for centuries in diet, medicine and cosmetics. Botanical characteristics: leaves pinnate, up to 3 m long; inflorescence dense, racemose, flowers brown or red, pentamerous; fruits botanically termed drupes, round, up to 2 cm in diameter, in bunches of 700 to 900, exocarp thin, dark red or dark blue to almost black, mesocarp fleshy, thin (approximately 1 mm), endocarp hard, 1 cm in diameter, with 1 seed.

Composition and characteristics

Fatty acid	
Palmitic acid (C_{16} : 0)	25%
Palmitoleic acid (C_{16} : 1, ω-7)	5%
Stearic acid (C_{18} : 0)	1%
Oleic acid (C_{18} : 1, ω-9)	52%
Vaccenic acid (C_{18} : 1, ω-7)	5%
Linoleic acid (C_{18} : 2, ω-6)	11%
Phytosterols	3,020 mg/kg (β-sitosterol: 2,410 mg/kg)
Phenols	7,482 mg/kg
Vitamin E	α-tocopherol: 450 mg/kg of fruits

Açai pericarp contains 25 to 50% oil. Approximately 50% of fatty acids in triglycerides are represented by oleic acid followed by palmitic and linoleic acids in descending order. The content of palmitic acid is high for a vegetable oil. Characteristic is the presence of palmitoleic acid, which is only rarely found in vegetable oils. Açai oil is also rich in phenols, particularly phenol acids (i.e. ferulic, *p*-hydroxybenzoic, protocatechuic, syringic and vanillic acids) and procyanidin dimers and trimers, which increase the oil's oxidative stability. It is therefore considered stable against oxidation. Açai oil has a dark-green colour, a distinctive sweetish odour reminiscent of the fruit pulp and is slightly more viscous than a typical vegetable oil.

In terms of its chemical composition, açai oil is considered a unique vegetable oil, and no suitable substitute among other vegetable oils exists. Given its content of palmitoleic acid, açai oil belongs to a special group of vegetable oils, together with avocado, Chilean hazel, macadamia and sea buckthorn oils.

Mechanism of action and use
Açai oil is usually found in cosmetic products for the care of mature skin, as it is supposed to have antioxidative, regenerative and anti-ageing properties expressed by phenols, phytosterols and linoleic acid. Due to its high content of palmitic acid, it is considered a substitute for vegetable butters, however, it gives a more pleasant, lighter, non-oily feeling on the skin. *In vitro* studies have proven its antioxidative activity to be higher than the antioxidative activity of olive oil. The amount of açai oil in a cosmetic product must be carefully planned, as it may leave a strong colouration. In addition, some caution is advised in terms of the long-term daily use due to the high content of oleic acid in açai oil, which may negatively affect the skin's barrier function (p. 50).

GENTLY for mature skin
Given its triglyceride composition, açai oil belongs to the group of base oils, but is usually not used alone due to its strong colour. Combinations with coconut oil or plum oil may create interesting relaxing scents.

ALMOND · almond oil

Scientific name: *Prunus dulcis* (Mill.) D. A. Webb, sweet almond, and *Prunus dulcis* var. *amara* (DC.) Buchheim, bitter almond
Family: Rosaceae (rose family)
Plant part: seed
INCI: *Prunus Amygdalus Dulcis Oil,* CosIng: *skin conditioning*

Description
Almond is a shrub or more typically a tree that grows 4 to 12 m in height. It originates in the regions from India to Asia Minor. It was introduced to the Mediterranean in the times of antiquity and later to North America. Both regions are the leading producers of almond today. Sweet almond bears edible fruit with a sweetish taste, while the fruit of bitter almond is bitter.
Botanical characteristics: bark reddish; leaves dark green, lanceolate, acuminate; flowers with 5 petals, 3 to 5 cm in diameter, pink in bitter almond, white in sweet almond; fruits botanically termed drupes, oblong, up to 6 cm long, exocarp greyish green, pubescent, endocarp hard, with 1 seed.

Composition and characteristics

Fatty acid	
Palmitic acid (C_{16} : 0)	3%
Stearic acid (C_{18} : 0)	2%
Oleic acid (C_{18} : 1, ω-9)	75%
Linoleic acid (C_{18} : 2, ω-6)	20%
Phenols	470 mg/kg
Vitamin E	273 mg/kg (mainly α-tocopherol)

Almond seeds contain approximately 50% oil, which is among the richest sources of oleic acid in triglycerides. Also considerably high is its content of linoleic acid, while saturated palmitic and stearic acids are present in minor amounts. Almond oil is oxidatively unstable. It has a light-yellow colour and a weak, sweetish-nutty odour. It is cold-pressed from bitter as well as sweet almond.

Description

Mafura is a tree that grows to a height of 25 m. It is native to South and Tropical Africa (from Sudan to the Kwa-Zulu Natal province), and the Arabian Peninsula. Its Latin name *Trichilia* means 'in three parts' and refers to a fruit that splits into three segments when ripe.
Botanical characteristics: bark dark green or dark brown; leaves shiny, dark green, elliptic; inflorescence cymose, born from the leaf axilla, flowers light green or yellow, pentamerous; fruits pear-shaped; seeds covered by a scarlet aril.

Composition and characteristics

Fatty acid	
Palmitic acid ($C_{16}:0$)	35%
Stearic acid ($C_{18}:0$)	3%
Oleic acid ($C_{18}:1$, ω-9)	50%
Linoleic acid ($C_{18}:2$, ω-6)	10%
Linolenic acid ($C_{18}:3$)	1%
Terpenoids	no data

Mafura seeds contain approximately 25% butter. The predominant fatty acid in triglycerides is oleic acid, which is unusual for a vegetable butter and results in a softer consistency. Characteristic is its specific composition of unsaponifiable matter, particularly terpenoids, which are represented by a special group of triterpenoids, i.e. limonoids: azadirachtin, nimbin and trichilin A. The melting point is approximately 30°C. Mafura butter is stable against oxidation. It is of light-yellow colour, with a characteristic nutty odour.
Its specific chemical composition makes mafura butter completely unique and no suitable substitute among other vegetable butters exists.

Mechanism of action and use

Mafura butter is particularly suitable for the care of inflamed and acne-prone skin, as it is supposed to have antioxidative, antimicrobial and anti-inflammatory properties due to limonoids. These effects have been demonstrated in *in vitro* studies using isolated compounds. Mafura butter is found as an emollient in moisturising and anti-ageing skin care cosmetic product, and in cleansing products, e.g. hard soaps and shampoos. Some caution is necessary regarding the long-term use of mafura butter due to the potential of oleic acid to reduce the integrity of the *stratum corneum*, especially in infants (p. 50). This only applies to the regular use of pure mafura butter.

GENTLY for hair and skin

Following the folk tradition of African tribes, mafura butter may be used as a moisturising facial or hair mask. It is also believed to have beneficial effects when treating minor skin scratches and burns.

MANGO · mango butter

Scientific name: *Mangifera indica* L.
Family: Anacardiaceae (sumac family)
Plant part: seed
INCI: *Mangifera Indica Seed Oil,*
CosIng: *emollient, skin conditioning*

Description

Mango is a tree that grows up to 40 m in height. It originates from the regions of Bangladesh, Myanmar, India and Indonesia. It is one of the most exploited tropical trees, both in its native regions and in Africa, Australia and South America, where the tree is grown commercially.
Botanical characteristics: bark greyish brown or black; leaves smooth, initially red, but become dark green during growth, lanceolate; inflorescence paniculate, flowers small, greenish white or pink, in groups of 500 to 6,000, petals 5, stamens 5, sepals 5, pubescent; fruits botanically termed drupes, oblong, 8 to 12 cm long, exocarp smooth, greenish yellow or greenish red, mesocarp fleshy, juicy, yellow, endocarp hard, with 1 large seed.

Composition and characteristics

Fatty acid	
Palmitic acid ($C_{16}:0$)	9%
Stearic acid ($C_{18}:0$)	40%
Oleic acid ($C_{18}:1$, ω-9)	41%
Linoleic acid ($C_{18}:2$, ω-6)	7%
Arachidic acid ($C_{20}:0$)	3%
Phytosterols	10,300 mg/kg
Vitamin E	130 mg/kg

Mango seeds contain 9 to 13% butter. Its triglyceride composition is characterised by the balanced proportion of predominant stearic and oleic acids. Another important feature is its content of phytosterols, which may be as high as 7%. The melting point is approximately 35°C. Mango butter is stable against oxidation. It is of yellow or light-brown colour and has a typical sweetish-oily odour.
Given its fatty acid composition, mango butter is most similar to shea butter and is considered its best substitute. However, the consistency of mango butter is slightly more solid and it contains less unsaponifiable matter.

Mango seeds contain up to 50% water and must therefore be quickly dried after harvesting to reduce the water content to approximately 10%. The harvesting period for mango fruit in the countries of southwest Asia, which are the leading producers of mango butter, coincides with the monsoon season. Such demanding climatic conditions make the processing of mango fruit very difficult. Wet seeds are suitable for the extensive development of microorganisms, especially *Aspergillus niger*. Fungus lipases degrade triglyceride molecules into free fatty acids. In unrefined mango butter produced from fresh seeds, the content of free fatty acids was shown to increase from 2 to 7% in 20 days, and to 46% in 120 days.

Mechanism of action and use

Mango butter is used as an emollient ingredient in a variety of cosmetic products, e.g. skin and hair cleansing cosmetics, skin and hair care cosmetics, lip care cosmetics and decorative cosmetics. It is also very popular in products for massage. Due to its high content of phytosterols, it may contribute to antioxidative activity and restore the impaired function of the lipid barrier. *In vivo* laboratory studies with an emulsion containing 25% mango butter have shown accelerated wound healing. Similar effects have been observed with the same emulsion used in volunteers. Scientific literature describes some very rare cases of contact dermatitis caused by the dermal use of mango butter.

It is assumed that the allergic reaction is due to alkylresorcinols, which are present in the fruit's exocarp and endocarp. These compounds are not contained in mango butter of suitable quality.

GENTLY for dry skin

A nourishing facial mask may be prepared by mixing mango butter, baobab oil and a few drops of sea buckthorn oil. The latter will enrich the mixture with vitamin E.

Mechanism of action and use
Plum oil is a less-known cosmetic oil. In terms of its composition and uses, it is closely related to almond, apricot and peach oils. It may therefore be used for many different purposes, e.g. as an emollient ingredient in cosmetic products for skin and hair cleansing and for skin and hair care, and as a massage oil with a characteristic scent. Based on recent scientific findings indicating possible damage to the *stratum corneum*, some caution is advised in terms of the long-term daily use of pure plum oil, particularly in infants (p. 50). These effects have been linked to the high content of oleic acid in triglycerides.

GENTLY for skin and hair cleansing
Using a cyanide-scented shower gel or shampoo certainly sounds a bit strange. Plum oil, however, delivers a pleasant note, which is usually strong enough for perfuming purposes at a concentration of up to 1%. Give it a try.

POMEGRANATE · pomegranate oil

Scientific name: *Punica granatum* L.
Family: Lythraceae (loosestrife family)
Plant part: seed
INCI: *Punica Granatum Seed Oil,* CosIng: *emollient*

Description
Pomegranate is a shrub or a small tree reaching a height of 5 to 8 m. It is mainly cultivated for its delicious fruit and also as a garden plant. In appearance, the pomegranate fruit is reminiscent of an apple. Its interior, however, resembles a spongy structure of cavities separated by white membranes containing numerous seeds. In terms of the latter, the pomegranate has been traditionally worshipped as a symbol of fertility and wealth. The tree originates from Iran, from where it has spread to the Mediterranean, Africa, Southeast Asia, Australia and America.
Botanical characteristics: phyllotaxis opposite-leaved, leaves shiny, elliptic-lanceolate, 3 to 7 cm long, 2 cm wide; flowers with 5 to 8 red petals, calyx red, tubular; fruits yellowish red, 5 to 12 cm in diameter, exocarp leathery, mesocarp fleshy; seeds 200 to 1,400, surrounded by a dark-red juicy aril.

Composition and characteristics

Fatty acid	
Palmitic acid (C_{16} : 0)	3%
Stearic acid (C_{18} : 0)	3%
Oleic acid (C_{18} : 1, ω-9)	7%
Linoleic acid (C_{18} : 2, ω-6)	3%
Punicic acid (C_{18} : 3, ω-5)	80%
Gondoic acid (C_{20} : 1, ω-9)	1%
Phytosterols	5,000 mg/kg (β-sitosterol: 4,000 mg/kg)
17α-Estradiol	3,000 mg/kg
Estrone	17 mg/kg
Phospholipids	3%
Vitamin E	10,000 mg/kg (mainly γ-tocopherol)

Pomegranate seeds contain approximately 20% oil. The triglyceride composition of pomegranate oil is completely unique in the plant world. It is mainly represented by punicic acid, a very rare omega-5 fatty acid that belongs to the group of conjugated linolenic acids. Another important feature of pomegranate oil is the presence of two estrogen hormones, 17α-estradiol and estrone (p. 367). Also exceptionally high is its content of vitamin E. Pomegranate oil is oxidatively very unstable. It is light yellow or golden yellow, with a characteristic sour-oily odour, and is considerably more viscous than a typical vegetable oil.
In terms of its unique chemical composition, pomegranate oil has no suitable substitute among other vegetable oils.

Mechanism of action and use
Interest in pomegranate oil as a dermatological and cosmetically active ingredient has only recently evolved. In contrast to most vegetable butters and oils, it has been studied intensively over the last decade. Laboratory research on skin cell and tissue cultures, both animal and human, has shown its anti-inflammatory, antioxidative, antitumour and photoprotective effects. It has been demonstrated that pomegranate oil improves the regeneration of injured skin, as it stimulates keratinocyte proliferation and the repair of the dermis. It also decreases damaging effects caused by ultraviolet radiation. Pomegranate oil is therefore considered the best choice in the care of demanding mature and stressed skin. It is also recommended in the care of dry and allergy-prone skin, as well as burnt skin and in the care of the skin after sun exposure. Due to its high oxidative instability, pure pomegranate oil should be used in combination with more stable oils or antioxidants.

GENTLY for mature skin
Try a regenerative night oil: mix pomegranate oil with sea buckthorn oil to enrich the mixture with vitamin E. For daily skin care, a combination with babassu oil or shea butter for very dry skin, may result in the desired skin softness.

5

EMOLLIENTS AND OCCLUSIVES

Mojca Lunder, Damjan Janeš, Nina Kočevar Glavač

INTRODUCTION

Lipids are essential for the normal functioning of the skin. They can be divided into cell membrane lipids, intercellular lipids and sebum lipids. Cell membrane lipids are components of cells. The two major classes are phospholipids, which build cell membranes, and cholesterol, which regulates the fluidity of membranes. Intercellular lipids are found among cells of the *stratum corneum*, and they consist of ceramides, cholesterol and free fatty acids. Sebum lipids (sebum is a secretion of sebaceous glands) are composed of diglycerides and triglycerides, free fatty acids, waxes, squalene and cholesterol.

In healthy skin with a normal barrier function, all lipids occur in the correct proportions. The physiological lipid ratio may be impaired due to excessive cleansing of the skin, the use of unsuitable cosmetic products (e.g. skin cleansing products containing aggressive surfactants), frequent contact with organic solvents or chemicals, and environmental factors, such as the cold. Skin with an impaired lipid barrier requires the appropriate care, which will supply the skin's own lipids. Such cosmetic ingredients are known as emollients. These include vegetable butters and oils (p. 47) as sources of triglycerides and essential fatty acids, as well as the skin's other own substances, i.e. ceramides, cholesterol and squalene, which are described in the monographs on the following pages. Emollients also include substances that do not occur naturally in the skin, but are very similar to them, i.e. phytosterols and lecithin. The latter is included in the chapter on emulsifiers (p. 193).

Most emollients also have an occlusive effect. This means that they form a semi-permeable layer on the skin, which reduces or inhibits transepidermal water loss, i.e. the evaporation of water from the skin. This increases skin moisturisation, which is also very important for the skin's normal functioning. Waxes are cosmetic ingredients with a strong occlusive function, and also play the role of lipid thickeners and co-emulsifiers. If the skin is very dehydrated, the occlusive effects of emollients and occlusives are insufficient. The combined use of moisturisers is thus recommended.

The most common occlusives in conventional cosmetic products are petroleum derivatives, e.g. paraffin, liquid paraffin, petroleum jelly and earth 'wax' (ozokerite). Chemically, they are a mixture of alkanes and cannot be used in natural cosmetics.

Waxes are substances that plants and animals produce to protect themselves from environmental influences. In plants, they cover leaves, fruits and seeds, and they protect against microorganisms and repel water. Their role is similar in animals: waxes cover skin, hair, feathers and fur. They also repel water and protect the skin from drying out and from parasites. Vegetable waxes include candelilla, carnauba and jojoba waxes, while animal waxes encompass beeswax, lanolin and spermaceti wax.

Spermaceti wax played an important role in cosmetics in the past. It was extracted from an organ in the head of sperm whales (*Physeter macrocephalus* L.). Its main component is the ester cetyl palmitate. The wax was mistaken for sperm when it was discovered, hence the name spermaceti. Industrial needs nearly led to the extermination of the sperm whale, as the animal was killed to extract whale wax. Sperm whales have been protected since 1981, and whale wax is no longer used in cosmetics. Synthetic cetyl palmitate is available as a substitute (p. 446).

According to their chemical composition, waxes are complex mixtures composed mainly of esters of long-chain fatty acids and long-chain alcohols. A number of other compounds are also found, including free acids and alcohols, hydrocarbons, plant pigments, sterols and triglycerides. Different waxes have different physical characteristics. Beeswax, for example, has a lower melting point than carnauba wax and is mouldable at body temperature, while carnauba wax is brittle.

Chinese and Japanese waxes are traditionally classified as waxes, although they are not really waxes according to their chemical composition. They belong to the group of triglycerides, i.e. vegetable lipids.

CERAMIDES

INCI: *Ceramide 1, 1 A, 2, 3, 4, 5, 6 II, NP,* CosIng: *hair conditioning, skin conditioning*
INCI: *Glucosyl Ceramide*; CosIng: *skin conditioning*

Natural sources
- millet, *Panicum miliaceum* L., Poaceae (grass family): seed
- rice, *Oryza sativa* L., Poaceae (grass family): seed
- soybean, *Glycine max* (L.) Merr. syn. *Glycine soja* (L.) Sieb. et Zucc., Fabaceae (pea family): seed (0.18%)
- wheat, *Triticum aestivum* L. syn. *Triticum vulgare* L., Poaceae (grass family): seed (0.04%)

Characteristics and physiological function
Skin ceramides are amides of sphingosine and ω-hydroxy fatty acids, with the hydroxyl group esterified with linoleic acid. They are colourless wax-like substances that are practically insoluble in water. They are usually available in powder form. They can be isolated from the above mentioned natural sources, but are mostly produced today by synthesis. Ceramides are the main intercellular lipids of the *stratum corneum* and are crucial for the proper organisation of lipid lamellar phases. They are classified in the group of sphingolipids.

8

MOISTURISERS AND HUMECTANTS

Katja Stojilkovski

INTRODUCTION

One of the most important factors for the normal functioning of the skin is the optimum water content in the *stratum corneum*, which is ensured by the skin's natural moisturising factor and intercellular lipids (p. 25). Adverse environmental conditions, e.g. the cold and low relative humidity, contribute to increased water loss from the skin, while frequent cleansing removes the lipids of the epidermis, which play an important role in the maintenance of the skin's barrier function. The skin thus becomes dry, chapped, flaky, less supple and shine-free.

Such skin can be helped by cosmetic products for skin moisturising that increase the skin's water content, simulate the role of the skin's lipids and restore the normal functioning of the lipid barrier. Cosmetic ingredients with these characteristics are called moisturisers.

Compounds found in the skin's natural moisturising factor, e.g. amino acids and their salts, other organic acids and their salts (lactic acid, sodium lactate, pyrrolidone carboxylic acid and sodium pyrrolidone carboxylate), glycerol and urea, are used successfully as moisturisers. Effective moisturising may also be achieved using other compounds that bind water, e.g. glycosaminoglycans (hyaluronic acid) and other polysaccharides (gums and mucilages, p. 200), proteins and peptides (elastin, collagen, and milk, silk and wheat proteins and peptides), sugars (honey and trehalose), polyols (sorbitol), allantoin and ectoin. The cosmetic ingredients listed above are addressed in this chapter.

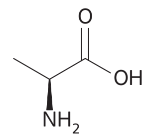
In a strict sense, compounds that bind water are called humectants. At a relative humidity in excess of 80%, they bind water from the air. At a lower humidity, they bind water from deeper layers of the epidermis, which usually results in the further drying of the skin. They are therefore commonly used together with occlusives. Humectants are also important from a technological point of view, as they prevent water evaporation from a cosmetic product and help avoid thickening. Humectants are therefore important as cosmetic ingredients used to retain the water content of cosmetic products.

Emollients and occlusives are also very important moisturising ingredients (p. 173). Emollients replace the skin's naturally occurring lipids and give it a soft and smooth feel, while occlusives form a protective hydrophobic layer that reduces or prevents transepidermal water loss. Some substances, e.g. lanolin and lecithin, act as both emollients and occlusives.

Gelatin also has a moisturising function, and is mainly used to increase the viscosity of cosmetic products. It is thus discussed in the chapter on thickeners (p. 208).

AMINO ACIDS

ALANINE, ASPARAGINE, ASPARTIC ACID, CYSTINE, GLYCINE, GLUTAMIC ACID, GLUTAMINE, HYDROXYPROLINE, HISTIDINE, ISOLEUCINE, LEUCINE, LYSINE, METHIONINE, PHENYLALANINE, PROLINE, SERINE, TAURINE, THREONINE, TRYPTOPHAN, TYROSINE, VALINE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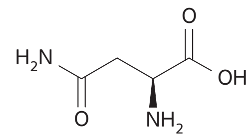
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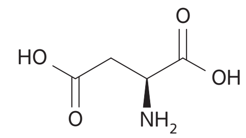
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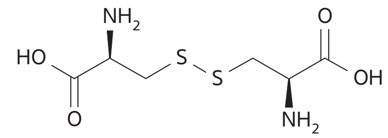
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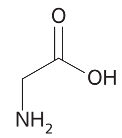
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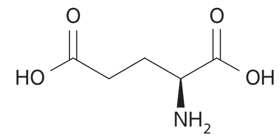
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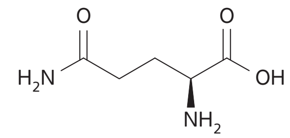
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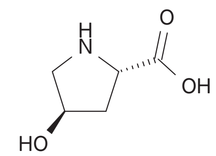
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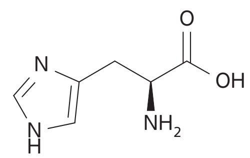
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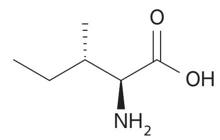
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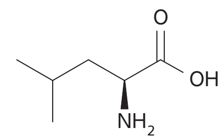
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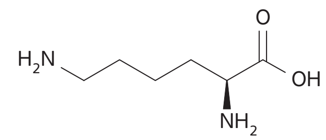
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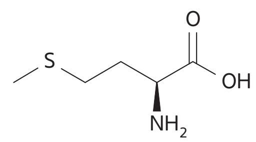
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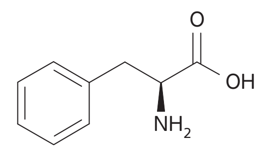
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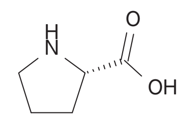
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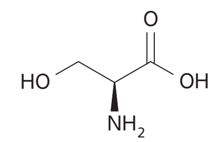
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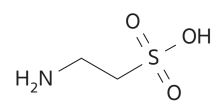
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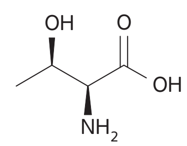
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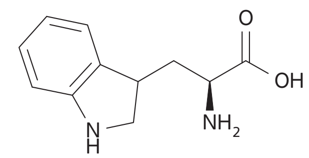
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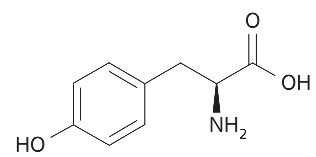
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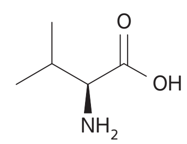

valine

10

ANTIOXIDANTS

Eva Tavčar Benković, Damjan Janeš

INTRODUCTION

Antioxidants are intriguing substances to which almost miraculous effects on human health and beauty have been attributed. It is a well-known and scientifically accepted fact that they reduce oxidative stress. For so many people, however, relieving stress has been perceived as a lifeline in recent years. Finding the most effective antioxidant has also become a major focus of research and marketing. Antioxidants not only slow or diminish the formation of visual signs of ageing, but also boost the immune system and physical performance. As a result, they are sometimes referred to as cosmeceuticals in the cosmetic industry.

The term 'cosmeceutical' is an unofficial expression used to refer to products that contain active pharmaceutical ingredients for use in cosmetics, i.e. cosmetic ingredients with convincing effects on the health of the skin. Such products have been, for the most part, nothing more than a flamboyant advertising approach used by the cosmetic industry, as the promises of miraculous effects usually lack substance.

An antioxidant is any substance that delays, prevents or eliminates the possibility of oxidative damage to a target molecule. To understand the importance of antioxidants for the skin, we must first address oxygen. Oxygen accounts for 20% of the Earth's atmosphere. The largest producers of oxygen are plants, while a small amount is created by the decomposition of water under the effect of ultraviolet radiation. Oxygen is essential for cellular respiration in aerobic organisms. During the process of cellular respiration, energy is converted into a form that can be utilised by an organism, while at the same time creating harmful substances, i.e. free radicals, which are unstable molecules that destroy other molecules. Among them, reactive oxygen species are the most important and include singlet oxygen, superoxide anion, hydroxyl and peroxyl radicals, and peroxynitrite. Free radicals cause damage to DNA, lipids and proteins, and change their structure and function, which leads to (oxidative) ageing and many diseases. The body resists such damage using its own antioxidant systems.

In recent years, the cosmetic industry has also begun offering anti-ageing cosmetic products enriched with pure oxygen, which is supposed to penetrate deeper into the skin and stimulate cell functions. The advertising of such claims is completely unjustified from a scientific point of view. As the largest organ of our body, the skin requires less than 5% of inhaled oxygen and thus has a relatively low blood supply. It should also be emphasised that oxygen cannot penetrate the *stratum corneum.* Applying oxygen to the skin only makes sense as a bleaching agent and as an antimicrobial agent in the form of hydrogen peroxide, and in exceptional circumstances, i.e. to treat necrosis, when it is delivered via the blood through the inhalation of pure oxygen.

Oxidative and antioxidative processes remain in balance at all times in a healthy body. However, the metabolic reactions that occur in the process of cellular respiration are fast, complex and branched reactions that lose control very quickly and cause the excessive formation of free radicals. Oxidative ageing occurs in such conditions and the body experiences oxidative stress, which is seen, for example, in inflammation, overeating and exaggerated physical activity. The formation of free radicals is also influenced by ionising and ultraviolet radiation, ultrasound, the ozone, chemicals and tobacco smoke. The older the body, the less capable it is of combatting free radicals without external help. Thus, the importance of nutrients, vitamins and minerals with antioxidative effects increases.

Chelators also play an important role in preventing the harmful effects of free radicals. Chelators are compounds that bind metal ions into chelate complexes. They are used in cosmetics to prevent the damaging oxidative effects of metal ions, as the latter often play a role in free radical reactions. Antioxidants therefore preserve normal cell functioning, and prevent skin inflammation and skin ageing, making them extremely popular cosmetic ingredients. Nevertheless, overuse is not recommended, as an excess of antioxidants may have the opposite effect (i.e. a prooxidative effect) because such an excess disturbs the redox balance in the body, while an excessive amount of chelators may bind minerals essential for the skin.

An antioxidant usually acts by transferring its electron or hydrogen to a free radical, thus making the latter unreactive. The antioxidant transforms itself into a stable radical that is less aggressive to the environment. Let us look at the example of ascorbic acid (vitamin C). The acid transfers its electron to the oxygen radical and moderates its destructive march, transforming itself into the ascorbyl radical. The latter is restored by the body's own antioxidant, i.e. glutathione. The glutathione radical is then further recovered by lipoic acid. All of the aforementioned compounds act in balance. It is thus important not to consume an individual antioxidant in excess. The exaggerated consumption of ascorbic acid, for example, leads to its reaction with iron ions and acts prooxidatively: a less reactive ferric(III) ion (Fe^{3+}) is reduced itself into a ferrous(II) ion (Fe^{2+}) that triggers free radical reactions. Reactions may therefore take an undesired path in cases of excessive exposure to specific antioxidants. It is thus recommended to ingest exactly the right amounts of antioxidants and diversify. We recommend the use of natural, complex and unprocessed sources of antioxidants, e.g. fresh fruits, vegetables and grains. Beautiful skin comes from the inside.

When incorporating antioxidants into cosmetic products, we have to take into account their chemical characteristics, so that they will perform successfully in the desired area of the skin. Hydrophilic antioxidants act in an aqueous environment and must therefore be dissolved in hydrophilic solvents. They are most frequently incorporated into moisturising skin care products.

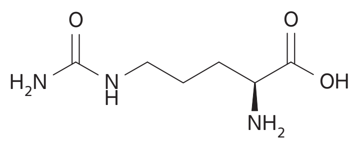
Fatty acids and cholesterol in the cell membrane are subject to lipid peroxidation if exposed to free radicals. This process starts as a chain radical reaction and proceeds in a complex and intertwined system of oxidations. There are three basic mechanisms of lipid peroxidation. Autoxidation occurs under the influence of peroxide radicals or hydrolases, and involves copper and iron ions. It may be successfully prevented by tocopherol (vitamin E). A much faster process is photooxidation triggered by singlet oxygen under the influence of, for example, chlorophyll and riboflavin. Effective quenchers of singlet oxygen are carotenoids, while tocopherols increase their activity. The third form of lipid peroxidation is catalysed by lipoxygenases and is balanced by lipophilic antioxidants.

> Lipid ingredients in cosmetic products, particularly vegetable butters and oils, are very prone to lipid peroxidation. Vegetable butters and oils, and cosmetic products themselves, thus become rancid, resulting in their altered appearance and odour. Antioxidants are thus usually added to extend the oxidative stability of cosmetic products. The use of containers that prevent contact with oxygen and light may also contribute significantly to improved oxidative stability, but is a more expensive approach.

This chapter addresses the activities and chemical characteristics of the most popular antioxidants that have favourable effects on the skin and are primarily used as cosmetically active ingredients due to their antioxidative activity. For improved transparency, they are divided into subchapters according to their chemical structure: amino acids, carotenoids, flavonoids, organic acids, peptides and enzymes, and phenols and quinones. Numerous other compounds also have an antioxidative activity. They are used, for example, as cosmetic colourants (p. 391), sunscreens (p. 373) and vitamins (p. 267), and are discussed in detail in the respective chapters.

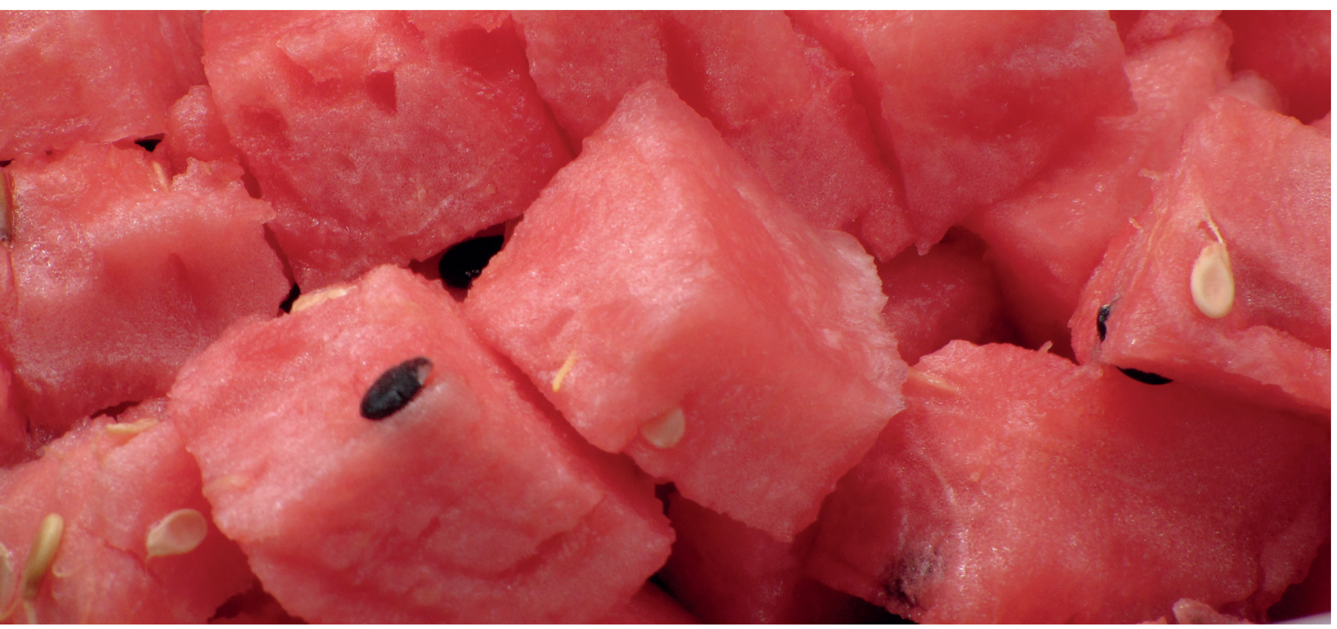
AMINO ACIDS

CITRULLINE



INCI: *Citrulline,* CosIng: *skin conditioning*

Natural source
– wild melon, *Citrullus lanatus* (Thunb.) Matsum. & Nakai, Cucurbitaceae (cucumber family): fruit

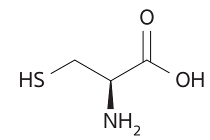


> Japanese scientists were the first to study citrulline. It was isolated from wild melon juice by Koga and Odake in 1914, while Wada discovered the chemical structure of the compound in 1930.

Characteristics and physiological function
Citrulline is a derivative of L-ornithine. Only the L-isomer is found in nature. It forms colourless crystals that are freely soluble in water (20 g in 100 ml). It is usually obtained by synthesis.

Mechanism of action and use
Citrulline acts as an antioxidant and may therefore be used to protect the skin against oxidative stress and to protect cosmetic products against oxidation. It is particularly recommended for incorporation into cosmetic products for sun protection.

CYSTEINE



INCI: *Cysteine,*CosIng: *antioxidant, antistatic, hair conditioning, hair waving or straightening, masking, reducing*

Natural sources
Cysteine may be isolated from hair and bird feathers, but is usually obtained today biotechnologically using *Escherichia coli*.

Characteristics and physiological function
Cysteine is a sulphur-containing essential amino acid. Only the L-isomer is found in living organisms. Cysteine is a basic constituent of structural proteins and enzymes, and it also plays the role of an antioxidant. L-cystine is formed from the oxidation of L-cysteine in the body. Cysteine forms colourless needle-like crystals with an unpleasant odour. It is freely soluble in water (28 g in 100 ml).

Mechanism of action and use
Cysteine is used to protect the skin against oxidative stress and to protect cosmetic products against oxidation. It is also a reducing agent used in the perming of hair instead of ammonium thioglycolate (also known as perm salt), which has an even more unpleasant odour. In the process of perming, disulfide cystine bonds in keratin are converted by thioglycolic acid into thiol residues,

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VITAMINS

Mateja Lumpert

INTRODUCTION

Vitamins are essential micronutrients that cannot be synthesised by our body or cannot be synthesised in quantities sufficient for our physiological needs. Because they are essential for a healthy life, they must be provided for through the proper diet. Vitamins play different roles within cells: they act as cofactors (coenzymes and prosthetic groups) in very important biochemical pathways and protect cell membranes from harmful free radicals. A lack of vitamins leads to medical conditions known as hypovitaminosis and avitaminosis, while hypervitaminosis occurs due to an excess of vitamins, which can also have adverse effects on the skin and body.

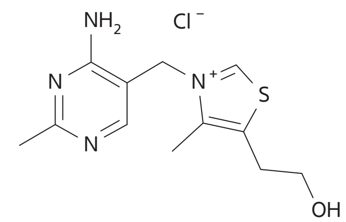
> The term 'vitamin' is a composite of the words *vita* and amine. In Latin, *vita* means life, while amine is the chemical name of the functional group containing nitrogen. The term was first used in 1911 by the Polish biochemist Kazimierz Funk (1884–1967), when he discovered the then unknown amine vitamin B_1. Although most vitamins do not contain an amine group, the name is still used today.

Vitamins vary in solubility in water and lipids, and are therefore divided into hydrophilic and lipophilic vitamins. Hydrophilic vitamins include vitamins B and C, while lipophilic vitamins include vitamins A, D, E and K. Some vitamins have proven cosmetic effects when applied to skin, and are used in cosmetic products as effective cosmetically active ingredients. These include vitamin A and its derivatives, vitamin B_3 (nicotinamide), provitamin B_5 (panthenol), vitamin C (ascorbic acid) and vitamin E (tocopherol). This chapter also presents monographs of other B vitamins that are listed in the CosIng database as cosmetic ingredients for skin and hair conditioning. For a comprehensive understanding of the cosmetic use of vitamins, this chapter also addresses vitamins D and K_1, despite the fact that they are included on the list of substances that are prohibited in cosmetic products in the European Union.

> Manufacturers of cosmetic products are very well aware of how appealing vitamins are for consumers. According to forecasts from industry analysts, the cosmetics market can expect extraordinary growth in the use of vitamins over the next few years. As cosmetically active ingredients, they are particularly popular in cosmetic products for the care of mature skin (i.e. anti-ageing cosmetic products) and in cosmetic products for sun protection. The most important among them is vitamin E. We must be aware, however, that the quantities of vitamins in cosmetic products are frequently far too low to see the promised effects on the skin. Unfortunately, natural cosmetics are no exception in this regard.

HYDROPHILIC VITAMINS

VITAMIN B_1



thiamine chloride

Other names: aneurin, thiamine
INCI: *Thiamine HCl,* CosIng: *masking, skin conditioning*

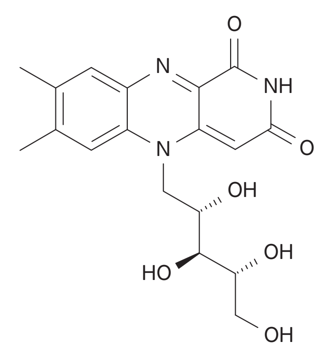
Natural sources
– cereals

> Vitamin B_1 is the first known water-soluble vitamin. It was discovered on the basis of observations made by the Dutch physician Christiaan Eijkman (1858–1930), for which he received the Nobel Prize for physiology in 1929. He observed the phenomenon of neurological disorders caused by the long-term consumption of food, in a diet of predominantly peeled and polished rice. Vitamin B_1 in its impure form was first isolated from rice bran in 1911 by the Polish biochemist Kazimierz Funk (1884–1967). In 1926 it was extracted in its pure form by two Dutch scientists: the chemist Barend Coenraad Petrus Jansen (1884–1962) and the physiologist Willem Frederik Donath (1889–1957).

Characteristics and physiological function
The biologically active form of vitamin B_1 is thiamine pyrophosphate, which plays an important role in the metabolism of carbohydrates. However, thiamine chloride is the form of vitamin B_1 that is used most frequently. It forms colourless crystals that are freely soluble in water (50 g in 100 ml). It is sensitive to temperature, especially in alkaline solutions. It is usually obtained by synthesis.

Mechanism of action and use
Vitamin B_1 is mainly used as a skin conditioning ingredient. There are, however, no scientific data regarding its effects on the skin.

VITAMIN B_2



Other names: E101, riboflavin
INCI: *Lactoflavin,* CosIng: *cosmetic colorant, hair dyeing*
INCI: *Riboflavin,* CosIng: *cosmetic colorant, skin conditioning*

Natural sources
– eggs, yeast, milk, cheese, wheat bran and soy

Vitamin A cannot be produced by the human body, and must therefore be obtained through dietary intake. A rich natural source of retinol is fish oil, while an indirect source of retinol or retinal is β-carotene, which is hydrolysed in the intestines into two molecules of retinal. Thus, β-carotene is also called provitamin A. The liver of a polar bear may contain such high concentrations of retinoids that its consumption may be fatal.

According to their activity, retinoids are classified as follows: retinoic acid > retinal > retinol > retinyl esters; but the exact opposite according to their tolerance. Retinoic acid is the most active, but also the most irritating to the skin, causing erythema and exfoliation of the *stratum corneum*. The effects of other retinoids depend on metabolism, as metabolites that are structurally closer to retinoic acid have a higher activity, but are more irritating to the skin. In the European Union, retinoic acid is on the list of substances that are prohibited in cosmetic products, and may only be used under dermatological control. Retinol and its esters (retinyl palmitate and retinyl propanoate) and retinal are used in cosmetic products.

Mechanism of action and use

RETINOIC ACID

Retinoic acid is used in dermatology for the dermal treatment of acne. It also improves signs of skin damage due to exposure to the sun (photoageing), e.g. small and distinct wrinkles and hyperpigmentation. Significant irritation and dryness of the skin are the main side effects of the treatment with retinoic acid, and thus limit its broader use.

RETINAL

Retinal is rapidly metabolised in epidermal cells when applied to the skin. The majority is converted to retinol and retinyl esters, while a lesser amount is oxidised into retinoic acid. Of all the retinoids for dermal use, retinal may be the most effective in supplying the skin with retinol and its esters, which represent a storage form. Retinal is a precursor of retinoic acid, and does not bind to nuclear retinoid receptors. It can be used to achieve the controlled delivery of retinoic acid to the skin and thus better tolerance. It is well-tolerated by the skin because it is less irritating than retinoic acid. The antibacterial effect of retinal has been demonstrated *in vitro* and *in vivo*. Retinal is not commonly used in cosmetic products. It is, however, effective against photoageing, as it improves the appearance of fine and deep wrinkles, hyperpigmentation and roughness of facial skin. It is used to treat acne in dermatology.

RETINOL AND RETINYL ESTERS

The effects of retinol and its esters depend on local conversion into retinoic acid. Retinyl palmitate, retinyl acetate and retinyl propanoate hydrolyse into retinol under the influence of esterases in the skin, while retinol oxidises via retinal into retinoic acid. A slow metabolism ensures the controlled delivery of retinoic acid, but also results in a modest effect. Retinol is less effective than retinoic acid. In order to achieve similar effects to those of retinoic acid, the concentration of retinol must be approximately ten times higher. Retinol and its esters cause less skin irritation than retinoic acid and are used in appropriate concentrations as cosmetically active ingredients. The use of retinol on the skin increases the thickness of the epidermis and stimulates the formation of collagen and glycosaminoglycans, which retain moisture in the skin. Retinol also normalises the keratinisation of the skin. It is used to reduce facial wrinkles, improve skin elasticity and maintain a youthful appearance. Cosmetic products with retinol are therefore suitable for the care of dry and mature skin. Retinol is very unstable, as it is sensitive to oxygen and ultraviolet light. As a cosmetically active ingredient, it is only effective in the appropriate concentration and in the appropriate packaging of a cosmetic product, which should have as little contact with light and air as possible (e.g. opaque containers with a small opening or airless push containers). These conditions are, in fact, met by very few cosmetic products. Retinyl esters are more stable than retinol, and are therefore found more frequently in cosmetic products. Retinol concentrations of up to 0.3%, and retinyl ester concentrations of up to 0.55% are recommended in cosmetic products for skin care. Higher concentrations irritate the skin and are not suitable for cosmetic use.

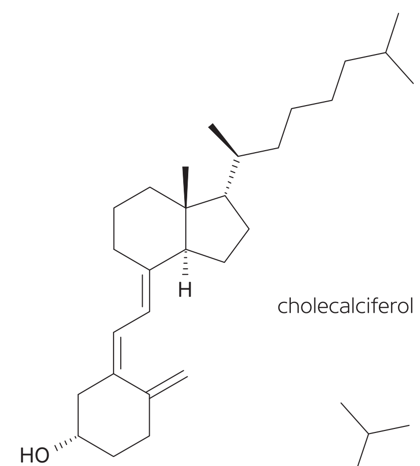
The excessive intake of vitamin A causes hypervitaminosis A, which leads to bone problems and has teratogenic effects. The most important source of vitamin A is diet, followed by food supplements and cosmetics. The risks associated with the use of vitamin A in cosmetic products have been assessed in Norway. If the intake of vitamin A through food is high, the dermal application of vitamin A in cosmetic products further enhances overall exposure to vitamin A. The contribution to this effect by cosmetics is particularly problematic in women of childbearing potential, as over-exposure to vitamin A before and during pregnancy increases the risk of damage to the embryo. Individuals with low bone mineral density and osteoporosis are also at risk, especially post-menopausal women. The absorption of vitamin A is also increased in damaged skin, e.g. in people with atopic dermatitis and dry skin, and in young children with irritated skin in the diaper area.

VITAMIN D

VITAMIN D_3 (CHOLECALCIFEROL)

Cholecalciferol is not included in the CosIng database.

Natural sources
– eggs, liver and oily fish

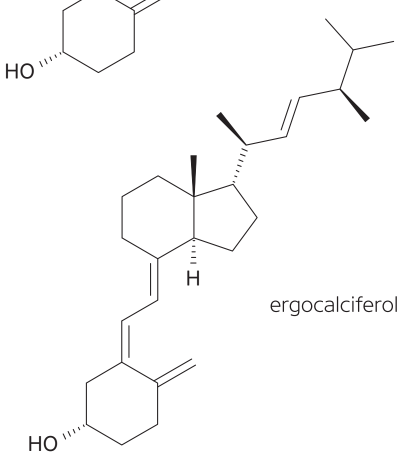


cholecalciferol

VITAMIN D_2 (ERGOCALCIFEROL)

Ergocalciferol is not included in the CosIng database.

Natural sources
– yeast and plants



ergocalciferol

Vitamin D was discovered in fish oil in 1922 by the American biochemist Elmer McCollum (1879–1967). It was later discovered that vitamin D is produced in the human body under the effect of ultraviolet light. If that definition is strictly applied, it should not be classified in the group of vitamins. The amount of vitamin D required by the body can be obtained through the exposure of the skin of the face or hands to sunlight for five to ten minutes.

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MODERN COSMETICS
CREATED BY

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Dr. Nina Kočevar Glavač and Dr. Damjan Janeš, Editors

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