SKIN CARE

SENSORIAL

Wheat germ oil

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Wheat germ oil

BOTANY

Triticum vulgare Vill. (= *Triticum aestivum subsp. aestivum.*, *T. sativum* Lamk., *T. durum* Desf., *T. hybernum* L., *T. turgidum* L.) belongs to the Poaceae family, also known as Graminiae. It is a perennial herbaceous plant. The stems are simple and hollow. The leaves are distich, enveloping, with parallelodromous leaf blades, membranous ligule and small and pilose auricles. The inflorescence is a panicle or a spike made of spikelets. The flower is reduced to three stamens and a pseudo-monomer gynoecium.

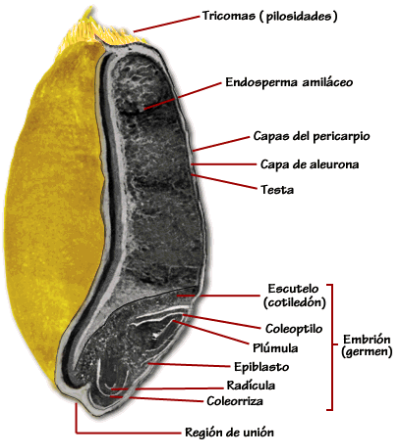

Figure 1 shows a longitudinal section of a wheat caryopsis.

The fruit is a caryopsis – dry indehiscent monospermous fruit, with a narrow pericarp welded to the seminal tegument. The embryo is small, basilar and exterior to the albumen.

The seed is oval shaped, somewhat flattened at one end with a brush of short hairs at the other and a deep crease along its whole length. The embryo or germ is situated at the more flattened end. It is made up of the coleorhiza, the radicle, the plumula, the coleoptile and the scutellum or cotyledon. The embryo leaves, which are collectively called the plumule, are covered by the coleoptile. The radicle is enveloped by the coleorhiza. The scutellum, which constitutes a large part of the embryo, is found in close contact with the amylase endosperm; the latter, which occupies most of the seed (70-80% of the grain), is the source for obtaining wheat flour.

Wheat is cultivated all over the world, from just outside the Article circle to near the Equator, although the harvest is most productive between 30º and 60º latitude north and between 27º and 40º latitude south. The altitudes where it can grow vary from the sea level to 3,050 m in Kenya and 4,570 m in Tibet. It is adaptable to diverse conditions, from xerophytic to the conditions at the coasts. Wheat prospers in sub-tropical, mild temperate and moderately cold climates. The most suitable is one with an annual rainfall of 229-762 mm, more abundant in the spring than in the summer. The average temperature in summer has to be 13°C (56°F) or more.

Translation: *Tricomas (pilosidades)* : trichomes (hairs), *Endosperma amilaceo*: amylase endosperm; *Capas del pericarpio*: pericarp layers; *Capa aleurona*: aleurone layer; *Testa*: testa; *Embión (germen)*: embryo (germ); *Escutelo (cotiledón)*: scutellum (cotyledon); *Coleoptilo*: coleoptile; *Plumula*: plumule; *Epiblasto*: epiblast; *Radícula*: radicle; *Coleorriza*: coleorhiza; *Región de unión*: point of attachment).

The principal wheat producers of the world are China, India, United States, Russia, France and Canada, in that order.

Wheat germ oil is obtained from wheat germ.

CHEMISTRY

Wheat germ oil mainly contains lipids and liposoluble vitamins.

Lipids

Wheat lipids (triglycerides, lecithins, sterids) are mostly stored in the germ. The lipid content of wheat flour varies between 1.5 and 2.5% depending on the extraction index of the flour. A portion of these (25%) is composed of lipids linked to the starch of wheat flour, consisting of non-polar lipids (6%), glycolipids (5%) and phospholipids (89%). The remaining 75% of the lipids are not linked to starch and consist of the same components in different proportions: non-polar lipids (59%), glycolipids (26%) and phospholipids (15%). The most abundant fatty acid is linoleic acid (55%), followed by oleic and palmitic acids (Belitz HD. & Grosch W., 1997).

The average fatty acids composition of wheat germ oil is:

Acid	% weight
Palmitic acid (16:0)	11-17
Stearic acid (18:0)	0.6-3.6
Oleic acid (18:1)	14-25
Linoleic acid (18:2)	49-59
Linolenic acid (18:3)	4-10

Table 1. Average fatty acids composition. Fat content in wheat germ: 8-11% weight (Belitz & Grosch, 1997).

Also ceramides and glycoceramides can be extracted from wheat. Ceramides are sphingosines N-acylated with a fatty acid. Vegetal ceramides like those of wheat offer an alternative to animal ceramides (Bruneton J., 2001). Ceramides are abundant in the skin.

Liposoluble vitamins

The oils produced from cereals germ are the main source of tocopherols (Belitz HD. & Grosch W., 1997).

Wheat germ oil is rich in vitamin E. The name vitamin E includes a family of tocopherols – molecules that consist of a chromanol nucleus and a saturated lateral chain of 16 carbons. The number and location of the methyl groups in the chromanol nucleus define the different forms of tocopherol: α, β, and δ (Carreras M., 2000). The antioxidant activity of the tocopherols in the series increases α→δ, opposite to the vitamin activity and the rate of reaction with peroxide radicals (Belitz HD. & Grosch W., 1997).

Tocopherol	mg/100g
α-T	133.0
α-T-3	<2.6
B-T	71.0
B-T-3	18.1
γ-T	26.0
γ-T-3	-
δ-T	27.1
δ-T-3	-

Table 2. Tocopherols and tocotrienols of wheat germ oil. Average composition expressed as mg/100g (Belitz HD. & Grosch W., 1997).

TRADITIONAL USES

There is no doubt that with the cultivation of Poaceae – in Neolithic times- agriculture was born. Every one of the great human populations linked its destiny to a main cereal. Even today cereals supply 80% of the calories required by humans (Bruneton J., 2001). Man established the Western civilisation bases when wheat was domesticated. No civilisation has been founded at any time with an agricultural base other than cereals. The ancient cultures of Babylon, Egypt, Rome and Greece, and later those of the north and west of Europe, were all based on the cultivation of wheat, barley, rye and oats. The populations of India, China and Japan had rice as their basic crop. The pre-Columbus populations of America -Incas, Mayas and Aztecs- cultivated corn to make their bread. The grains of wheat not only have the embryo, but also possess the reservoir necessary for its development during the first stages of its life. For this reason a grain of wheat contains the five types of nutrients: carbohydrates, proteins, fats, minerals and vitamins. Man discovered this fact a long time ago and learned to benefit from it. The cultivation of cereals has always appeared to be accompanied by a stable way of life. Also, it obliged men to be more aware of the seasons and the movements of the sun, the

moon and the stars. In the Old World as well as in the New World astronomy was developed by cereal cultivators, and a calendar and an arithmetic system arose along. Since the agriculture of cereals secured a stable supply of food, it facilitated leisure, and leisure in turn promoted the arts, trades and sciences. It has been said that cereal agriculture is unique among the ways of food production in that it obliges, recompenses and stimulates work and inventiveness all to a same degree.

Use of wheat in popular medicine (preparation, administration and uses):

- Topical. Skin desquamation; the bran is boiled and applied over the skin with soaked cloths for problems of skin desquamation.
- Mixed with milk for breakfast. Orally administered. It is used as a vitamin “to stay young” and to treat constipation.
- “Wheat germ oil pearls”, which are now sold as such. It is used as a source of vitamins for women and to regulate menstruation.

In popular medicine it is used as an antiphlogistic, anti-catarrhal, demulcent, wound ointment, antiseptic, stimulant for the circulation, anti-rheumatic, anti-venom, etc. In pharmacy it is used as an agglutinant for the preparation of pills and tablets. Wheat germ oil is used for heart and circulation disorders, and in weakness and exhaustion situations. It contains vegetable fibre, gluten, cellulose and starch.

COSMETIC PROPERTIES

Conditioning activity

The cosmetic industry uses ceramides for their capacity to prevent or to slow down skin ageing (Bruneton J., 2001),

Ceramides make up a large part of the horny layer of the skin. They are widely used as protectors of the skin integrity and restorers of its moisturizing levels. It has been shown that people with damaged skin

structure and with a tendency for irritant dermatitis have low levels of ceramides in the horny layer. Skin ageing is associated with a decrease in the activity of sphingomyelinase, an enzyme required for the production of ceramides.

It is known that different lipid substances may inhibit serine proteases such as the leukocyte proteinase, pancreatic elastase and plasmin. Specifically, it has been demonstrated that the human neutrophil elastase (HNE) has an hydrophobic region near its active-site, which gives this molecule a strongly hydrophobic character. Thus, the HNE may be inhibited by long chain fatty acids and their derivatives. On this basis, it was postulated that the ceramides present in plants may inhibit the HNE enzymes and therefore reduce those extracellular matrix alterations that are catalized by HNE. Bizot-Foulon V. et al (1995) carried out a series of studies to demonstrate the capacity of wheat ceramides to inhibit HNE. They extracted isolated and characterized the wheat ceramides. The main fatty acids that they found were 16:0, 18:1, 18:2 in the proportions 19%, 12% and 53% respectively of the total non-glycosilated ceramides (CER) and glycosilated ceramides (gly-CER-). When they used a synthetic specific substrate, the necessary concentration to reduce the HNE activity to 50% was 33 µg ml^{-1} for CER and 41 µg ml^{-1} for gly-CER. When insoluble elastin was used as a physiological substrate CER and gly-CER showed similar HNE inhibition levels (differently from other HNE inhibitors, which are less efficient on natural substrates). Wheat ceramides also protected the elastic fibbers from degradation by HNE in *ex vivo* studies.

It is also known that a reduction of the essential fatty acids level results in the thickening of the epidermis, a hyperplastic and irregular basal layer and a thick dense stratum corneum. Fatty acids deficiency causes deterioration of the epidermal barrier function and consequently, an important water loss through the stratum corneum (Ranson W., 1993). Thus, local applications of these acids also contribute to restore and preserve the integrity of the skin.

The moisturizing activity of ceramides is also reinforced by the vitamin E content of wheat germ oil. Topic applications of vitamin E have moisturizing and soothing effects on skin, not only exerting occlusive effects, as it happens with Vaseline, but also with amplified efficacy on repeated applications. Emulsions containing vitamin E also improve the conditions of the skin surface (Erlemann G., 1988).

Antioxidant activity

The antioxidant activity of wheat germ oil is due to its vitamin E content. The antioxidant activity of vitamin E is based on its actual antioxidant action and its anti-radical action.

- Antioxidant action: reduction in the formation of lipoperoxides in the skin. The cell membrane is rich in highly unsaturated phospholipids. The oxidation of these phospholipids, due to endogenous as well as exogenous factors, produces lipoperoxides, which destabilise the cell membrane and cause ageing of the skin.

- Anti-radical action: protect the cells from the free radicals released by the lipoperoxides and are involved in ageing of the skin.

Un producto de reacción de los lipoperóxidos es el malonil dialdehido (MDA). El MDA se interpone entre las fibras de colágeno del tejido conectivo reduciendo la elasticidad de la piel y contribuyendo de esta manera a su envejecimiento. El MDA es fácilmente detectable mediante métodos analíticos. Se indujo la formación de lipoperóxidos y de radicales libres por irradiación con UV-B (290-320 nm). Después de la irradiación pudo comprobarse un claro aumento del MDA en la piel. Entonces se realizó un experimento donde ratones lampiños fueron tratados antes de la irradiación con UV-B con una solución de acetato de vitamina E al 5%. Se observó una disminución de entre el 40-80% de la formación del MDA. Estos resultados demuestran que la vitamina E frena la formación de lipoperóxidos en la piel (Erlemann G., 1988).

Malonyldialdehyde (MDA) is a reaction product of lipoperoxides. MDA intervenes between the collagen fibres of the connective tissue reducing the elasticity of the skin and, in this way, contributing to its ageing. MDA is easily detectable with analytical methods. The formation of lipoperoxides and free radicals was induced by irradiation with UV-B (290-320 nm). After irradiation a clear increase in the MDA levels of the skin could be demonstrated. In a subsequent experiment, hairless mice were treated with a 5% solution of vitamin E acetate, before UV-B irradiation. A decrease in the formation of MDA of between 40-80% was observed. These results showed that vitamin E stopped the formation of lipoperoxides in the skin (Erlemann G., 1988).

It has been demonstrated that the absorption of vitamin E is very high at the topical level. A high amount of topically applied vitamin E has been found in the stratum corneum of the skin as well as in its deeper layers. It has also been shown that this vitamin is directly absorbed by the hair cortex (Idson B., 1993).

Thus, wheat germ oil is well recommended when formulating cosmetic products for protecting the skin and hair from oxidative processes.

Photo-protection activity

Skin exposure to UV radiation markedly impairs its antioxidant "arsenal" and significantly increases oxygen free radicals, which are partly responsible for cell alterations and photo-induced immunosuppression. Additionally, human skin chronically exposed to the sun shows an increase in lipid peroxidation. The activity of different derivatives of vitamin E against the production of free radicals induced by pheomelanin irradiated with UV light has been demonstrated. By the way of an example, 0.5% of vitamin E acetate causes a 23.9% reduction in the production of free radicals. The activity against these free radicals induced by UV radiation will boost the protective capacity of sun filters not only against erythema, but also against immunosuppression (Carreras M., 2000).

Therefore, Wheat germ oil is well recommended when formulating cosmetics aimed at protecting the skin and hair from the damages produced by sun radiation.

Anti-inflammatory activity

The neutrophil elastase is a serine protease with marked specificity for the extracellular matrix molecules, which plays an important role in the inflammatory processes and the consequent alterations of the connective tissue constituents. Ceramides are good anti-inflammatory agents because they can inhibit this elastase; thus, the extracellular matrix is protected against degradation by leukocyte proteinases (Bizot-Foulon V., 1995).

It has also been demonstrated that patients with dermatitis have low tissular levels of all of the poly-unsaturated derivatives of linoleic acid. Different clinical tests demonstrated that local applications of linoleic acid (as well as its poly-unsaturated derivatives) soothes the skin and reduces the trans-epidermal

water loss (Wright S., 1991). Conti A. et al. (1995) as well as Jiménez-Arnau A. (1997) also verified these properties of linoleic acid.

Skolnik P. et al. (1977) carried out a study, where they demonstrated in three cases that local applications of linoleic acid reversed the effects of essential fatty acids deficiency (EFA) produced by chronic EFA malabsorption, and increased the epidermal levels of this acid.

The anti-inflammatory activities of ceramides and linoleic acid are strengthened by the vitamin E present in wheat germ oil. An experiment was carried out, in which a 2% α-tocopherol cream was applied to rabbits for seven consecutive days. After the termination of this treatment, croton oil was applied to induce irritation in that area. It was observed that the degree of inflammation, the magnitude of the lesion and the duration of the dermatitis in the vitamin E-pretreated rabbits were significantly reduced as compared with those of control rabbits (Idson B., 1993).

The anti-inflammatory activity is a consequence of its activity against the formation of lipoperoxides, since this prevents the synthesis of the inflammation mediator prostaglandins from arachidonic acid, so that local applications show anti-oedema and anti-erythema effects (Carreras M., 2000).

Thus, Wheat germ oil is recommended to formulate products aimed at the care of sensitive or irritated skin.

Microcirculation stimulant activity

This activity of wheat germ oil is due to its vitamin E content.

As a consequence of the protective activity of vitamin E on the membrane lipids at the blood vessels level, skin circulation is improved, which allows for a better supply of nutrients to the skin and makes the elimination of the catabolites resulting from skin metabolism easier. This effect is especially important when the nutrients supply from blood has decreased, as, for example, in the course of skin ageing or when nutrients are more necessary, such as for the prevention of stretch marks during pregnancy (Carreras M., 2000).

One effect of the microcirculation stimulant action of vitamin E is its anti-hair loss activity. Vitamin E exerts an accelerator effect on the venous and arterial microcirculation. Microcirculation is accelerated because this vitamin helps recovering the movement of blood vessels, thus facilitating their decongestion. Vitamin E plays a key role in the prevention of hair loss by stimulating the microcirculation of the scalp and the recovery of dystrophic cells in the hair bulb (Idson B., 1990).

It has been shown that the presence of lipids of sebaceous origin, such as those obtained in alopecia areas, as well as non-alopecia areas, inhibit hair growth *in vitro*. Vitamin E not only prevents the hair growth inhibition induced by lipids of sebaceous origin, but also has a direct, dose dependent, stimulant effect on it. These results, on their own, clearly justify the inclusion of vitamin E in anti-hair loss formulas, in shampoos and lotions, independent of the hair type, dry or greasy; they are intended for (Carreras M., 2000).

COSMETIC APPLICATIONS

Action	Active	Cosmetic Application
Skin/hair conditioning	Linoleic acid Ceramides Vitamin E	Moisturizing Firming Soothing
Antioxidant	Vitamin E	Anti-aging Hair colour protection -Photo-protection
Anti-inflammatory	Linoleic acid Ceramides Vitamin E	Sensitive/irritated skin -Photo-protection
Stimulant of capillary microcirculation	Vitamin E	Anti-aging Prevents stretch marks Anti-hair loss

RECOMMENDED DOSE

The recommended dose is between 0.5% and 5.0%.

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