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(54) **USE OF FREE RADICAL SCAVENGERS FOR PROTECTING AND TREATING SKIN AND HAIR DAMAGES CAUSED BY CHEMOTHERAPY**

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(57) **ABSTRACT**

The present invention relates to the use of one or more free radical scavengers as prophylactically or therapeutically effective substances and microparticles having an average particle size ranging from 5 to 200 μm for the preparation of a topical pharmaceutical composition for the protection or treatment of skin or hair damages caused by chemotherapeutic treatment.

The invention also concerns a method for the protection or treatment of skin and hair damages of a mammal caused by chemotherapy. The invention further relates to a kit for the protection or treatment of hair damages caused by chemotherapeutic treatment consisting of a topical composition comprising microparticles together with free radical scavengers and a shampoo for an effective hair cleaning and supporting the hair treatment. A kit for the protection or treatment of skin damages caused by chemotherapy consisting of a topical composition comprising microparticles together with free radical scavengers and a cleansing milk for an effective skin cleaning and supporting the skin treatment is a further object of the present invention.

USE OF FREE RADICAL SCAVENGERS FOR PROTECTING AND TREATING SKIN AND HAIR DAMAGES CAUSED BY CHEMOTHERAPY

[0001] The present invention relates to the use of one or more free radical scavengers as prophylactically or therapeutically effective substances and microparticles having an average particle size ranging from 5 to 200 μm for the preparation of a topical pharmaceutical composition for the protection or treatment of skin and/or hair damages caused by chemotherapeutic treatment.

[0002] The invention also concerns a method for the protection or treatment of skin and hair damages of a mammal caused by chemotherapy. The invention further relates to a kit for the protection or treatment of hair damages caused by chemotherapeutic treatment consisting of a topical composition comprising microparticles together with free radical scavenger and a shampoo for an effective hair cleaning and supporting the hair treatment. A kit for the protection or treatment of skin damages caused by chemotherapy consisting of a topical composition comprising microparticles together with free radical scavengers and a cleansing milk for an effective skin cleaning and supporting the skin treatment is a further object of the present invention.

[0003] When carcinogenic diseases are treated, the use of chemotherapeutic substances is widespread when combating tumour cells and pathogens such as viruses and fungal infections as part of so-called chemotherapy or cytostatic therapy treatment. Chemotherapy is used, among other things, with acute or chronic leukaemia, malignant lymphomas or other tumours in the intestine, lung, breast and other organs. Different medications are used, depending on the type of illness and the condition of the patient. Cytostatic agents which are frequently used in chemotherapy and which cause severe side effects are for instance the antracyclines. They include daunorubicin (Cerubidine), doxorubicin (Adriamycin, Rubex), epirubicin (Ellence, Pharmorubicin), and idarubicin (Idamycin).

[0004] The occurrence of acute or long-term side effects, or side effects which occur later in connection with the chemotherapy, including side effects to the skin and mucous membranes of patients, is generally known. A further consequence of chemotherapy treatment is also increased sensitivity to herpes viruses or fungal infections.

[0005] The side effects to skin include dry or scaly skin, itchy skin swellings, red patches, the formation of blisters, skin lesions with low-level mechanical impacts, allergies, skin discoloration along the infusion veins, pigment spots, hand and foot syndrome (PPE) etc.

[0006] Aside from the treatment by medication of skin in medium and severe cases (e.g. in the case of shingles with virustatica), patients are usually simply advised to avoid mechanical irritants by wearing suitable clothing, avoiding cosmetic preparations with allergy potential, or to use dermatological treatments which soothe the skin, such as *calendula* cream. These procedures are frequently not satisfactory.

[0007] Furthermore, it is known that chemotherapy is frequently accompanied by a temporary partial or total loss of hair, in particular of head hair (Alopecia), which can lead to severe psychological damage, particularly among women.

[0008] It is therefore object of the present invention significantly to reduce or completely to prevent skin and hair damages during chemotherapeutic treatment.

[0009] The object of the present invention is solved by a topical pharmaceutical composition which is applied prior, during and/or subsequent to chemotherapeutic treatment to the concerned skin or scalp areas of the mammal, this composition comprising one or more free radical scavengers as prophylactically or therapeutically effective substances and microparticles having an average particle size ranging from 5 to 200 μm as carrier materials.

[0010] It was found that chemotherapeutic substances which are administered systemically or intravenously quickly penetrate from inside-out onto the skin via sweat, and are distributed homogeneously over the skin surface by lateral spreading. Then they penetrate the skin from outside in the same manner as topically applied substances. The concentration of the systemically and intravenously applied substances correlates in terms of time with the concentration of these substances in the blood. The highest concentration of chemotherapeutic substances on the skin was observed in places where a high concentration of sweat glands occurs, e.g. on the forehead, the axilia, and the balls of the hands and feet. The majority of skin irritations also occur here. Without wishing to be bound by theory, it is believed that this appears to be the reason for the formation of PPE.

[0011] Furthermore, it was found that chemotherapeutic substances frequently accumulate in the hair follicles. They are in part expelled there together with the extruded fat from the sebaceous gland, and this coincides with a rapid loss of hair during a chemotherapeutic treatment.

[0012] Now it was found that the occurrence of side effects from chemotherapeutic substances on the skin or on the hair can be prevented or significantly reduced when antioxidation agents or such substances which are known as radical scavengers can be effective on the skin prior, during or subsequent to chemotherapy together with microparticles. Obviously, to ensure an effective protection or treatment it seems to be necessary to neutralize the free radicals on the skin or scalp surface before they penetrate the skin from outside again and are stored there over a long period of time causing the above described side effects. For this, according to the invention, the free radical scavengers and antioxidation agents have been administered together with microparticles having an average particle size from 5 to 200 μm to ensure the neutralization of the free radicals on the skin or scalp surface before they penetrate the skin from outside again.

[0013] "Side effects to the skin", "skin side effects" or "skin damages" are understood as being all the effects described in the introduction, together with further side effects which are not explicitly listed, but which are generally known, such as those named in the "Schweizerische Rundschau for Medizin" 91(2002) no. 24, p. 1063-1087. "Hair side effects" or "hair damages" are understood as being the full or partial loss of body hair, in particular of head hair, hair brittleness, hair discoloration, loss of hair colour and similar other effects.

[0014] The term "applying topically" also includes application to the mucosa, especially of the head and neck region.

[0015] Chemotherapeutic treatment is understood as being the systemic or intravenous dosage of pharmaceutical, synthetic or microbiologically manufactured products, or products isolated from a mixture, which are suitable for use as anti-cancer agents. Stem cell transplants are regarded as being equivalent to this treatment, which can lead to similar effects on the skin. Chemotherapeutic substances of this nature include Fluoruracil, Fluordesoxyuracil, Leucovorin, Taxol, Gemzur, Doxorubicin and those named for example in

the "Schweizerische Rundschau für Medizin" 91(2002) no. 24, p. 1078ff. Chemotherapeutic substances which lead to hand and foot syndrome include in particular Vinorelbin, Methotrexat and Etoposide.

[0016] According to one embodiment of the invention, scavengers which a high capacity for capturing free radicals are used in the topical preparation, whereby the radical protection factor of the preparation constitutes at least 85×10^{14} radicals per mg of preparation, measured by determining the number of free radicals of a solution of a test substance (S_1) using electron spin resonance (ESR) in comparison with the ESR measurement result of the preparation according to the ratio

$$RPF=(RC\times RF)/PI$$

whereby $RF=(S_1-S_2)/S_1$; RC=the concentration of the test substance (radicals/ml); PI=the concentration of the active substance preparation (mg/ml). S_2=signal amplitude of the antioxidant.

[0017] The radical protection factor (RPF) gives the activity for the binding of free radicals by antioxidation agents or scavengers against a test substance.

[0018] According to the invention, all generally known enzymatic and non-enzymatic antioxidants can be used as free radical scavengers, insofar as they can be formulated to a topical preparation and comprise a corresponding radical protection factor.

[0019] The antioxidants used are selected, for example, from the group of vitamins consisting of tocopheroles and their derivatives, in particular α-tocopherole or α-tocopherylester, in particular tocopherylacetate, tocopherylacylate, -laurate, -myristate, -palmitate, -oleate or -linoleate; vitamin A and its derivatives, in particular retinyl palmitate; vitamin C and its derivates, in particular isoascorbate, (2- or 3- or 6-) o-alkylascorbic acids, ascorbic acid ester, such as ascorbyl acetate, ascorbyl phosphate, 6-o-lauroyle-, myristoyle-, palmitoyle-, oleoyle- or linoleoyle-L-ascorbic acid; folic acid and its derivatives.

[0020] Further scavengers which can be used according to the invention have been selected from the group consisting of flavonoids, comprising flavons, flavonols, flavanonals and chacons, in particular citrus flavonoids such as rutin, naringin and neohesperidin; carotinoids and carotines such as α-carotine and β-carotine; α-lipon acid, lipon acid amide; amino acids such as histidine, glycine, tyrosine, tryptophane and amino acid derivatives; α-hydroxy acids such as citron acid, milk acid, apple acid; uric acid and its derivatives; rutin acid, α-glucosylrutine; phenolcarbon acids such as rosemary acid or ferula acid; humin acid; gallic acid and gallic acid derivatives such as methyl-, ethyl-, propyl-, amyl-, butyl- and laurylgallate; gallic extracts; unsaturated fatty acids; ubichinon, ubichinol; zinc and its salts; selenium compounds; coenzyme Q10; urocanin acid; lecithin; anthocyanes; polyphenolenes; tetrahydrodiferuloylmethane (THC).

[0021] Preparations from plant extracts with a high radical protection factor (designed as RPF complex) are described in WO 99/66881, WO 01/26617 and DE 103 25 156 A1 (which disclosures are incorporated herein by reference). These preparations can also be used in the present invention as antioxidants.

[0022] Further advantageous plant extracts which are useful as free radical scavengers in the present invention are acerola extract, citrus peel or leaf extracts (*Citrus bigaradia, Citrus hystrix, Citrus aurantifolia, Citrofurtunella microcarpa, Citrus aurantium, Citrus reticulate*), bitter orange extract (peel or fruit), cherry extract from Spanish cherries, kiwi extract (*Actinidia chinensis*), papaya fruit extract (*Caricae papayae*), tea extract [leaves from green or black tea, leaves or bark from New Jersey tea (*Ceanthus velutinas*)], coffee bean extract from green or roasted beans, prunus extract, e.g. from *Prunus armeniaca, Prunus dulcis, Prunus persica, Prunus domestica, Prunus spinosa, Prunus serotina, Prunus virginiana*, extracts from the bark of the Mexican skin tree (*Mimosa tenuiflora*), angelica root extract (*Angelica archangelica*), *Pongamia pinnata* extract, and tomato extract.

[0023] The amount of these plant extracts in the topical preparation can preferably be between 0.05 and 45 weight %, preferably 0.1 to 40 weight %, in particular 1.5 to 20 weight %, whereby mixtures of these extracts can also be contained in the effective substance preparation. The concentration depends on the radical protection factor of the extract or scavenger. In this way, extracts with very high radical protection factors of between 10000 and 90000 can be contained in relatively low concentrations of 0.1 weight %, insofar as they maintain the corresponding RPF over longer periods of time of several weeks to several months.

[0024] Specifically preferred are content levels of scavengers in the topical composition of 3-33 weight %, in particular 9-26 weight %, relating to the total weight of the composition.

[0025] The radical protection factor of the preparation advantageously constitutes at least 110×10^{14} radicals per mg of preparation, preferably at least 300×10^{14} radicals per mg of preparation, in particular at least 500×10^{14} radicals per mg.

[0026] Embodiments of the invention in which the radical protection factor of the preparation is between 200 and 12000×10^{14} radicals per mg of preparation are specifically preferred.

[0027] The concentration of the radical scavenger or radical scavenger mixture of about 1 to about 40 weight % is preferred.

[0028] Particularly preferred is a mixture of plant extracts (RPF complex III), consisting of between 0.1 and 2 weight % extract of green coffee beans, between 0.1 and 2 weight % extract of leaves of *Camellia sinensis*, between 0.1 and 2 weight % extract of *Pongamia pinnata* and between 0.1 and 2 weight % extract of the roots of *Angelica archangelica* and the rest of up to 100 weight % from a single-value C_2-C_5 alcohol. The extract mixture is free of liposomes, and has a radical protection factor in the region of $1400\text{-}2900\times10^{14}$ radicals per mg. This extract mixture can preferably be contained in a proportion of between 8 and 25 weight %, preferably between 10 and 15 weight %, in a preparation according to the invention in relation to the total weight of the preparation.

[0029] A further preferred scavenger is the RPF complex I from WO99/66881 as mentioned above (e.g. from example 1 or 2) or WO 01/26617. This consists of an effective substance preparation containing a product gained from the extraction of the bark of Quebracho blanco and the subsequent enzymatic hydrolysis, which contains at least 90 weight % proanthocyanidin oligomers and a maximum of 10 weight % of gallic acid, in microcapsules, and a silkworm extract gained from extraction, which contains the peptide cecropine, amino acids and a vitamin mixture, and a non-ionic, cationic or anionic hydro-gel or a mixture of hydro-gels, and one or more phospholipids and water (RPF 2400), where appropriate supplemented by cyclodextrine and a yeast digest described later (RPF 4800).

[0030] An advantageous scavenger is also a mixture of enzymes and vitamins, specifically a digest from a yeast produced by ultrasound treatment, whereby the digest contains SOD, protease, vitamin B_2, vitamin B_6, vitamin B_{12}, vitamin D_2 and vitamin E. Preferably, it contains at least 150 U/ml SOD, protease and vitamins B and D, whereby the ratio SOD: protease as international units lies at least in the region of between 3:1 and 8:1 (RPF 2020×10^{14} radicals/mg). The enzyme/vitamin mixture is produced using an extraction method using ultrasound, which is described in DE 4241154C1, and in which a cell dispersion or suspension is passed through an ultrasound area in an ultrasound through-flow cell, in which the sonotrode protrudes into the through-flow cell up to between half and two-thirds of its length, and is immersed into the medium to be acoustically irradiated. Here, the sonotrode has an angle of 80.5 to 88.5°, and the ratio between the immersion length of the sonotrode in mm to the acoustic irradiation volume in ml is set at between 1:1.1 and 1:20. The proportion of solid substances in the medium to be acoustically irradiated is in the region of between 1:0.02 and 1:2.2 (weight %).

[0031] Yeasts such as baker's yeast, brewer's yeast, wine yeast and specially treated yeasts, such as SOD-enriched yeasts, can be used as the cell dispersion. A cell dispersion which can advantageously be used contains e.g. *Saccharomyces cerevisia.*

[0032] The addition of e.g. 1-10 weight % of a yeast digest of this nature from baker's yeast or organic yeast can synergetically increase an already present radical protection factor from another oxidation agent.

[0033] Further preferred radical scavengers include (in brackets are the RPF values without the addition "$\times10^{14}$ radicals/mg") tomato extract (1000); carrot extract (300); RPF complex+vitamin E in cyclodextrine (7200); stabilised vitamin C (8290); an ultrasound yeast digest from baker's yeast (2020); rape extract (67000); RPF complex I in cyclodextrines (720); oregano oil (Origanox)(90306); *Origanum vulgare* extract (80000); tannic acid (310000); pine bark extract (12500); *Himothatus sucruba* extract (700); Emplica® (Merck) (42400); grape skin, white (53000); grape skin, red (95100); flavonoid extract from red wine (6000); rosemary acid (36000-68000); curry extract (12500); saffron extract (900); orange peel extract (24000); rape oil (2550); strawberry oil (1300); green tea extract (21500); grapefruit extract (53000); natrium-ascorbyl-phosphate (35000); edelweiss extract (15500); *Camellia sinensis* extract (840).

[0034] According to the invention the topical composition comprises microparticles with an average size of from 5 to 200 μm, preferably from 5 to 100 μm, more preferred from 5 to 50 μm and especially preferred from 8 to 40 μm. Without wishing to be bound by theory the particle size seems to be important to prevent the penetration of microparticles carrying the free radical scavengers into the skin and/or to prevent the penetration of microparticles carrying the chemotherapeutic substances they may have caught into the skin.

[0035] In a preferred embodiment of the invention the microparticles are selected from porous materials, cyclodextrins or mixtures thereof. The porous materials are preferably selected from the group consisting of ground natural organic compounds such as for instance ground fixed algae or horny sponges, ground plants or parts thereof such as for instance bamboo powder, grain starches, pigments, iron oxides, silicates, mica, kaolin, clays containing manganese, white clay, silica gel calcium carbonate, talcum, bismuth-oxychloride, activated carbon, ceramic particles, SiO_2, ZnO, SrO_2, TiO_2 or mixtures thereof. Especially preferred for the purpose of the present invention are horny sponges, preferably horny sponges of types *Euspongia officinalis, Spongia usitatissima, Hippospongia equina* or mixtures thereof, bamboo powder, kaolin, white clay, SiO_2, calcium carbonate, silica gel, silicates, activated carbon or mixtures thereof.

[0036] Preferred cyclodextrins according to the invention are β- or γ-cyclodextrins. The microparticles of the invention are commercially available or easily obtainable as it is well known in the prior art.

[0037] The concentration of the microparticies in the composition ranges from 0.1 to 10% by weight, relating to the total weight of the composition, preferably 0.6 to 8% by weight, more preferred 1 to 6% by weight.

[0038] According to one embodiment of the invention the topical composition can be prepared by soaking the microparticies with an aqueous solution or emulsion of the corresponding free radical scavenger(s) and adding this phase by stirring slowly (50-200 rpm) at room temperature (18-25° C.) to the auxiliary substances and further components necessary for the formulation of a topical composition.

[0039] The compositions of the invention may contain, alongside the scavengers and the microparticles, other dermatological auxiliary substances, as are commonly used in preparations of this type, such as water, preservation agents, colorants, thickening agents, moistening substances, alcohols, polyols, electrolytes, gel-forming substances, polar and non-polar oils, polymers, copolymers, emulsifying agents and stabilisers. In a preferred embodiment of the invention, the topical preparations contain stabilisers for the antioxidants.

[0040] In order to apply the scavengers topically, they are formulated in the usual way with auxiliary substances to solid formulations which can be applied to the skin, such as creams, gels, salves or emulsions, or to liquid formulations which can be applied to the skin, such as solutions, suspensions, lotions, sera or oils.

[0041] Transdermal systems can also be used as topical preparations, such as adhesives, plasters or bandages, which contain the antioxidants together with the microparticles.

[0042] Advantageous therapeutic preparations are also aqueous systems in the form of tinctures (e.g. for the mucosa) or dry substances which are designed for the preparation of baths (bath concentrates).

[0043] A further component the preparation can contain are finely distributed, hard magnetic mono-area particles (monocrystals) with a high coercitive field force of 3000 to 5000 Oerstedt and with grain sizes in the region of between 50 and 900 nm, preferably 50-250 nm, whereby these hard magnetic particles are in particular barium and/or strontium hexaferrites, produced using glass crystallisation technology by cultivating monocrystals from a quenched glass melt (see WO95/-03061 e.g. example 2 or 3; and WO98/44895 e.g. example 1C). The proportion of monocrystals can be between 0.1 and 5 weight %.

[0044] The preparation according to the invention can furthermore contain moisturising agents such as glycerine, butylenglycol, propylenglycol or mixtures of these.

[0045] The oils used in the topical preparation according to the invention can be standard cosmetic oils such as mineral oil, hydrogenated polysobutene, squalane produced synthetically or from natural products, cosmetic esters or ethers which can be branched or non-branched, saturated or unsat-

urated, plant oils, or mixtures of two or more of these. Particularly suitable oils are for example silicon oils, mineral oils, hydrogenated polyisobutene, polyisoprene, squalane, tridecyltrimellitate, trimethyl-propane-triisostearate, isodecylcitrate, neopentylglycol-diheptanoate, PPG-15-stearylether and plant oils such as *calendula* oil, jojoba oil, avocado oil, *macadamia* nut oil, olive oil, castor oil, cocao buffer, coconut oil, maize oil, cotton seed oil, olive oil, palm kernel oil, rape seed oil, saflor oil, sesame seed oil, soja bean oil, sunflower seed oil, wheatgerm oil, grape seed oil, kukui nut oil, thistle oil and mixtures of these.

[0046] Depending on which oils are selected, the dermatological properties of the fixed composition are affected, such as the degree of transparency, the softness, hardness and spreading properties.

[0047] The preparations according to the invention can be O/W or W/O emulsions. Suitable emulsifying agents for OIW emulsions are for example adsorption products from 2-30 Mol ethyl oxide on linear C_8-C_{22} fatty alcohols, on C_{12}-C_{22} fatty acids and on C_8-C_{15} alkyl phenoles; C_{12}-C_{22} fatty acid mono and diesters from adsorption products from 1-30 Mol ethyl oxide on glycerine.

[0048] Suitable emulsifying agents for W/O emulsions are for example adsorption products from 2-15 Mol ethyl oxide on castor oil, ester from C_{12}-C_{22} fatty acids and glycerine, polyglycerine, pentaerythrite, sugar alcohols (e.g. sorbitol), polyglucosides (e.g. cellulose); polyalkyl-glycols; wool fat alcohols; copolymers of polysiloxan-polyalkylpolyether.

[0049] As has already been described, the radical protection factor (RPF) determines the activity of a substance for binding free radicals against a test substance. This test substance consists of a highly reactive, semi-stable radical which reacts with all known antioxidation agents. Such radicals include nitroxides such as proxo (2,2,5,5-tetramethyl-1-dihydropyrrolinoxy-nitroxide), tempol (2.2,6.6-tetramethyl-1-piperidinoxy-4-ol-nitroxide), DTBN (di-tert-butyl-nitroxide or preferably DPPH (1.1-diphenyl-2-picryl-hydrazyl.

[0050] The RPF is measured in such a way that the signal amplitudes of the test radical created by electron spin resonance (ESR/EPR) are measured before and after mixing with an antioxidation agent/scavenger, and the RPF is calculated from this. The RPF is known for a series of standard antioxidation agents; for all-trans-retinol it is 827, for all-trans-retinolacetate, 196; for DL-α-tocopherol it is 41200 and for α-tocopherylacetate, it is 48, in each case$\times 10^{14}$ radicals/mg.

[0051] The precise measuring procedure for the radical protection factor has been described by Hemming, Groth, Fuchs and Zastrow in Conference Materials "Modern Challenges To The Cosmetic Formulation" 5.5.-7-5.97, Düsseldorf, p. 150-155, Verlag f. chem. Ind. 1997. Here, based on the known concentration of the test substance (here: DPPH) or the number of its free radicals (radicals per ml), a signal amplitude S_1 is measured using an ESR spectrometer. The test radical is dissolved in the same way as the antioxidation agent in a (e.g. 0.1 m) water/alcohol solution. Then the signal amplitude S_2 of the antioxidation agent is measured. The normalised difference between the two signal amplitudes is the reduction factor RF

$$RF=(S_1-S_2)/S_1.$$

The result of the radical reduction of the test substance RC×RF is normalised in relation to the quantity of the product input PI (mg/ml). Here, the RC is the quantity of the test substance, i.e. the known number of radicals in the test substance. The radical protection factor is calculated according to the following equation:

$$RPF = \frac{RC[\text{radicals/ml}] \times RF}{PI[\text{mg/ml}]}$$

The result is:

$$RPF=N\times 10^{14}\ [\text{radicals per mg}],$$

whereby N is a positive, real figure and the RPF can be reduced to the abbreviated numerical value N. This abbreviation is used in the examples of the present invention.

[0052] The radical protection factor can be determined using an ESR spectrometer (GALENUS GmbH, Berlin, Germany), and is a value for labelling products with regard to their ability to bind free radicals. The procedure is an in-vitro procedure, in which no individual properties of the user influence the antioxidants.

[0053] By adding cyclodextrines, which have a radical protection factor of 0, a further increase of this factor of 1.3 to 10 times can surprisingly be observed. Standard α-, β- or γ-cyclodextrines (Wacker-Chemie) or mixtures of these can be used as cyclodextrines. Cyclodextrines are known as encapsulation materials for effective pharmaceutical and cosmetic substances, and can therefore also be used here for encapsulating scavengers.

[0054] The invention also relates to the use of scavenger substances for the protection or treatment of hair loss, especially alopecia, as a side effect of chemotherapy. When hair, in particular head hair, is treated simultaneously during the chemotherapy with a mixture which comprises at least one RPF of between 100 and 10000×10^{14}, preferably $100\text{-}2600\times 10^{14}$ radicals per mg of the treatment preparation, the anticipated hair loss does not occur, or only occurs to a limited degree. A particularly preferred scavenger for the protection or treatment of hair damages is an aqueous extract of walnut or hazelnut leaves.

[0055] The use of scavenging substances is preferably achieved as a hair pack, hair gel, hair water, hair emulsion, hairspray, hair lather, protein pack, hair structure, vitaliser, combing aid or any other suitable form. This is applied fresh to the hair at least twice daily, in particular, 3-5 times daily. For hair packs or hair treatments, the product is left on the scalp and hair for at least 1 to 2 hours before being rinsed out. It is also possible to leave the hair packs one or more days on the scalp.

[0056] The hair treatment is conducted prior to, simultaneously, or subsequent to the chemotherapy treatment, and preferably at least 6 to 7 days following the chemotherapeutic treatment, in particular for 14 to 60 days afterwards or until the next treatment with the cytostatic agent.

[0057] The use of the preparation according to the invention is supported by an additional massage at the site where the preparation is applied, in particular a massage of the scalp, preferably 5 to 10 minutes.

[0058] The invention also relates to a method for the protection or treatment of skin and hair damages of a mammal caused by chemotherapeutic treatment comprising topically administering to the concerned skin and scalp areas of the mammal a prophylactically or therapeutically effective amount of one or more free radical scavengers which are administered in the form of a topical pharmaceutical compo-

sition comprising microparticles having an average particle size ranging from 5 to 200 μm.

[0059] The skin damages which are treated according to the invention are for instance the palmar-plantar erythrodysaesthesia syndrom (PPE), erythema and dry skin.

[0060] A severe side effect of chemotherapeutic treatment to the hair is alopecia. According to the invention the topical composition is administered to the concerned skin and/or scalp areas prior to, during and/or subsequent to chemotherapeutic treatment with cystostatic agents, preferably 1 day prior to chemotherapeutic treatment, during the treatment and at least 6 to 7 days after the chemotherapeutic treatment, preferably 14 to 60 days afterwards or until the next treatment with the cytostatic agent. The topical composition should be administered to the concerned skin or scalp area at least twice daily, preferably 3-5 times daily, in an amount of at least 2 mg/cm^2, preferably of 2 to 10 mg/cm^2.

[0061] A kit for the protection or treatment of hair damages caused by chemotherapeutic treatment consisting of

a) a topical composition comprising one or more free radical scavengers and microparticles having an average particle size ranging from 5 to 200 μm, wherein the concentration of the radical scavenger(s) in the composition ranges from 0.05 to 45% by weight, and the concentration of the microparticle(s) in the composition ranges from 0.1 to 10% by weight and

b) a shampoo comprising a free radical scavenger up to 2% by weight of the total weight of the shampoo is a further object of the present invention. In a preferred embodiment the radical protection factor R_F of the topical composition of this kit should be at least 85×10^{14} radicals/mg composition.

[0062] The invention also concerns a kit for the protection or treatment of skin damages caused by chemotherapeutic treatment consisting of

a) a topical composition comprising one or more free radical scavengers and microparticles having an average particle size ranging from 5 to 200 μm, wherein the concentration of the radical scavenger(s) in the composition ranges from 0.05 to 45% by weight, and the concentration of the microparticle(s) in the composition ranges from 0.1 to 10% by weight and

b) a cleansing milk comprising a free radical scavenger up to 2% by weight of the total weight of the cleansing milk. In a preferred embodiment the radical protection factor R_F of the topical composition of this kit should be at least 85×10^{14} radicals/mg composition.

[0063] A further object of the present invention is the use of one or more free radical scavenger(s) as prophylactically or therapeutically effective substances for the preparation of a topical pharmaceutical composition for the protection or treatment of skin and hair damages caused by chemotherapeutic treatment and a method for the protection or treatment of skin and hair damages of a mammal caused by chemotherapeutic treatment comprising topically administering to the concerned skin and scalp areas of the mammal a prophylactically or therapeutically effective amount of one or more free radical scavengers which are administered in the form of a topical pharmaceutical composition.

[0064] The invention will now be explained with reference to examples. All data is given as a weight percentage, insofar as no other information is given.

EXAMPLE 1

Anti-Radical Cream I

Phase A

[0065] Isopropylmyristate 3.0; steareth-2 2.3; steareth-21 1.5; PPG-15 stearylether 3.0

Phase B

[0066] Water q.s. ad 100; EDTA 0.04; carbomere 0.3; Water/NaOH 0.3; glycerine 2.0; kaolin 0.1 (particle size 5-50 μm); bamboo powder 0.5 (particle size 5-50 μm)

Phase C

Dimethicone 2.0

Phase D

[0067] Conservation agent 0.1
β-carotine 5.0

[0068] The separately prepared phases A and B are heated to 75° C. and combined by stirring. Phase C is added to the mixture by stirring and it is cooled to approximately 40° C. Phase D is added by stirring at 35° C. and the mixture is homogenised.

RPF=1270×10^{14} rad./mg.

EXAMPLE 2

Anti-Radical Cream II

[0069] Phases A and C correspond to those in Example 1.

Phase B

[0070] Water q.s. ad 100; EDTA 0.04; carbomere 0.3; Water/NaOH 0.3; glycerine 2.0; horny sponges 1.0 (particle size 5-50 μm); cyclodextrine 0.01

Phase D

[0071] Conservation agent 0.08
β-carotine 3.0
RPF-complex I[1]/cyclodextrine 10.0
Rosemary acid 0.5

[1] according to WO99/66881 (active substance complex according to Example 1)

[0072] The preparation corresponds to that in Example 1

RPF=3820×10^{14} rad./mg.

EXAMPLE 3

Anti-Radical Cream III

[0073] Phases A and C correspond to those in Example 1.

Phase B

[0074] Water q.s. ad 100; EDTA 0.04; carbomere 0.3; NaOH 0.3; glycerine 2.0;

Phase D

[0075] Conservation agent 0.08

RPF-complex I[1] 5.0

[0076] [1] according to WO99/66881 (active substance complex according to Example 1)

Phase E

[0077] horny sponges 2.0 (average particle size 10-40 μm); β-carotine (liquid) 1.5; Rosemary acid (liquid) 0.5

[0078] β-carotine and Rosemary acid are mixed. The horny sponges are added to this mixture at room temperature (18-

25° C.). For soaking the microparticles it is stirred slowly (50-200 rpm) for about 10 minutes.

[0079] Then, the separately prepared phases A, B, C and D are mixed together. Phase E is added at room temperature (18-25° C.) by stirring slowly (50-200 rpm).

EXAMPLE 4

Anti-Radical Cream IV

[0080] Phases A and C correspond to those in Example 1.

Phase B

[0081] Water q.s. ad 100; EDTA 0.04; carbomere 0.3; Water/NaOH 0.3; glycerine 2.0; horny sponges 1.0 (particle size 8-40 μm); bamboo powder 0.1 (particle size 8-40 μm); SiO_2 0.2 (particle size 5-50 μm)

Phase D

[0082] Conservation agent 0.09

RPF-complex I[2] 10.0

[0083] Peel extract of red grape 2.0

Origanox®WS 1.0

[0084] Vitamin C stabilised 2.0;

[0085] The preparation corresponds to that in Example 1

RPF=6310×10^{14} rad./mg.

[0086] [2] according to WO01/26617 (active substance complex according to Example 1)

EXAMPLE 5

Anti-Radical Cream V

[0087] Phases A and C correspond to those in Example 1.

Phase B

[0088] Water q.s. ad 100; EDTA 0.04; carbomere 0.3; Water/NaOH 0.3; glycerine 2.0, white clay 1.0 (average particle size about 5 μm); kaolin 0.1 (average particle size 50 μm)

Phase D

[0089] Conservation agent 0.1
Tomato extract 2.0
Pine bark extract 0.5
RPF-complex I[1]/cyclodextrine 10.0

[1] according to WO99/66881 (active substance complex according to Example 1)

[0090] The preparation corresponds to that in Example 1.

RPF=4040×10^{14} rad./mg.

EXAMPLE 6

Cleansing Milk

Phase A

[0091] Water q.s. ad 100; propylene glycol 3.0; glycerine 2.0; carbomere 0.5

Phase B

[0092] cetyl alcohol 3.0; sheabutter 0.1
Neutralizer/pH adjuster: Triethanolamine 0.5
Preservative: 2-Bromo-2-nitropropane-1,3-diol 0.1
RPF-complex III[3] consisting of alcohol denat. (99.2); *Pongamia Pinnata* Seed Extract (0.2); *Angelica Archangelica* Root Extract (0.2); *Camellia Sinensis* Leaf Extract (0.2); *Coffea Arabica* (Coffee) Leaf/Sead Extract (0.2)

[0093] (The procentages relate to the total weight of the RPF-complex.)

[3] according to the extract mixture of Example 1 of DE 103 25 156 A1

Preparation

[0094] Phase A is put in the main vessel and heated up to 45-50° C. The carbomere is slowly added and homogenized totally. Phase A is now heated to 65° C. Phase B is separately heated to 65° C. and stirred until it is homogenous. Then, Phase B is added into Phase A in the main vessel and homogenized well. Stirring is continued. Then it is cooled down to 50-55° C. under stirring. After that the triethanolamine is added and homogenized well. Now, under stirring it is cooled down below 40° C. and the RPF-complex and the preservative agent are added till homogeneity. Cooling to room temperature is continued and parameters such as pH and viscosity are controlled.

EXAMPLE 7

Permanent Hair Rinse

[0095] Water q.s. ad 100; carbomere 0.08; triethanolamine 0.08; RPF-complex I[1] (liposomes) 2.0; RPF complex I[2] 2.0; β-carotine 1.0; concentrate of red grape skin 3.0; α-tocopherolacetate 1.0; vitamin C, stabilised 1.5; horny sponges 1.0 (average particle size 40 μm); white clay 0.1 (average particle size 5 μm).

[0096] The components are mixed together. The rinse obtained has a RPF of 1630×1014 rad./mg.

EXAMPLE 8

Hair Pack I

[0097] Water q.s. ad 100; carbomere 2.5; triethanolamine 2.5; Green coffee oil 2.0; rape oil 3.0; oregano oil 2.0; ethanol 4.0; hard magnetic particles 100-300 nm according to WO98/44895 example 1C 0.1; RPF complex I[1] 2.0; RPF complex I[2] 2.0; 1'-carotine 1.0; concentrate of red grape skin 3.0; birch bark extract 2.0; polyethylene globules 300-900 nm 3.0; bamboo powder 0.01 (particle size 100-200 μm); SiO_2 3.0 (particle size 100-200 μm); white clay 0.01 (particle size about 100 μm); silica gel 0.1 (particle size 100-150 μm).

[0098] The components are mixed together. The obtained composition has a RPF of 2410×10^{14} rad./mg.

EXAMPLE 9

Hair Pack II

[0099] Water q.s. ad 100; carbomere 2.5; triethanolamine 2.5; Green coffee oil 2.0; rape oil 2.0; *calendula* oil 2.0; ethanol 4.0; hard magnetic particles 100-300 nm according to WO98/44895 example 1C 0.1; Yeast extraction product from baker's yeast according to DE 4241154 C1 2.2; Pine bark extract 2.0; silica gel 2.7 (average particle size 5 μm); horny sponges 0.5 (particle size 50-80 μm); kaolin 0.1 (particle size 100-200 μm); bamboo powder 0.5 (average particle size 100

μm); activated carbon 0.01 (particle size 150-200 μm). The preparation is conducted as described in example 7; RPF=2590×10^{14} rad./mg.

EXAMPLE 10

Shampoo

[0100] H_2O q.s. ad 100; RPF I^1 1.0; Sodium Chloride 0.1; Flagrance 1.2; Preserving Agent 0.8; Sodium Hydroxide (10%) 0.5.

[0101] The components are mixed at room temperature (part A).

[0102] D-Panthenol 0.2; Tocopherolacetat 0.5; Propylene Glycol 2.0; Sodium Laureth Sulfate 15.00; TEA-Lauryl Sulfate 10.00; Quaternium 80/Propylene Glycol 3.0; Citric Acid 0.09; Cocamidopropyl Betaine 10.00.

[0103] The components are mixed at room temperature and added to part A.

EXAMPLE 11

Protection of PPE

[0104] The creme of Example 1 was administered to 8 femal cancer patients who had to be treated with doxorubicin for 6 months. The administration of the creme was started one day before the first treatment with doxorubicin. This day each patient was creamed on the palm and plantar areas in the morning and in the evening. Next day, the day of the chemotherapy, each patient was creamed in the morning and in the evening and two times during the day. Starting with the first day after the treatment with doxorubicin each patient was creamed each day in the morning and in the evening for at least 6 or 7 days, preferably until the next treatment with doxorubicin. In general, before each repeated administration of the creme the concerned areas have been cleaned with the cleansing milk of Example 6. Non of the 8 patients developed a PPE.

[0105] By comparison, three patients who had to be treated with doxorubicin for 6 months received the creme of Example 1 without the carrier particles (bamboo powder and kaolin) prior, during and subsequent to the chemotherapeutic treatment according to the above described regimen. These three patients developed a low-level PPE which revealed in erythemas.

[0106] Two further female cancer patients were treated according to the above described regimen with the creme of Example 1 without free radical scavengers and without carrier particles. These two patients developed a strong PPE.

EXAMPLE 12

Treatment of PPE

[0107] The creme of Example 3 was administered to 7 femal cancer patients who had developed a PPE on palm and/or plantar areas after 3 months of chemotherapy with epirubicin. The creme was administered to the concerned areas three days three times daily and the skin damages healed up completely within 3 days. In general, before each repeated administration of the creme the concerned areas have been cleaned with the cleansing milk of Example 6.

[0108] By comparison, three female cancer patients with PPE in the same areas after three months of chemotherapy received the creme of Example 3 without the microparticles (horny sponges) with the same treatment regimen. After 3 days an improvement was noted, the skin damages completely disappeared after 8 days.

[0109] Two female cancer patients with PPE in the same areas after three months of chemotherapy received the creme of Example 3 without free radical scavengers and without the microparticles with the same treatment regimen as described above No improvement was noted up to 10 days of administration.

EXAMPLE 13

Protection of Alopecia

[0110] The permanent hair rinse of example 7 was administered to 5 female cancer patients who were treated with Taxol during a period of 3 months. Taxol was applied every 3 weeks.

[0111] The permanent hair rinse was administered on the scalp area two times daily—one day before and during the period of treatment of 3 months. Every fifth day the scalp was washed with the Shampoo of example 10.

[0112] During the first fife days after the Taxol treatment the hair pack II of Example 9 was applied in the evening.

[0113] Usually all patients lost their hairs during the first two weeks of the Taxol treatment.

[0114] In the present case the alopecia was reduced during the 3 months significantly. Even after 3 months of Taxol treatment ca 50% of the hairs remained on the scalp.

1. Use of one or more free radical scavengers as prophylactically or therapeutically effective substances together with microparticles having an average particle size ranging from 5 to 200 μm as carrier materials for the preparation of a topical pharmaceutical composition for the protection or treatment of skin and hair damages caused by chemotherapeutic treatment, wherein the microparticles are selected from the group consisting of porous materials, cyclodextrins and mixtures thereof.

2. Use according to claim **1**, wherein the radical protection factor of the composition constitutes at least 85×10^{14} radicals per mg of the composition, measured by determining the number of free radicals in a solution of a test substance (S_1) using electron spin resonance (ESR) in comparison with the ESR measurement result of the composition according to the ratio

$$RPF=(RC\times RF)/PI$$

whereby $RF=(S_1-S_2)/S_1$; RC=the concentration of the test substance (radicals/ml); PI=the concentration of the active substance composition (mg/ml); S_2=signal amplitude of the antioxidant.

3. Use according to claim **1**, wherein the radical protection factor of the composition is from 200 to 12 000×10^{14} radicals per mg of the composition.

4. Use according to claim **1**, wherein the concentration of the one or more free radical scavengers in the composition ranges from 0.05 to 45% by weight relating to the total weight of the composition, preferably 1 to 40% by weight, more preferred 3 to 33% by weight, especially preferred 9 to 26% by weight.

5. Use according to claim **1**, wherein as free radical scavengers water-soluble and/or fat soluble antioxidants, enzymes or mixtures thereof are used.

6. Use according to claim **1**, wherein the free radical scavenger is selected from the group consisting of (1) an alcoholic extract mixture of green coffee beans, *Camellia sinensis,*

Pongamia pinnata and *Angelica archangelica*; (2) a mixture of a) a product obtained by extraction of the bark of *Quebracho blanco* and subsequent enzymatic hydrolysis, containing at least 90% by weight of proanthocyanidine oligomers and a maximum of 10% by weight gallic acid, in microcapsules, b) an extract of silkworm obtained by extraction, containing the peptide cecropine, amino acids and a vitamin mixture, c) a non-ionic, cationic or anionic hydrogel or mixture of hydrogels, d) one or more phospholipids and e) water; (3) the product of (2) with one or more cyclodextrines selected from β- and γ-cyclodextrines and an ultrasound decomposition product of baker's or brewer's yeast containing at least 150 units/ml superoxide dismutase; and mixtures of (1) to (3).

7. (canceled)

8. Use according to claim **1**, wherein the porous materials of the microparticles are selected from the group consisting of horny sponges, preferably horny sponges of types Euspongia officinalis, Spongia usitatissima, Hippospongia equina or mixtures thereof, bamboo powder, kaolin, white clay, SiO_2, calcium carbonate, silica gel, silicates, activated carbon or mixtures thereof.

9. Use according to claim **1**, wherein as cyclodextrins β- and/or γ-cyclodextrins are used.

10. Use according to claim **1**, wherein the concentration of the microparticle(s) in the composition ranges from 0.1 to 10% by weight, relating to the total weight of the composition, preferably 0.6 to 8% by weight, more preferred 1 to 6% by weight.

11. Use according to claim **1**, wherein microparticles ranging from 5 to 100 μm, preferably from 5 to 50 μm, most preferred from 8 to 40 μm are used.

12. Use according to claim **1** for the preparation of a cream, lotion, ointment, gel or emulsion.

13. Use according to claim **1**, wherein pharmaceutically acceptable auxiliary agents are added.

14. A method for the protection or treatment of skin and hair damages of a mammal caused by chemotherapeutic treatment comprising topically administering to the concerned skin and scalp areas of the mammal a prophylactically or therapeutically effective amount of one or more free radical scavengers which are administered in the form of a topical pharmaceutical composition comprising as carrier materials microparticles having an average particle size ranging from 5 to 200 μm, wherein the microparticles are selected from the group consisting of porous materials, cyclodextrins and mixtures thereof.

15. The method according to claim **14**, wherein the skin damages caused by chemotherapeutic treatment are the palmar-plantar erythrodysaesthesia syndrom (PPE), erythema and dry skin.

16. The method according to claim **14**, wherein the hair damage caused by chemotherapeutic treatment is alopecia.

17. The method according to claim **14**, wherein the concentration of the one or more radical scavengers in the topical composition ranges from 0.05 to 45% by weight, relating to the total weight of the composition.

18. The method according to claim **14**, wherein the concentration of the microparticles in the topical composition ranges from 0.1 to 10% by weight, relating to the total weight of the composition.

19. The method for the protection of skin and hair damages according to claim **14**, wherein the composition is administered to the concerned skin and/or scalp areas of the mammal prior to, during and/or subsequent to chemotherapeutic treatment with cytostatic agents, preferably 1 day prior to treatment, during the treatment and at least 6 to 7 days after the treatment.

20. The method according to claim **14**, wherein the composition is administered to the concerned skin or scalp area at least twice daily, preferably in an amount of at least 2 mg/cm^2, especially in an amount of 2 to 10 mg/cm^2.

21. The method according to claim **14**, wherein the topical administration of the composition to the scalp includes a massage of the scalp, preferably from 5 to 10 minutes.

22. Kit for the protection or treatment of hair damages caused by chemotherapeutic treatment consisting of

a) a topical composition comprising one or more free radical scavengers and microparticles having an average particle size ranging from 5 to 200 μm, wherein the concentration of the radical scavenger(s) in the composition ranges from 0.05 to 45% by weight, and the concentration of the microparticles in the composition ranges from 0.1 to 10% by weight and

b) a shampoo comprising a free radical scavenger up to 2% by weight of the total weight of the shampoo.

23. Kit for the protection or treatment of skin damages caused by chemotherapeutic treatment consisting of

a) a topical composition comprising one or more free radical scavengers and microparticles having an average particle size ranging from 5 to 200 μm, wherein the concentration of the radical scavenger(s) in the composition ranges from 0.05 to 45% by weight, and the concentration of the microparticles in the composition ranges from 0.1 to 10% by weight and

b) a cleansing milk comprising a free radical scavenger up to 2% by weight of the total weight of the cleansing milk.

24-25. (canceled)

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