Turmeric

BOTANY

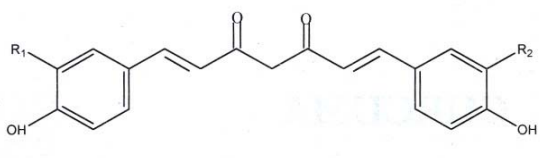
Curcuma longa L. (= *Curcuma domestica* Val; *Amomum curcuma* jacq; *Stissera curcuma* Raevsch.). It is an herbaceous perennial plant, belonging to the Zingiberaceous family. It has a large oval rhizome with sessile cylindrical tubers, orange coloured inside. Its leaves start from the rhizome, are elliptical and can reach up to 1.2 m in length. Its flowers are yellow, between 10 to 15 cm in length and they group together in dense spikes, which appear from the end of spring until the middle of summer. No fruits are known for this plant.
The Curcuma genus contains around 30 species. The plant originates from India and South-East Asia. It was introduced later in America (West Indies) and in temperate regions in Europe. It grows in rich, humid and clayey soils. It is cultivated in the majority of tropical countries such as India, China, Pakistan, Sri Lanka and Indonesia.

Turmeric extract is obtained from the rhizome of *Curcuma longa*.

CHEMISTRY

Curcuminoids

Curcuminoids are between 2 and 9%. Their main components are: curcumin (60%), desmethoxycurcumin, monodemethoxycurcumin, bisdemethoxycurcumin, dihydrocurcumin and cyclocurcumin. Curcumins oxidation yields vanillin.



	R1	R2
curcumina	OCH3	OCH3
desmetoxicurcumina	H	OCH3
bisdesmetoxicurcumina	H	H

Fig.1. Structure of the main curcuminoids of turmeric (Alonso J., 2004). Curcumina: curcumin; Desmetoxicurcumina: desmethoxycurcumin; Bisdesmetoxicurcumina: bisdesmethoxycurcumin).

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Essential oils
They are about 1.5 and 5.5% of the composition. These essential oils consist of a 60% of the sesquiterpene lactone turmerone. They also contain zingiberene (25%), α- and γ-atlantone, bisabolene, guaiane, germacrene, 1,8-cineole, borneol, δ-sabinene, caprilic acid, dehydroturmerone, 1-phenyl-HO-N-pentane, limonene, linalol, eugenol, curcumenol, curcumenone, curlone and phelandrene.

Other active principles
Turmeric extract is rich in carbohydrates, especially in starch (45-55%). It also contains arabinogalactans (ukonans), potassium salt and resins.

TRADITIONAL USES

In ancient times turmeric was much appreciated for its nutritional value as well as the ginger. It was mentioned in the Atharva Veda of India and in ancient Sanskrit writings. In China it is mentioned in the Pent-sao of the VII century and in Arab countries it is mentioned from the X century. However, its use began to decline in the Middle Ages. Dioscorides in the year 77 called it Cyperus, although in the XVI century it was given other names: Crocus indicus, turmerack and currently, curcuma, which is derived from the Arabic kurkum and from the Hebrew karkom which means «yellow». The term longa refers to the elongated shape of its rhizome. The fact that it is a domestic plant led the botanist, Valeton, to coin the name Curcuma domestica. The English name turmeric is taken from Sanskrit and means «yellow», in reference to the colour which comes from the coloured substances of the rhizome, and with which the Hindus dyed their clothes for ceremonial acts: births, marriages or deaths. The Peruvian name «palillo» in reality is an abbreviation of palo amarillo (yellow stick), a name given to those plants, which can stain in that colour. The Buddhist monks still use to stain their tunics with this species.

Turmeric is traditionally used a lot in the Middle East as a liver protector, a stimulant of bile duct secretions, anti-flatulent, diuretic, for curing catarrh, aphrodisiac, anti-parasite, for the circulation, anti-fever and anti-inflammatory. In extreme cases, it is used for healing and disinfection of wounds (even in purulent opthalmopathies) and for rheumatism or sprains. The boiled extract of the rhizome is used for these purposes. Some Hindu women apply or rub the turmeric rhizome on the skin to prevent or reduce hair growth. In the north-east of Brazil they usually draw a circle around the eyes of children who suffered from measles, to prevent them from contracting conjunctivitis. In the French West Indies the boiled extract is used to prevent scurvy and in the island of Guadeloupe as an antidote against poisoning by the tree, manzanillo-Hippomane mancinella. In Haiti they prepare the extract of the rhizome with salt to treat jaundice.
Nowadays it is used as a food, being the main constituent of curry, medicine and colouring.

COSMETIC PROPERTIES

Turmeric extract – rich in curcuminoids – is widely known for its anti-inflammatory, anti-oxidant and anti-microbial properties, among others.
The action mechanism of curcumin may be considered multicentric since it acts as a prostaglandin inhibitor, stabilizer of the liposomal membranes, inhibitor of the activity of leucotrienes and thromboxane B4 without affecting the synthesis of prostacyclins, stimulator of adrenal steroidogenesis, substance P depletor in nerve terminals (similarly to cayenne) and antioxidant (Alonso J., 2004; Srimal RC., 1997).

Anti-inflammatory activity
Inflammation is the starting point in the skin ageing process. An inflamed area is in reality, a micro-wound, which, stimulated by certain environmental factors (ultra-violet rays, contamination, etc.), progresses to a wrinkle or skin imperfection. The inflammation also affects the skin pigmentation.

Several types of inflammation mediator agents, for example leukotrienes, prostaglandins, cytokines and growth factors may accelerate melanogenesis due to their stimulant action on the proliferation and functioning of melanocytes (Prakash L. & Majeed S., 2003).

Curcumin showed anti-inflammatory properties in animal models by inhibiting the activity of the enzymes cycloxygenase-2 and lipoxygenase as well as the enzyme nitric oxide synthase (Alonso J., 2004).

Curcumin showed anti-inflammatory activity in mice and rats acute, sub-acute and chronic inflammation models. When acute oedema was induced in mice by using carrageenan, it was found that the effective dose (ED_{50}) of orally administered (p.o.) curcumin was 100.2 mg/kg while that of cortisone was 78 mg/kg. In rats, the ED_{50} was 48 mg/kg for curcumin, while it was 45 mg/kg for cortisone and 48 mg/kg for phenylbutazone.

In the cotton pellet-induced sub-acute inflammation and granuloma tests carried out with rats, a curcumin dose range of 80-160 mg/kg p.o. inhibited the granuloma formation in 14-30% during 7-14 days. Additionally, curcumin produced no gastric irritation or effects on the cardiovascular or the central nervous systems. Sodium curcuminate and turmeric essential oil were also effective anti-inflammatory agents. The ED_{50} of intra-peritoneal (i.p.) sodium curcuminate on carrageenan-induced acute oedema was 0.36 mg/kg. Compare with the 47.8% oedema inhibition produced by a dose of 10 mg/kg hydrocortisone (Srimal RC., 1997).

Some studies demonstrated that the turmeric volatile oils (0.1 ml/kg per day, orally administered) suppress acute oedema. The action of these essential oils has been attributed to their capacity to stimulate the adrenohypophyseal axis because they were found ineffective in adrenalectomized animals. Additionally, turmeric essential oils have been observed to inhibit the trypsin and hyaluronidase enzymes (Ammon H. & Wahl M., 1991).

Curcumin is an excellent anti-inflammatory agent. *In vitro* assays indicate that curcumin inhibits the arachidonic acid-induced mouse ear oedema (Pons Ll., 2003).

A double-blind study involving 18 rheumatoid arthritis patients revealed that the administration of 1200 daily mg of curcumin resulted in anti-inflammatory effects equivalent to those observed for a group that received 300 daily mg of phenylbutazone. It was shown that local injections in the areas affected with arthritis were more effective than oral administration. Another similar double-blind versus placebo experiment demonstrated that the administration of curcumin (450 mg 3 times a day) to 13 patients with post-surgery pelvic inflammation resolved the pain and oedema symptoms in a similar way to 300 daily mg of phenylbutazone. Among the action mechanisms, they mentioned the inhibition of lysosomal enzymes (acid phosphatase and cathepsin D) as well as the inhibition of lipid peroxidation, a process that Blake catalogued in 1989 as one of the ways in which rheumatoid arthritis is produced. For cases of arthritis and tendinitis in humans, clinical studies have demonstrated the beneficial effects of taking capsules containing turmeric rhizome extracts at doses of one or two 500mg capsules three times a day (Alonso J., 2004).

Thus, the use of turmeric extract is highly recommended when formulating a wide spectrum of cosmetic products such as anti-ageing cosmetics, depigmenting, sun protectors, and cosmetic products aimed at the care of sensitive and/or irritated skins.

Antioxidant activity

It is known that the damages caused by oxidation in the different cellular components are one of the main causes of many diseases, including ageing (Osawa T., 1994).

Curcumin has a free radical scavenger activity, especially on the hydroxyl radical, which explains its capacity to protect DNA from damage in human cell cultures exposed to radiation. *In vitro* studies have demonstrated its capacity to block the activity of the cyclooxygenase and lipooxygenase enzymes. Topical applications of curcumin on the skin of mice increase the glutathione level and the glutathione S-transferase activity, while at the same time, inhibits lipid peroxidation in the skin tissue. The local application of turmeric extract has a recognised antioxidant and anti-inflammatory activity. It is more efficient than vitamin E as an anti-radical agent and as an inhibitor of lipid peroxidation (Prakash L. & Majeed S., 2003).

Local applications of curcumin may noticeably inhibit the ODC (ornithine decarboxylase) activity induced by simultaneous UVA radiation and TPA (tetradecanoylphorbol acetate) application on mouse epidermis. It is accepted that such activity of curcumin may be due to its capacity to scavenge free radicals or to interrupt the activation of protein kinase C (Pons Ll., 2003).

In rats with ethanol-induced brain damage, curcumin exerted protective effects, which were mainly due to its antioxidant activity resulting form the increased glutathione levels and decreased lipid peroxidation in neuronal membranes. Additionally, certain curcuminoids present in the rhizome: curcumin, demethoxycurcumin and bisdemethoxycurcumin protected *in vitro* human umbilical cord endothelial cells and rat pheochromocytome cells against the entry of beta-amyloid, a substance that induces oxidative stress and is involved in the neuronal deterioration observed in Alzheimer. It was demonstrated that the water and ethanol extracts of turmeric rhizomes inhibit the oxidation of erythrocyte membranes and hepatic microsomes of rabbits undergoing an atherogenic diet (Alonso J., 2004).

Osawa T. (1994) isolated an hydrogenated derivative of curcumin, tetrahydrocurcumin. This molecule has a strong antioxidant action because its structure includes a phenol group and a β-diketone. Prakash L. & Majeed S., (2003) also reported the relationship between molecular structure and activity of tetrahydrocurcuminoids.

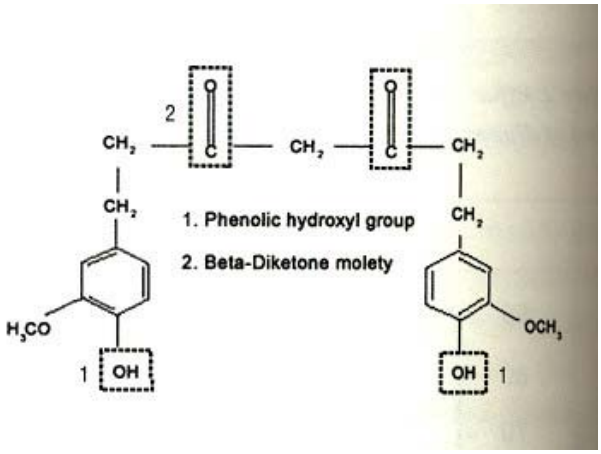

Fig.2. Relationship between molecular structure and biological activity of tetrahydrocurcuminoids (curcuminoids derivatives) (Prakash L. & Majeed S., 2003).

Thus, the antioxidant activity of turmeric extract makes it highly recommendable when formulating cosmetic products destined to protect the skin and hair from oxidative processes.

Photo-protector activity

This action is due to its antioxidant activity. 25% of the lipids of the surface of the skin are unsaturated, and therefore, are easily attacked by free radicals. The ultraviolet rays of the sun penetrate the skin and accelerate the damage caused by these radicals. Prolonged exposure to these radiations means that the collagen and elastin fibres, responsible for the elasticity and integrity of the skin, may be degraded by inherent enzymes, thus causing deterioration in the texture of the skin. In laboratory studies, extract of turmeric was shown to be effective in suppressing inflammation and protecting the epidermal cells from the damages caused by ultraviolet B radiation (Prakash L. & Majeed S., 2003).

Curcumin, in small doses, has been shown to have the capacity to protect against chromosomal damage caused by gamma radiation. Curcumin has also been shown to inhibit the mutagenic induction effect of UV rays (Alonso J., 2004).

Also, a higher activation against sun exposure has been observed with curcumin, which would make it suitable as a coadjuvant in skin diseases such as psoriasis (Alonso J., 2004).

Investigations indicate that curcumin has very diverse actions on the skin, the majority of which can be interpreted as photo-protection. For all these reasons, the extract of turmeric has an interesting application as protection from the damages caused by solar radiation on the human skin (Pons Ll., 2003).

Antimicrobial activity
It has been shown that curcumin *in vitro* is highly toxic to *Salmonella* sp. but not to *Escherichia coli*. The water, alcohol and ethanol extracts of turmeric rhizome have a moderate inhibitory activity on a *Staphylococcus* sp. and *Escherichia coli*. Other *in vitro* studies evidenced that the essential oil has a weak inhibitory activity on *Staphylococcus aureus*, *S.epidermidis*, *Proteus vulgaris* and *Aspergillus fumigatus.* As anti-protozoa agents, curcumin and bisdemethoxycurcumin showed moderate *in vitro* activity against *Plasmodium falciparum* and *Leshmania major*. The water and ether extracts of turmeric showed repellent effects on the insect species *Aedes aegypti*, *Rhizopertha dominica*, *Sitophilus oryzae*, *Spodeptera litura* and *Tribolium castaneum*, antifungal effects against *Helminthosporium* sp., *Pyricularia oryzae*, *Rhizoctonia solani*, *Sclerotium oryzae* and *Sclerotium rolfsii*, and nematicide effects against *Meloidogyne incognita*. Turmeric essential oil showed repellent effects on the mosquitoes *Aedes aegypti*, *Anopheles dirus* and *Culex quinquefasciatus*. Such repellent activity is strengthened by the addition of 5% vanillin. The hexane extract of turmeric rhizome inhibited the growth of the fungi *Piedraia hortae*, *Trichophyton mentagrophytes* and *Microsporum cannis*. It also inhibited *Aspergillus* sp. A preliminary study carried out in India with 814 patients with scabies demonstrated the efficacy of local applications of a turmeric rhizome paste, which did not produce toxic or adverse effects (Alonso J., 2004).

The anti-bacterial *in vitro* activity of the turmeric alcohol extract, curcumin and its essential oils against Gram-positive bacteria is well known. Significant anti-fungal activity has also been described. Turmeric essential oils have demonstrated anti-fungal activity on being applied topically on guinea pigs and *in vitro* tests against different isolated pathogens (Srimal RC., 1997).

Thus, the antimicrobial action of turmeric extract makes it a very recommendable component when formulating cosmetic products with antiseptic activity as well as cosmetic products with an insect repellent function.

Inhibitory activity on tyrosinase
Turmeric extract showed efficient inhibition of the enzyme tyrosinase. This enzyme initiates the melanogenesis process. Turmeric extract showed better efficacy than the best known depigmenting agent , the kojic acid (Prakash L. & Majeed S., 2003).

Therefore, turmeric extract should be taken into account when formulating depigmenting cosmetic products.

Wound healing activity
The topical administration of curcumin extracts on skin wounds on the skin of diabetic rats demonstrated an improvement in the wound healing process. The reparation action mechanism involved an increase in the levels of beta transforming growth factor plus an increase in the activity of the enzyme nitric oxide synthase (Alonso J., 2004).

The wound-healing activity of turmeric has been widely studied and it has been seen that its local application is effective. In Chinese medicine it has been used for this purpose since ancient times (Srimal RC., 1997).

This action makes turmeric extract a good ingredient when formulating cosmetics with regeneration activity.

COSMETIC APPLICATIONS

Action	Active	Cosmetic Application
Anti-inflammatory	Curcumin Sodium curcuminate Essential oils	-Anti-ageing -Photo-protection -Depigmenting -Sensitive/irritated skin
Antioxidant	Curcumin	- Anti-ageing - Photo-protection
Anti-microbial	Curcumin Essential oils	-Antiseptic -Repellent
Tyrosinase inhibitor	Curcumin	-Depigmenting
Wound healing	Curcumin	-Regeneration

RECOMMENDED DOSE

The recommended dosage is between 0.5% and 5.0%.

BIBLIOGRAPHY

Alonso, Jorge. Tratado de Fitofármacos y Nutracéuticos. Barcelona: Corpus, 2004; p:395-403 (633.8 ALO).
Ammon H. & Wahl M. Pharmacology of Curcuma longa. Planta Med., 1991; 57: 1-7 (ref.557).
Bruneton J. Farmacognosia. Zaragoza: Ed. Acribia, 2001; p:294-96 (651*1 BRU).
Council of Europe. Natural sources of flavourings. Germany: Council of Europe Publishing, 2000; p:161-62 (633.82 BAU).
Osawa T. Plant Antioxidants: Protective Role Against Oxygen Radical Species. C&T, 1994; 109 (10): 77-81 (ref.1115).
Pons Ll. Fotoprotección vegetal (II). OFFARM, 2003; 22: 163-64 (ref.6567).
Prakash L. & Majeed S. Multifunctional Ingredients: The Novel Face of Natural. C&T, 2003; 118 (11): 41-47 (ref.6303).
Ross I. Medicinal Plants of the World. Totowa (New Jersey): Humana Press, 1999; p:139-53 (633.8 ROS).
Srimal RC. Turmeric: a brief review of medicinal properties. Fitoterapia, 1997; 68 (6): 483-94 (ref.2503).

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www.fitoterapia.net
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