From A to K – Vitamin dictionary focussing on skin care

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Besides minerals and omega-3- and omega-6-fatty acids, the vitamins are a group of vital substances for the human metabolism that can only be orally ingested or topically absorbed. Dr Lautenschläger, chemist, has compiled a list of the most important vitamins for the skin care.

In company with enzymes that are endogenously produced, the vitamins control biochemical reactions in the body. While enzymes work as catalysts and can regularly be substituted by new formation, the vitamins use up and cannot be synthesised although they usually are incorporated into endogenous cycles in which they are recycled to a certain extent. Just to mention an example: after their antioxidative effects, most but not all of the abreacted vitamin E molecules are regenerated with the help of vitamin C. After a certain time, however, there is need for exogenous replenishment.

On the skin surface and depending from the applied dose, the vitamins have completely different effects than in the intra-physiological context. Vitamin C can be mentioned here as a significant example which in its form as free ascorbic acid in high concentration has keratolytic effects outside the body analogous to an alpha hydroxy acid.

Vitamin B_{12} cannot be topically absorbed and only has a slight antioxidant effect on the skin surface due to its high molecular mass.

Besides its genuine functions, provitamin B_5 has additional effects on the skin that are not allowed for in physiological respect – such as for instance the increased skin hydration or the penetration-enhancing effects for exogenous active agents.

In their campaigns for cosmetic skin care products sales promotion departments freely use information on the effects of vitamins as known from technical literature for vitamin deficiency. However, these effects will never materialise with a balanced way of life. In the following survey only the cosmetic effects and the resulting applications are compiled.

Vitamin[1)]	Chemical name or alias	Cosmetic purpose[2)]	Synergies and limiting conditions	Carrier[3)] and processing	Cosmetic stabilisation	Derivatives[4)], provitamins[5)] and substitutes[6)]
Vitamin A	Retinol Occurrence: herbal oils (carotenoids); synthetic	• Regeneration: stimulation of cell growth and collagen formation • Blemished (acne) skin • Aging skin • Scars and cornification disorders • Oxidises into vitamin A acid (INN: Tretinoin) in the skin which has been banned as a cosmetic ingredient	• Irritation threshold (erythema) and tolerance increase with continued application • Begin with low doses! Receptors multiply • Not to be used during sun exposure! • BfR[7)] (31.1.14): not to be used in lip- and body care preparations; only for facial and hand care • Regeneration: combination with vitamin B_3	• Oil phase of emulsions • Nanodispersions (carrier) with carrier oils	• Retinoids are oxygen- and photosensitive • Combination with vitamin C and/or vitamin E • Light-tight containers	• Derivatives (esters): retinyl acetate, retinyl propionate and retinyl palmitate are more frequently used than free vitamin A; cleavage by dermal esterases • Retinal (aldehyde): pre-stage of vitamin A acid • Provitamins: β-carotene and other carotenoids • 3-Dehydroretinol (Vitamin A_2)
Vitamin B_1	• Thiamin • Alias: aneurin Occurrence: yeast extract; synthetic	• Blemished skin • Accompanied by other B-vitamins in yeast extract	• Heat-induced degradation and slow degradation in water generates a meat-like flavour. Storage-induced losses when contained in aqueous cosmetic preparations. • Due to its characteristic flavour it is rarely added to cosmetic products.	• Water phase of emulsions • Liposomes (carrier)	• Instable in aqueous medium; the thus generated flavour and also the flavour of yeast extracts is rarely accepted.	• Alternative: used as a solid matter in food supplements
Vitamin B_2	Riboflavin Occurrence: yeast extract; biotechnological	• Yellow food colour (E 101) • Participating in the formation of oxidoreductases (enzymes)	• Rarely used as a pure substance due to its colour and low solubility	• Water phase of emulsions	• Cosmetically stable	• Alternative: food supplement
Vitamin B_3 (non-essential)	• Niacin (nicotinic acid or • Niacinamide (nicotinamide); standard form in cosmetic products Occurrence: yeast extract; synthetic	Niacinamide: • Skin regeneration (incl. barrier) • Anti-inflammatory • Inhibition of melanin formation • Reduction of sebum production	Niacinamide: • Synergy with tranexamic acid (effective against hyperpigmentation) • Regeneration: combination with vitamin A	Niacinamide: • Water phase of emulsions • Liposomes (carrier)	• Nicotinic acid and nicotinamide are cosmetically stable	Derivatives: • Depending on the alcohol component, nicotinic acid esters have more or less vaso-dilating effects (hyperaemic effects). • Tocopheryl nicotinate (ester with vitamin E) stimulates dermal microcirculation • Nicotinic acid benzyl ester is a component of warming anti-rheumatic ointments
Vitamin B_5	Pantothenic acid Occurrence: yeast extract; synthetic; D-panthenol usually is used as a provitamin	D-panthenol: • Moisturizer • Anti-inflammatory • Cell formation • Epithelisation • Antipruritic	• Pre-treatment with D-panthenol before the application of cosmetic masks. Due to the toning the skin easily integrates the active agents contained in masks.	D-panthenol: • Water phase of emulsions • D-panthenol is a penetration-enhancing substance	• D-panthenol and pantothenic acid are cosmetically stable	• Provitamin D-panthenol is a frequently used cosmetic component
Vitamin B_6	• Pyridoxine (alcohol) or • Pyridoxal (aldehyde) or • Pyridoxamine (amine) Occurrence: brewer's yeast extract; synthetic	• Treatment of seborrhoeic skin • Blemished skin	Yeast extract often is preferred to the pure components: • Pyridoxine hydrochloride • Pyridoxal is the most stable among the three forms of the vitamin	• Water phase of emulsions • Liposomes (carrier)	• No long-term stability in aqueous cosmetics, hence only rarely used in its pure form	• Alternative: food supplement
Vitamin B_7	• Biotin • German alias: vitamin H Occurrence: yeast- and wheat germ extract; synthetic	• Growth failure of hairs, nails and skin	• Low solubility in water • Combination with allantoin (complex)	• Water phase of emulsions • Liposomes (carrier)	• Cosmetically stable	• Meaning of the old German term vitamin H (H = "Haut", English translation: skin)
Vitamin B_9	• Folic acid • Alias: folate • German alias: vitamin M Occurrence: yeast- and wheat germ extract; synthetic	• Due to its instability rarely used in cosmetics • Regenerative effects when used with other B-vitamins (yeast extract)	• Yellow colour • Limited storage of aqueous preparations, even when cooled	• Water phase of emulsions • Liposomes (carrier)	• Oxygen- and photosensitive • Combination with antioxidants • Light-tight containers	• Alternative: food supplement
Vitamin B_{12}	Cobalamin Occurrence: yeast extract; biotechnological	• Skin care benefits still have to be proved	• Red colour	• Water phase of emulsions • Liposomes (carrier)	• Cobalamin is an antioxidant	• Alternative: food supplement

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Vitamin C	Ascorbic acid Occurrence: herbal extracts; synthetic (main use)	• Antioxidant • Radical scavenger Liposomal ascorbyl phosphate (AP) in low concentration: • Tyrosinase inhibition • Collagenase inhibition • Stimulation of the collagen synthesis	• Fruit acid analogous keratolysis due to concentrated free acid • In contrast to free acid, liposomal AP penetrates into the skin; low concentrations can suppress melanin formation during laser treatments.	• Water phase of emulsions • AP-liposomes (carrier) • Oil phase of emulsions: ascorbyl palmitate, ascorbyl stearate	• Combination with vitamin E	Derivatives: • Ascorbyl phosphate (AP), water-soluble • Ascorbyl palmitate and ascorbyl stearate, oil-soluble
Vitamin D_3 (non-essential)	• Cholecalciferol • Alias: calciol Occurrence: minor amounts in avocado oil, wheat germ oil; synthetic production from animal or herbal prestages	7-Dehydrocholesterol, after dermal conversion into vitamin D_3 it has analogous functions, among others: • Influence on the formation of antimicrobial peptides (AMP) • Influence on the keratinocyte differentiation (psoriasis)	• Vitamin D_3 and vitamin D_2 (ergocalciferol) are not licenced in cosmetics • UV filters are counterproductive for the endogenic synthesis of vitamin D	7-Dehydrocholesterol: • Oil phase of emulsions • Nanodispersions (carrier) with carrier oils	7-Dehydrocholesterol: • photosensitive	• UV-B radiation transforms provitamin 7-dehydrocholesterol into vitamin D_3 • Alternative: food supplement
Vitamin E	• α-, β-, γ- and δ-Tocopherol (herbal oils) • dl-α-Tocopherol (isomer mixture, synthetic)	• Antioxidant, for instance in combination with vitamins A and C • Epithelisation • Skin hydration	• Radical chain reactions in the case of high dosage and UV radiation	• Oil phase of emulsions • Nanodispersions (carrier)	• Combination with Vitamin C • Esters only have antioxidative effects after cleavage by dermal esterases	• The derivatives (esters) tocopheryl acetate, tocopheryl palmitate, tocopheryl linoleate are frequently used
Vitamin K	• K_1: phylloquinone (synthetic) or • K_2: menaquinone (intestinal flora)	• K_1: reduction of erythema (rosacea), • K_2: stabilisation of the blood capillaries (rosacea, couperosis)	• Since 2009 banned in cosmetics due to the risk of pre-sensitisations (with surgery)	• Oil phase of emulsions • Nanodispersions (carrier) with carrier oils	• Photosensitive • Light-tight containers	• Physiological vitamin K epoxide is not banned although in topical- allergological respect it is more critically seen than vitamin K. • Substitutes for the rosacea and erythema treatment: butcher's broom extract, tranexamic acid, echinacea extract, boswellic acids

[1)] The numerical gaps in the enumeration of vitamins are due to the fact that the formerly assumed vitamin properties of the vitamins B_4, B_8, B_{10} and B_{11} have not been proved.
[2)] The typical vitamin deficiencies as described in literature have neither been listed in the table nor in the section cosmetic purpose since they will never materialise in the context of a normal European diet. Functions and occurrence have been specified in H. Lautenschläger, Vitamine in der Kosmetik, medical Beauty Forum 2011 (1), 14-16 und (2), 16-18.
[3)] The carrier function of liposomes and nanodispersions is based on their content in native phosphatidylcholine that fluidises the skin barrier and so improves its permeability for active agents.
[4)] Derivatives are chemical modifications of the vitamins; they are enzymatically transformed into free vitamins in the skin. By-products of this process are further physiological substances such as acidic acid, propionic acid, palmitic acid, stearic acid, linoleic acid, phosphoric acid or alcohol.
[5)] Provitamins are naturally occurring physiological compounds that are enzymatically transformed into vitamins in the skin.
[6)] Substitutes are active agents without structural resemblance to vitamins but with (partially) analogous cosmetic effects.
[7)] BfR: Bundesinstitut für Risikobewertung (Federal Institute for Risk Assessment in Germany)

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