

RESEARCH

USES OF ALGAE IN THE CONTEXT OF PROBLEMS OF THE ENVIRONMENT AND OF PUBLIC HEALTH

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7th part

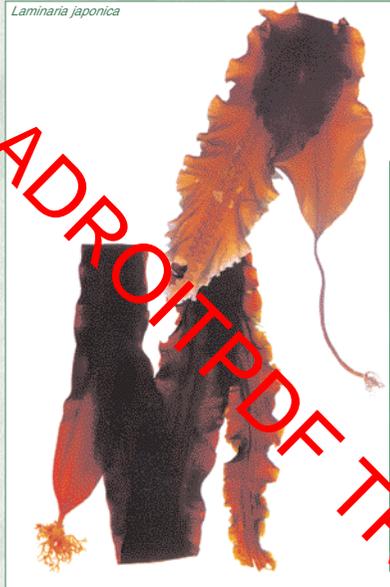
ELEMENTS OF ALGAL COSMETICS

Algae are a source of raw materials of growing interest in the cosmetic sector. Phycocolloids, including alginic acid and the alginates obtained from brown algae (Pheophyceae, mainly Laminariaceae, Lessoniaceae, Durvillales and Fucoaceae) and the others obtained from red algae (Rhodophyceae), in particular from Gigartinales (from which carrageenans are derived) and from Gelidiales, Gracilariaceae and Ceramiales (from which agar is obtained), are included in the composition of cosmetics especially due to their rheological, binding and stabilizing properties. In the form of extracts, various algae, in association with other substances and natural extracts help give the finished products functional properties for the skin.

Law no. 713 of 11th October 1986, which regulates cosmetic products, does not contain specific references to the use of algae. Phycocolloids (shown according to the INCI nomenclature: agar, algin, alginic acid, ammonium alginate, calcium alginate, carrageenan, glyceryl alginate, potassium alginate, propylene glycol alginate) are only mentioned in Section One of the European Inventory of cosmetic ingredients (CE, 1996) together with a limited number of extracts derived from specific algal species (Chondrus crispus, Euglena gracilis, Fucus crispus, Fucus vesiculosus, Macrocystis pyrifera, Spirulina maxima). In the case of other algal extracts, the use is declared on the label of the end product with the general INCI name of Algae. In Section Two of the same Inventory, which lists the aromatizing and/or perfuming substances that are not specifically shown on the label, but which are indicated under the general name of "fragrance" or "aroma", the only algal products listed are extracts of Fucus crispus and Fucus vesiculosus. Information was given about this in Table 4 in Part Five of this series of articles.

There exists a revision completed by the Scientific Committee of cosmetic products and non-food products intended for consumers of the European Union (SCCNFP, 2000 a,b) of this Inventory, which although obsolete is still in force. Reference has been made here to this new text to give a more suitable view of the current use of algae in

Laminaria japonica



Ulva pertusa



cosmetics: thus all the algal products in it have been included in Table 1 below which, compared to Table 4 of Part Five, includes a greater number of algal ingredients, which are also better defined in their name and function.

In defining here below the functions mentioned in Table 1, the algal ingredients which have the same function have been grouped together:

- Binding encourages cohesion in cosmetics: Agar, Algin, Alginic acid, Ammonium alginate.
- Emulsion stabilising helps the process of emulsion and improves stability and shelf-life: Potassium undecylenoyl alginate, Potassium undecylenoyl carrageenan, Sodium/TEA-undecylenoyl alginate, Sodium/TEA-undecylenoyl carrageenan.
- Film forming produces, when it is spread,

a continuous film on the skin, hair and nails: Ammonium alginate.

- Gel forming gives the consistency of a gel (semi-solid and supple preparation) to the liquid preparation: Ahnfeltia concinna extract, Euglena gracilis polysaccharide.
- Hair conditioning makes the hair easy to comb, removes tangles, makes hair soft, glossy, lightweight, shiny and gives body: Potassium undecylenoyl alginate, Potassium undecylenoyl carrageenan, Sodium/TEA-undecylenoyl alginate, Sodium/TEA-undecylenoyl carrageenan.
- Humectant helps retain moisture: Algae.
- Perfume and aromatic raw materials are those listed in Section Two of the Inventory, i.e. those which are not indicated on the cosmetic labels except with the general wording of "aroma" or "fragrance": Fucus crispus thalle extract, Fucus crispus thalle

Table 1. Ingredients of algal origin in the first revision of the European Inventory of cosmetic products (SCCNFP, 2000 a.b)

INCI NAME 1	CAS EINECS/ELINCS	CHEM/UPAC NAME OR DESCRIPTION	FUNCTION
Agar	9002-18-0 232-658-1	Agar	Binding / viscosity controlling
Ahnfeltia concinna extract	223749-75-5	is an extract of the algae, <i>Ahnfeltia concinna</i> , Phylloporaceae	Skin protecting / gel forming
Algae			Tonic / refreshing / soothing / humectant
Algin	9005-38-3	Alginic acid, sodium salt	Binding / viscosity controlling
Alginic acid	9005-32-7 232-680-1	Alginic acid	Binding / viscosity controlling
Ammonium alginate	9005-34-9	Alginic acid, ammonium salt	Binding / film forming / viscosity controlling
Caulerpa taxifolia extract	223749-77-7	is an extract of the algae, <i>Caulerpa taxifolia</i> , Caulerpaceae	Skin protecting
Chlorella emersonii extract	223749-78-8	is an extract of the algae, <i>Chlorella emersonii</i> , Oocystaceae	Skin conditioning
Chlorella ferment		is an extract of the product resulting from the fermentation of <i>Chlorella</i> by yeast	Skin conditioning
Chlorella pyrenoidosa extract	223749-81-3	is an extract of the plant, <i>Chlorella pyrenoidosa</i> , Oocystaceae	Skin conditioning
Chlorella vulgaris extract	223749-83-5	is an extract of the algae, <i>Chlorella vulgaris</i> , Oocystaceae	Skin conditioning
Chondrus crispus extract	244023-79-8	is an extract of the algae, <i>Chondrus crispus</i> , Gigartineaceae	Viscosity controlling
Corallina officinalis extract	89997-92-2 289-730-0	is an extract of the algae, <i>Corallina officinalis</i> , Corallinaceae	Skin conditioning
Delesseria sanguinea extract	223749-86-8	is an extract of the algae, <i>Delesseria sanguinea</i> , Delesseriaceae	Skin conditioning
Digenea simplex extract	90027-98-8 289-785-0	Digenea simplex extract in an extract of <i>Digenea simplex</i> , Rhodomelaceae	Skin conditioning
Durvillea antarctica extract	223749-87-9	is an extract of the algae, <i>Durvillea antarctica</i> , Durvilleaceae	Skin protecting
Enteromorpha compressa extract	223749-88-0	is an extract of the thallus of the algae, <i>Enteromorpha compressa</i> , Ulvaceae	Skin protecting
Euglena gracilis polysaccharide		is the biosynthesized product obtained from cells of the alga, <i>Euglena gracilis</i> , Euglenidae	Gel forming / viscosity controlling
Fucus crispus thalle extract	95009-46-4 305-775-1	Extract obtained from the dried thalle of the algae, <i>Fucus crispus</i> , Fucaeeae	Perfume and aromatic raw materials
Fucus crispus thalle oil	95009-46-4 305-775-1	Essential oil obtained from the dried thalle of the algae, <i>Fucus crispus</i> , Fucaeeae	Perfume and aromatic raw materials
Fucus vesiculosus thalle extract	84696-13-9 283-633-7	Extract obtained from the dried thalle of the bladderwrach algae, <i>Fucus vesiculosus</i> , Fucaeeae	Perfume and aromatic raw materials
Fucus vesiculosus thalle oil	84696-13-9 283-633-7	Essential oil obtained from the dried thalle of the bladderwrach algae, <i>Fucus vesiculosus</i> , Fucaeeae	Perfume and aromatic raw materials
Gelidiella acerosa extract	223749-81-1	is an extract of the red algae, <i>Gelidiella acerosa</i> , Gelidiaceae	Skin protecting

oil, *Fucus vesiculosus* thalle extract, *Fucus vesiculosus* thalle oil.
 - Refreshing gives a pleasant freshness to the skin: Algae.
 - Skin conditioning keeps the skin in good condition: *Chlorella emersonii* extract, *Chlorella ferment*, *Chlorella pyrenoidosa* extract, *Chlorella vulgaris* extract, *Corallina officinalis* extract, *Delesseria sanguinea* extract, *Digenea simplex*.
 - Skin protecting helps avoid the harmful effects on the surface of the skin caused by external factors: *Ahnfeltia concinna* extract, *Caulerpa taxifolia* extract, *Durvillea antarctica* extract, *Enteromorpha compressa* extract, *Gelidiella acerosa* extract, *Gelidium cartilagineum* extract, *Gigartina stellata* extract, *Himanthalia elongata* extract, *Hypnea musciformis* extract, *Lactobacillus/algae ferment*, *Laminaria cloustoni* extract, *Laminaria digitata* extract, *Laminaria hyperborea* extract, *Laminaria japonica* extract, *Laminaria ocharina* extract, *Lithothamnium calcareum* extract, *Pelvetia canaliculata* extract, *Porphyra umbilicalis* extract, *Porphyridium cruentum* extract, *Porphyridium/zinc ferment*, *Ulva lactuca* extract, *Undaria pinnatifida* extract.
 - Soothing tends to make the surface of the skin smooth, reducing roughness and irregularities: Algae.
 - Tonic produces a sensation of well-being on the skin and hair: Algae.
 - Viscosity controlling increases or decreases the viscosity of the cosmetics: Agar, Algin, Alginic acid, Ammonium alginate, *Chondrus crispus* extract, *Euglena gracilis* polysaccharide, *Macrocystis pyrifera* extract.
 There are fundamentally two reasons for the use of algal ingredients in cosmetics:
A – to produce natural "rheological modifiers", i.e. those substances that due to their gel forming, viscosity and thixotropic controlling properties are used technologically "to form gels of aqueous and oily systems, to increase the consistency of dispersions and emulsions, to control the viscosity of solutions or suspensions, to disperse bodies (for example, pigments) with a high specific weight by modifying Newtonian systems into pseudoplastic or thixotropic systems and, in general, altering the rheological characteristics of monophasic or bi-phasic fluid systems" (Proserpio, 2000). The rheological modifiers belong to various categories of chemical products, including "natural biopolymers"; these include: - vegetal exudates (acacia or gum arabic, karaja gum, gum tragacanth, gum ghatti); - extracts from seeds (gum guar, carob gum, pectin, starch and derivatives); - extracts from leaves and flowers (aloe, althaea, mallow, calendula, plantain); - products of animal origin (casein, gelatine); - products of marine origin (from brown algae: alginic acid and arginates; from red algae: carrageenans and agar).
B – due to the conferment of particular

Gelidiella acerosa extract	223749-81-1	is an extract of the red algae, <i>Gelidiella acerosa</i> , Gelidiaceae	Skin protecting
Gelidium cartilagineum extract	94945-01-4 305-680-5	is an extract of the algae, <i>Gelidium cartilagineum</i> , Gelidiaceae	Skin protecting
Gigartina stellata extract	223751-69-7	is an extract of the thallus of the algae, <i>Gigartina stellata</i> , Gigartineaceae	Skin protecting
Himanthalia elongata extract	223751-70-0	is an extract of the thallus of the algae, <i>Himanthalia elongata</i> , Himanthaliaceae	Skin protecting
Hypnea musciformis extract	223751-71-1	is an extract of the algae, <i>Hypnea musciformis</i> , Hypneaceae	Skin protecting
Lactobacillus/algae ferment		Product obtained by the fermentation of algae extract by lactobacillus	Skin protecting
Laminaria cloustoni extract	90046-11-0 289-979-5	is an extract of the algae, <i>Laminaria cloustoni</i> , Laminariaceae	Skin protecting
Laminaria digitata extract	90046-12-1 289-980-0	is an extract of the algae, <i>Laminaria digitata</i> , Laminariaceae	Skin protecting
Laminaria hyperborea extract	90046-13-2 289-981-6	is an extract of the algae, <i>Laminaria hyperborea</i> , Laminariaceae	Skin protecting
Laminaria japonica extract	223751-72-2	is an extract of the algae, <i>Laminaria japonica</i> , Laminariaceae	Skin protecting
Laminaria saccharina extract	90046-14-3 289-982-1	is an extract of the algae, <i>Laminaria saccharina</i> , Laminariaceae	Skin protecting
Lithothamnium calcareum extract	223751-73-3	is an extract of the algae of <i>Lithothamnium calcareum</i> , Corallinaceae	Skin protecting
Macrocystis pyrifera extract		is an extract of the kelp, <i>Macrocystis pyrifera</i> , Phaeophytae	Viscosity controlling
Pelvetia canaliculata extract	2223751-75-5	is an extract of the algae, <i>Pelvetia canaliculata</i> , Fucaeeae	Skin protecting
Porphyra umbilicalis extract	223751-76-6	is an extract of the algae, <i>Porphyra umbilicalis</i> , Rhodophyceae	Skin protecting
Porphyridium cruentum extract	22375-77-7	is an extract of <i>Porphyridium cruentum</i> , Algae	Skin protecting
Porphyridium/zinc ferment		Extract of the fermentation product of porphyridium in the presence of zinc ions	Skin protecting
Potassium undecylenoyl alginate	224580-88-5	Alginic acid, reaction products with 10-undecylenoyl chloride, potassium salts	Emulsion stabilising / hair conditioning
Potassium undecylenoyl carrageenan	224580-89-6	Carrageenan, reaction products with 10-undecylenoyl chloride, potassium salts	Emulsion stabilising / hair conditioning
Sodium/TEA-undecylenoyl alginate	224580-93-2	Alginic acid, 10-undecylenoyl derivatives, sodium tris(2-hydroxyethyl)amine salts	Emulsion stabilising / hair conditioning
Sodium/TEA-undecylenoyl carrageenan	224580-91-0	Carrageenan, 10-undecylenoyl derivatives, sodium tris(2-hydroxyethyl)amine salts	Emulsion stabilising / hair conditioning
Ulva lactuca extract	97281-59-9 306-561-0	is an extract of the algae, <i>Ulva lactuca</i> , Ulvaceae	Skin protecting
Undaria pinnatifida extract	223751-81-3	is an extract of the algae, <i>Undaria pinnatifida</i> , Alariaceae	Skin protecting

dermo-cosmetological effects, mainly regarding the moisturizing function, the stimulating activity of biological functions, the anti-inflammatory action, anti-ageing, anti-wrinkles and prevention of damage caused by free radicals. This is linked to the fact that algae are an extraordinary source of biologically active ingredients: polysaccharides (predominant in brown algae and in red algae), amino acids (especially proline, glycine, lysine, in close analogy with the composition of the structural protein of the dermis), proteins (the highest content is in blue and green microalgae), minerals (in progressively decreasing percentages from brown algae, about 30 %, to red and green algae, about 20 %, and freshwater microalgae, about 10 %; the highest mineral content is in Lithothamnium calcareum, 99 %), vitamins, lipids, carotenoids, phospholipid and volatile substances.
 Proserpio (2000) also claims the film-forming properties on the skin and hair of the rheological modifiers (A) made up of hydrocolloids extracted from brown and red algae. The following information also comes from the same source. Alginates appear in the formulation of lotions, emulsions, gels, shaving foams, toothpaste and shampoo. The arginate gels are excellent vehicles of softening hydrophilic substances. The viscosity controlling and O/W emulsion stabilising doses are between 0.5 % and 1 %. The cosmetic uses of carrageenans are to control viscosity, suspend and stabilise, especially O/W emulsions in shaving creams, lotions, creams for the face and hands, beauty masks and toothpaste. Agar has been used in the formulation of gels for the hands and in some products for eye make-up. Patri, together with the viscosity controlling properties of these rheological modifiers also shows the protective effects on the skin and mucous (Proserpio, 2000). Poggi (2001) indicates them as essential vehicles of active ingredients and therefore of great use in clinical dermatology.
 As far as the topical effects that can be attributed to algal extracts are concerned (B), Proserpio (2000) only gives general indications in the case of marine oak or *Fucus vesiculosus* (softening and anticellulite).
 From the works of Bartoli (1999) and Poggi (2001 and 2002), on the other hand, there is a more promising view of the positive dermo-cosmetological properties of algal extracts of greater interest. A brief synthesis is given here, supplementing the data of these authors with information from other sources.
 Algae as cosmetic ingredients are used mainly in the form of glycolic extracts. Some types are available on the market, of which Indena Phytéliènes' claim specific cosmetological functionalities and are also described according to the formulating methods of certain categories of cosmetics. These are the glycolic extracts of *Laminaria digitata* L., *Laminaria saccharina* Lamx, *Undaria pin-*

¹ CAS, Chemical Abstracts Service Number; EINECS, European Inventory of Existing Commercial Chemical Substances Number; ELINCS, European List of Notified Chemical Substances, Number.

natifida, *Fucus vesiculosus* L., *Ascophyllum nodosum*, *Himanthalia elongata*, *Palmaria palmata* and *Spirulina maxima*.

LAMINARIA DIGITATA, LAMINARIA SACCHARINA, UNDARIA PINNATIFOLIA

Laminaria digitata appears during the spring tides. It is currently the most widely used algae in France. Its wealth of mineral salts, trace elements and vitamins is mainly at the basis of cosmetic applications (Indena, EG 483).

A marked sebum-regulating activity is referred by Bartoli (1999). Extract of *Laminaria* appears to be the best sebum-regulator, both for the skin and for the hair: treatment of 7-8 days is sufficient to notice a significant reduction of sebum. The same author also refers a delivery system of active ingredients, revitalizing for the epidermis and depurative in the treatment of cellulite, of a brown-coloured extract (called CLM2) with a high viscosity and neutral pH (5.4 – 6.6), obtained from *Laminaria digitata* and *Laminaria saccharina* (mineral salts 5 %; iodine 800 - 2000 mg/L; magnesium 500 - 800 mg/L).

The skin protective action against environmental pollutants (cigarette smoke, heavy metals, pesticides), the anti-inflammatory and protective activity of Lagerhans cells from UV rays, the blocking activity of free radicals and UV protective action have been associated with the various fractions of an oligosaccharide extracted from *Laminaria digitata*, obtained at various degrees of hydrolysis (Bennet and Vallee, 2001): respectively the fraction with the greatest molecular weight (20,000 D), the fraction with the molecular weight equal to 3500 D and that with the lowest molecular weight (below 3500 D). The glycolic extract of *Laminaria digitata* (Phytélènes® of *Laminaria* Thallus EG 483), appears as a clear liquid (propylene glycol: 47.5 – 52.5 %), light yellow in colour, with a characteristic odour, soluble in water and alcohol at 60 % v/v (pH: 5.5 – 7.0; relative density at 20°C: 1.040 – 1.045; dry residue: 0.60 – 1.20 %; heavy metals: ≤ 5 ppm). It is suitable for local adiposity, to stimulate the synthesis of the constituents of the connective tissue and to give the skin tone. They are recommended for facial care in moisturizing creams (1 – 3 %), anti-wrinkle and anti-ageing creams (3 – 7 %), after-sun products (3 – 5 %), revitalizing and anti-ageing serums (5 – 10 %) and for the body in bath products and soaps (5 %).

Laminaria saccharina is thus called due to the sugars which crystallize on its external parts when it dries. Its properties are strictly linked to those of *Laminaria digitata*, but it differs due to the thicker structure and due to the organoleptic characteristics, including its sweet taste. The glycolic

extract (Phytélènes® of Neptune Kelp Thallus EG 752) appears as a clear liquid (propylene glycol: 47.5 – 52.5 %), bright yellow in colour, soluble in water and alcohol at 60 % v/v (pH: 6.0 – 7.0; relative density at 20°C: 1.035 – 1.045; dry residue: 0.60 – 1.20 %; heavy metals: < 40 ppm). It is indicated to decongest irritated skin, it is protective against free radicals, stimulates the microcirculation and encourages cutaneous moisturization. In products for the face (revitalizing, soothing, for sensitive and irritated skins), in soaps and body products, the percentages of use reach 5 %.

Undaria pinnatifolia is a "fossil" algae; its residues of 10,000 years ago have been found in archaeological sites. It was cultivated for years on the coasts of Brittany (France) and in Japan it has been consumed for thousands of years. Due to its special composition in minerals, vitamins, polysaccharides, proteins and amino acids, it has more specifically regenerating properties, encouraging moisturization and cutaneous regeneration. Glycolic extract (Phytélènes® of Wakame Thallus EG 755) appears as a clear liquid (propylene glycol: 47.5 – 52.5 %), bright yellow, soluble in water and alcohol at 60 % v/v (pH: 5.0 – 6.0; relative density at 20°C: 1.035 – 1.045; dry residue: 0.60 – 1.20 %; heavy metals: < 40 ppm). It is indicated to maintain good cutaneous moisturization and for protection against free radicals. It is used in a variety of products for the face (to revitalize, refresh, in anti-wrinkle products, to humidify and to soothe), in soaps and other products for the body in percentages which vary from 1 – 7 % and in some cases even up to 15 % (treatment ampoules for the face and treatment gels for the body).

MACROCYSTIS PYRIFERA

The anti-seborrheic action obtained with packs on the hair with this algae powdered is significant (Bartoli, 1999).

In vitro tests, on a model of reconstructed epidermis based on the culture of human keratinocytes, conducted under UV rays at different concentrations of an extract of this algae (4, 10 - 20 mg/ml), have shown an inhibition of the expression of the degradation of the metalloproteinases (MMPs). These degrading enzymes, which split proteins by hydrolysis of the peptide bonds between the protein chain are active on the components of the extracellular matrix (ECM) and of the dermo-epidermal joints; the disorganization of the ECMs causes slackening of the tissue and the appearance of fine wrinkles on the epidermis. Topical applications of the extract of this algae carried out on volunteers have shown an anti-ageing action with a reduction in the fine lines and a smoother and more compact skin (Ansaldi and Bo-

smann, 2001).

FUCUS VESICULOSUS AND ASCOPHYLLUM NODOSUM

Fucus vesiculosus grows on the rocks along sea coasts. The algae is collected at low tide and grows abundantly on the coasts of Brittany (France) where marine activities are concentrated. The virtues of *Fucus* are very familiar to Breton girls who traditionally use a mixture of marine plants to prepare a softening beauty milk to soothe their skin which has been hardened due to tanning and sunburn (Indena, EG 006/BG 006). An W/O emulsion based on sroglycerides, containing a solution at 10 % of liposoluble extract of *Fucus* in octylodecanol, has been tested on women aged between 30 and 40 with unsightly, tired, slackened and very dry skins with evident signs of precocious senescence. After 30 days of daily applications, the clinical observations (lenticular pigmentation with 20 enlargements completed with 100 % cent light; tests to the touch; subjective measurements; moisturization tests, have shown: improvement of the colour (which has become rosier) of the skin which appeared firmer, smoother and more polished; improvement of sebo-genesis; improvement of the appearance of the face due to the cutaneous hydration induced by the extract (Rovesti and Prato, 1981).

A Japanese patent (2000) is relative to the moisturizing function carried out by a collagen of marine derivation (from fish) in association with an extract of *Fucus vesiculosus*. The suggested uses, with a marked restorative effect of the moisturization and softening of the skin, concern products for the treatment of the face and body in general (Poggi, 2002).

The glycolic extract of *Fucus vesiculosus* (Phytélènes® of *Bladderwrack* Thalle EG 006), appears as a clear liquid (propylene glycol: 47.5 – 52.5 %), from amber yellow to brownish pink, soluble in water and alcohol at 60 % v/v (pH: 6.0 – 7.0; relative density at 20°C: 1.045; dry residue: 0.4 – 2 %; heavy metals: ≤ 5 ppm). The extracts are recommended for those products intended to reduce excess local fat or the consequences of cellulite. They are recommended for body slimming products in the form of serums, ampoules and gels from 10 – 30 %; the percentage of use in lotions is 3 – 5 %. The extract in glycol butylene (Phytélènes® of *Bladderwrack* Thalle BG 006) is differentiated in the following data: pH: 6.0 – 7.3; relative density at 20°C: 1.021 – 1.024; dry residue: 0.4 – 1 %; heavy metals: ≤ 5 ppm).

Ascophyllum nodosum grows on rocky coasts in Europe. In the past the women on the British coast would rinse their hair with decoctions of this algae. Their hair became supple and shiny thanks to the film-forming and revitalizing properties of *Ascophyllum*. The glycolic extract (Phytélènes® of *Ascophyllum* Thallus EG 744) appears as a clear liquid (propylene glycol:

47.5 – 52.5 %), bright yellow in colour, soluble in water and alcohol at 60 % v/v (pH: 6.0 – 7.0; relative density at 20°C: 1.035 – 1.045; dry residue 0.30 – 0.60 %; heavy metals: < 40 ppm). The extracts are recommended to stimulate the microcirculation and for the protection of the capillary veins. They are also recommended to protect the skin against free radicals. They are used for facial care in creams, milks and lotions with different functionalities (revitalizing, for skin with spots, after-sun care, moisturizing and soothing) and for products for the body, the percentage of use is up to 10 %. In the gels for tired legs, the percentage is 10 – 30 %; in shampoos and in tonics for dry hair the percentage is contained between 3 and 5 %.

HIMANTHALIA ELONGATA

This algae is found in the seawater renewed by the low tide and wind in the exposed coastal areas. It grows forming a band around which *Laminaria digitata* grows. This algae is rich in Vitamin C, trace elements and also alginic acid. The claimed properties are emollient and moisturizing and protection of the skin and therefore it is suitable for anti-ageing and anti-wrinkle treatments and treatment against free radicals. The glycolic extract (Phytélènes® of *Himanthalia* Thallus EG 754) appears as a clear liquid (propylene glycol: 47.5 – 52.5 %), orange yellow in colour, soluble in water and alcohol at 60 % v/v (pH: 5.6 – 6.0; relative density at 20°C: 1.035 – 1.045; dry residue: 0.6 – 1.20 %; heavy metals: < 40 ppm). The percentages of use in products for facial care (revitalizing, anti-free radicals, anti-wrinkle moisturizing, soothing) reach 7 %. It is also used in relaxing and toning lotions and bath creams for the body (1 – 5 %).

FUCUS SERRATUS

It contains a marine fluorotannin that can reduce dental plaque and fights the receding gums, including in cases of pyorrhea. The aqueous extract is used in odontostomatology as a dental whitener, gum emollient and astringent (Bartoli, 1999).

PALMARIA PALMATA

This is an algae that is purple brown in colour which grows abundantly on the Atlantic coasts and can live in epiphytism on the stems of *Fucus vesiculosus* and *Laminaria hyperborea*. It has been used since the 10th century, especially in Iceland (Indena, EG 745). It is particularly rich in B group vitamins which help renew hair, scalp and nails, in repithelization and regeneration of the tissues. Vitamin B5 or pantoic acid is notoriously the vitamin of the skin and hair; it activates the growth of nails and encourages pigmentation. It is indicated in cases of hair loss. B5 is also anti-seborrheic. Vitamin B6 is essential for cystine which is one of the constituents of the nails and hair and takes part in the synthesis of keratin. Vitamin B9 or folic acid acts in cases of cutaneous affections. Vitamin PP helps cellu-

lar respiration, contributes to the transport of oxygen and helps the blood circulation through vasodilatation. This algae, known as Dulse, can be particularly recommended in affections of the skin, hair and nails, especially in cases of depigmentation, dryness, dullness and fragility of the hair or with seborrheic disorders. The glycolic extract (Phytélènes® of *Dulse* Thallus EG 745) appears as a clear liquid (propylene glycol: 47.5 – 52.5 %), bright yellow in colour, soluble in water and alcohol at 60 % v/v (pH: 6 – 7; relative density at 20°C: 1.035 – 1.045; dry residue: 0.6 – 1.20 %; heavy metals: < 40 ppm). In the products for facial care (revitalizing, anti-wrinkle, tonics) and for scaly or oily skins, the percentages of use are between 1 – 3 % and 5 %, in some cases they reach 7 %. It is also used in soaps, in bath products (relaxing, revitalizing, remineralizing, purifying) up to 5 %. The glycolic extract is indicated in products against hair loss and toning lotions (3 – 5 %).

SPIRULINA MAXIMA

This is a blue microalgae which grows in some freshwater lakes with a high content of sodium bicarbonate. It is particularly rich in proteins. Together with chlorophyll, it produces a blue pigment called phycocyanin. Its components are particularly useful for the skin. The amino acids are essential for the formation of collagen and the elastic fibres. *b*-carotene is a protective agent for the skin, particularly against ageing. Vitamin B12, in synergy with B9, revives the connective tissue. Vitamin E has anti-oxidant properties, protects the skin and counteracts the formation of wrinkles. Vitamin F is involved in the mechanisms of maintaining cutaneous elasticity. Fe encourages cellular oxygenation and in the tissues it counteracts the formation of wrinkles. *Spirulina* is particularly suitable in anti-ageing and anti-wrinkle products.

An aqueous or hydroalcoholic extract, characterized by a high content of magnesium (about 10 % on dry) can stimulate the cellular ATP, the synthesis of the protein matrix and the differentiation of keratinocytes. The topical use recommended in the German patent concerns the hair and skin (Poggi, 2002). The glycolic extract (Phytélènes® of *Spirulina* the whole algae EG 718) appears as a clear liquid (propylene glycol: 47.5 – 52.5 %), greenish yellow in colour, soluble in water and alcohol at 60 % v/v (pH: 7.0 – 8.0; relative density at 20°C: 1.035 – 1.045; dry residue: 0.6 – 1.20 %; heavy metals: < 40 ppm).

The percentages of use in products for facial care (revitalizing, for sensitive skins, anti-wrinkle, moisturizing, soothing and anti-free radical) and body care (soaps and relaxing and toning lotions, toning, stimulating or soothing bath creams) are 1 – 5 %.

CHONDRUS CRISPUS

It acts on the sebaceous functions and also has a marked antiseptic and emollient activity

(during the First World War, it was given by mouth as a syrup to French soldiers who were victims of yperite). The extract of the thallus in propylene glycol and in butylenic glycol are used. More recent extractive methods use the protoplasts from the spores (spore-protoplasts) that are more vital and that reproduce more quickly than the thallus-thallus-algal base protoplasts. The extracts of *Chondrus* are particularly active as hair conditioners thanks to the presence of amino acids and as cutaneous revitalizers when dispersed in the bathwater (Bartoli, 1999).

DUNALIELLA SALINA

As it is a source of Provitamin A or *b*-carotene, which has an important role in the physiological equilibrium of the organism (increase in visual capacity, prevention of cellular degeneration, boosting the immune defences due to T and B lymphocytes), this algae is seen with a certain interest to activate the cellular regeneration of the skin and of the connective tissue. The extracts of the algae have also been reported for their effectiveness in the stimulation of melanin (Poggi, 2002).

Stimulating the growth of the algae in the presence of *b*-carotene inhibitors produces other carotenoids, phytoenes and phytofluenes. The culture product, extracted and dried, is colourless and can be used in products for topical use (Soudant et al., 2000; Poggi, 2002).

CODIUM TOMENTOSUM

Two extracts exist on the market, one obtained with propylene glycol and the other with butylenic glycole, called "MMF" (Moisturizing Marine Factor) and which act as osmo-regulators, capturing extremely quickly the water molecules that they then slowly release on the treated skin, forming a veil (called the "second skin") on the same part of the skin, which becomes velvety to the touch. MMF is included in the composition of a mixture of algae called SPD 92/28 or "marine radical scavenger", helpful in the prevention of the damage caused by the free radicals responsible for some neoplasias and melanomas. These extracts are already included in the formulation of commercial products, such as lotions and creams against skin ageing (Bartoli, 1999).

DELESSERIA SANGUINEA AND UNDARIA PINNATIFOLIA

A skin moisturizing and toning and anti-wrinkle functionality has been reported (Bartoli e Bartoli, 1991).

HAEMATOCOCCUS PLUVIALIS

This is a microalgae that grows along the coasts of Hawaii; the extract has shown a marked anti-oxidant activity. The extract contains in significant quantities (Poggi, 2002).

GELIDIUM CORNEUM