

# Nutrition and nutritional supplementation

## Impact on skin health and beauty

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Skin acts as a natural barrier between internal and external environments thus plays an important role in vital biological functions such as protection against mechanical/chemical damages, micro-organisms, ultraviolet damage. Nutrition has a critical impact on strengthening skin's capabilities to fight against these multiple aggressions.

Nutritional deficiencies are often associated with skin health disorders, while diets can either positively or negatively influence skin condition. More recently, the concept of nutritional supplementation has emerged as a new strategy in the daily practice of dermatology as well as a complementary approach to topical cosmetics in the field of beauty. Focusing on human clinical data, this paper proposes to illustrate the link between skin health and nutrition and to exemplify the beneficial actions of nutritional supplementation in skin health and beauty.

### Introduction

Skin is the most extended and heaviest organ of the human body acting as a barrier between the internal and external environment. Skin structure associates tissues from various origins (epithelial, connective, vascular, muscular and nervous) and is organized in three different layers: the epidermis, the dermis and the hypodermis. With the exception of epidermis which is a non-vascular tissue, skin possesses a rich vascular network involved in tissues feeding, thermoregulation, wound healing, immune reactions and control of blood pressure.

Nutrition is defined as a biological process in animals and plants involving the intake of food and its subsequent assimilation into the tissues. From the 20<sup>th</sup> century scientists have identified different nutrients, which constitute the food and have defined nutritional standards and recommendations in order to prevent deficiencies and to promote human health. Nutritional supplements are defined as concentrated sources of nutrients or other substances with a nutritional or physiological effect that supplement the normal diet. At the beginning of the 21<sup>st</sup> century, increase life expectancy has emerged as new preoccupation for industrial countries and for nutritional science, which one of the challenges is to offer new strategies to improve the quality of human life.<sup>1</sup> In this context, nutritional supplements may be used to optimize diet and consequently to improve quality of life. Increased life expectancy is also associated with a need to appear healthy and handsome. Beside the traditional use of topical care, nutritional supplements have emerged as a new strategy to improve skin beauty.

Focusing on human clinical data, this paper proposes to illustrate the link between skin health and nutrition, and more particular the

effects of malnutrition and diets on cutaneous disorders and beneficial actions of nutritional supplementation in skin health and beauty.

### Influence of Diet Deficiencies and Specific Diets on Skin Health

Nutrition is one of the most important parameters that is involved in modulating skin health and condition.<sup>2,3</sup> Some of our understandings come from the description of the cutaneous manifestations of nutritional deficiencies.<sup>4,5</sup> In the 1970s, Vasantha et al.<sup>6</sup> demonstrated that kwashiorkor, a severe protein/calorie deficiency, was associated with skin biochemical changes in children, thus providing an explanation for the occurrence of cutaneous lesions of this syndrome. More recently, the reduction of total melanin content of scalp hair has been reported to be a characteristic of malnutrition in children.<sup>7</sup>

The impact of malnutrition on skin health is also illustrated by skin changes (xerosis, hair effluvium, nail modifications...) observed in anorexia nervosa.<sup>8</sup>

Vitamin deficiencies whether due to malnutrition or other factors (malabsorption and genetic defects) are associated with various dermatological modifications such as pellagra the classical image of niacin deficit,<sup>9</sup> or hyperpigmentation which is associated with B<sub>12</sub> deficiency.<sup>10</sup> Also trace elements are essential for skin health and their deficit is related to skin modifications.<sup>2,11</sup>

Malnutrition as well as excessive food intake can impair skin physiology. Indeed, obese people exhibit significant increase in transepidermal water loss suggesting an alteration of skin barrier function. Furthermore, obesity may affect sebum production, contribute to micro and macro circulation changes, and modify

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collagen metabolism. Finally, obesity is associated with a number of dermatoses such as acanthosis nigricans, acrochordons and keratosis pilaris.<sup>12</sup>

Wound healing is a complex phenomenon involving interactions between different cells type, cytokine, and the extracellular matrix. Nutritional deficiencies can impair wound healing, while some nutrients (vitamins A and C, zinc, glucosamine) may reduce healing time and improve wound quality.<sup>13</sup>

Still controversial,<sup>14</sup> the link between diet and acne has been recently highlighted by a study on male volunteers with acne showing a greater improvement in total lesion count in the low glycemic diet group compared to the control group.<sup>15</sup> In the same study, acne lesion count has been shown to be correlated with the increase of the ratio of saturated to monounsaturated fatty acids of skin triglycerides.

Atopic dermatitis (AD) is a chronic inflammatory skin disorder characterized by an impaired skin barrier function associated with a Th2-driven T cells overproduction. Foods hypersensitivity seems to play a pathogenic role in the development of AD lesions<sup>16</sup> and dietary exclusion of specific food has been reported to improve the disease in children.<sup>17</sup> Moreover, Tanaka et al.<sup>18</sup> have recently evaluated the effect of a vegetarian diet as an alternative therapy for the management of AD. After 2 months of this specific regimen, the SCORAD (SCORing Atopic Dermatitis) decreased by almost 50%.

Diet has also been described to play a key role in the etiology and pathogenesis of psoriasis, one of the most common chronic skin inflammatory disorders.<sup>19</sup> Low energy diet could be an important adjuvant factor in the prevention and treatment of psoriasis.<sup>20</sup> Vegetarian diet as well as fasting periods may be also beneficial.<sup>21</sup> These effects could be explained by a lack of arachidonic acid, limiting thus the inflammation cascade and a reduction of oxidative stress due to caloric restriction.

Furthermore some evidences exist about the influence of food on the development of UV-induced skin lesions. Indeed, a review of the results obtained in epidemiological studies suggests a positive relationship between fat intake and both basal and squamous cell carcinoma.<sup>22</sup> A few years later, the same team demonstrated, in a cohort of 1,360 adults, that diet with high meat and fat intake significantly increases the risk of squamous cell carcinoma, particularly in persons with history of skin cancer.<sup>23</sup> In 2009, the results of a prospective study showed a moderate decrease of actinic keratosis among the highest consumers of fish oil.<sup>24</sup> In the same way, some dietary factors present in the Mediterranean diet might protect against skin melanoma.<sup>25</sup>

### **Beneficial Effects of Nutritional Supplementation on Skin Health and Beauty**

Many attempts have been made to improve skin health and beauty by changing or by supplementing the diet.<sup>26</sup> In 2001, Boelsma et al.<sup>27</sup> reviewed the effects of vitamins, carotenoids and fatty acids supplementation in optimizing skin condition and preventing skin diseases and concluded that nutritional factors show potential beneficial actions on the skin.

Specific nutritional interventions using probiotics are described in some studies to exert beneficial effects in the treatment and/or prevention of AD, with a decrease in SCORAD or a decrease of the frequency of AD in the first two years of life.<sup>28</sup> In a recent paper Koch et al. reported the beneficial effect (decrease of SCORAD) of docohexaenoic acid supplementation in atopic eczema.<sup>29</sup> In the same way, oral evening primerose oil has shown to have a beneficial effect in eczema<sup>30</sup> and a dietary supplement with fish oil has shown beneficial effect in the management of psoriasis and eczema.<sup>31</sup>

Photoprotection obtained by nutrients is well documented. Skin exposure to ultra-violet (UV) leads directly or indirectly through the generation of reactive oxygen species to a large range of photodamage affecting cellular lipids, proteins and DNA. It is involved in erythema appearance, premature skin aging, photo-immunosuppression and skin cancer.<sup>32-34</sup>

The most frequent damage induced by UV exposure is sunburn, and evidence of nutritional supplementation in sunburns' prevention has been reported.  $\beta$ -carotene (from 15 to 180 mg/day) and lycopene (up to 10 mg/day), two efficient singlet oxygen quenchers, have been shown to prevent sunburn in humans.<sup>35-38</sup> Systemic administration of antioxidants such as vitamins C (2 mg/day) and E (1,000 IU/day), as well as dietary fish oil (2 g/day) rich in omega-3 free fatty acids increased minimal erythema dose.<sup>39,40</sup> The effect of fish oil on UV-induced inflammation may be partially explained by its ability to reduce prostaglandin  $E_2$  levels.<sup>41</sup> Polyphenol provided by the ingestion of high flavanol cocoa (326 mg/day) reduced UV-induced erythema.<sup>42</sup> *Polypodium leucomotos* (7.5 mg/kg body weight), a tropical fern plant used traditionally in Central America for the treatment of anti-inflammatory disorders, has also been shown to counteract the erythemagenic effect of UV exposure.<sup>43</sup> Finally a specific association of a probiotic (*Lactobacillus johnsonii*, La1) with carotenoids ( $\beta$ -carotene: 4.8 mg/day; lycopene: 2 mg) was also shown to increase minimal erythema dose.<sup>44</sup>

UV exposure can lead to both direct and indirect DNA damage. The major direct DNA damage is the release of cyclobutane pyrimidine dimers (thymine dimers and 6–4 photoproducts). Placzek M et al.<sup>45</sup> have shown that the oral administration of vitamins C (2 mg/day) and E (1,000 IU/day) during 3 months had a protective effect against UV-induced thymine dimers.

UV exposure also causes local and systemic immunosuppression, and several mechanisms are involved in this deleterious effect, among which UV-induced depletion of Langerhans cells (LC), the major antigen presenting cells in the skin.<sup>46</sup>

A placebo controlled study demonstrated that  $\beta$ -carotene (30 mg/j) protects against photo-immunosuppression.<sup>47</sup> Oral administration of *Polypodium leucomotos* (1,080 mg) prior to UV exposure seemed to protect CD1a<sup>+</sup> cell density and to preserve the dendricity of immune cells.<sup>48</sup> More recently, oral supplementation with the probiotic strain *Lactobacillus johnsonii* has been shown to accelerate the recovery of human skin immune homeostasis after UV-induced immunosuppression.<sup>49</sup> This specific strain associated with carotenoids ( $\beta$ -carotene: 4.8 mg/day; lycopene: 2 mg) was also able to counteract UV-induced decrease of LC density in human volunteers.<sup>44</sup>

Increased life expectancy is associated with a need to appear healthy and handsome. Very recently, epidemiological study evidence that multivitamin use is associated with longer telomere length, a marker of biological aging, in women.<sup>50</sup> Skin, especially facial skin, is one of the most important factors in attractiveness. Two papers reported that food and nutrients intake can influence skin aging. In 2001, Purba et al. described that actinic damage especially skin wrinkling may be associated with food habits. In this study, high intake of vegetables, legumes and olive oil seem to be protective against cutaneous actinic damage.<sup>51</sup> In another paper, higher intakes of vitamin C and linoleic acid and lower intakes of fat and carbohydrates were shown to be associated with better skin appearance.<sup>52</sup> Beside the traditional use of topical care, nutritional supplements have emerged as a new strategy to improve skin beauty.

Yamakoshi et al.<sup>53</sup> investigated the effect of oral intake of a proanthocyanidine enriched-extract (201 mg a day, during 6 months) on facial hyperpigmentation in women and demonstrated that this extract was able to improved chloasma determined by clinical evaluation as well as by using colorimetric method. Oral fish polysaccharides (3 x 250 mg per day, during 8 weeks) associated with an antioxidant mix have been shown to improve dermal thickness, skin wrinkling, color and viscoelasticity after 2 months of supplementation.<sup>54</sup> Silicon (20 mg per day) taken during 20 weeks enhanced skin microrelief and mechanical properties in women with photo-damaged skin.<sup>55</sup> A combination of lycopene (6 mg), vitamin C (60 mg) and soy isoflavones (50 mg) has been shown to maintain skin density, improve skin firmness, microrelief, hydration and tone in menopausal women.<sup>56</sup> Hair loss is a very common problem for both men and women: it affects up to 80% of men and 50% of women in their life time.<sup>57</sup> It has been shown in both men and women that the association of

antioxidants with polyunsaturated fatty acids, zinc, taurine and plant polyphenols was able to restore a more balanced hair cycle leading to decreased hair loss and increased hair density together with an improvement of hair quality.<sup>58</sup>

In recent decades, the incidence of subjects presenting reactive skin has considerably increased in industrialized countries. Reactive skin is characterized by marked sensitivity of the skin to physical (heat, cold, wind) or chemical (topical product application) stimuli and occasionally by impaired ability for skin barrier function recovery. A recent study demonstrated that after 43 days of supplementation, a specific probiotic called *L. paracasei* decreased significantly skin sensitivity compared to placebo, and also increased the recovery rate of the skin barrier function induced by mechanical disruption.<sup>59</sup>

## Conclusions

The data presented in this paper show evidence of a clear link between nutrition and skin condition demonstrating the impact of nutrition on skin health and beauty. Evidence from literature review as well as internal published or unpublished work show that appropriate nutritional supplementation is beneficial in the prevention of the harmful effect of UV exposure, in the management of skin aging and of reactive skin, as well as for limiting hair loss.

Altogether, the data show that a balanced diet associated with cosmetics and/or oral supplementation at nutritional dose and/or drugs could represent a globalized approach for improving skin health and beauty.

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