

## OUTLOOK ON ROLE OF VITAMINS IN COSMECEUTICALS

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### ABSTRACT

Cosmetics are products used to enhance the appearance of one's and cosmeceuticals take the concept of cosmetics and elevate it to another level by using various compounds for that not only beautify the appearance but also takes care of the skin. With the desire of looking young for as long as possible cosmeceuticals are at the center of attention. Cosmeceuticals incorporate various substances like vitamins, minerals, peptides, growth factors and botanical extracts for the protection of the skin. Vitamins A, B, C, E and K all find their use in skin protection and healing. Vitamin A and beta-carotene finds its use in the anti-aging preparations as well as in the treatment of acne vulgaris. Vitamin B<sub>3</sub> (nicotinamide) is frequently used in cosmeceuticals. Vitamin C in its active form and other esters is a competent cosmeceuticals agent. Vitamin E is termed as the "protector" vitamin of its UV protective properties while Vitamin K also is an important because of its blood clotting factor. This review puts light on the role of these various compounds used in the formulation of cosmeceuticals backed by the relevant scientific data from various experiments and studies including both in-vitro as well as in-vivo studies performed over the years.

**KEYWORDS:** Cosmetics, Cosmeceuticals, Vitamin, Antioxidant, Anti-aging, Acne, Photo-aging.

### Abbreviations used

UVA: - Ultraviolet A; UVB: - Ultraviolet B; ROS: - Reactive Oxygen Species; DNA: - Deoxyribonucleic Acid; RNA: - Ribonucleic Acid; AP: - Activator protein; MMP: - Matrix Metalloproteinase; NF: - Nuclear Factor; TGF-B: - Transforming Growth Factor-b.

### 1. INTRODUCTION

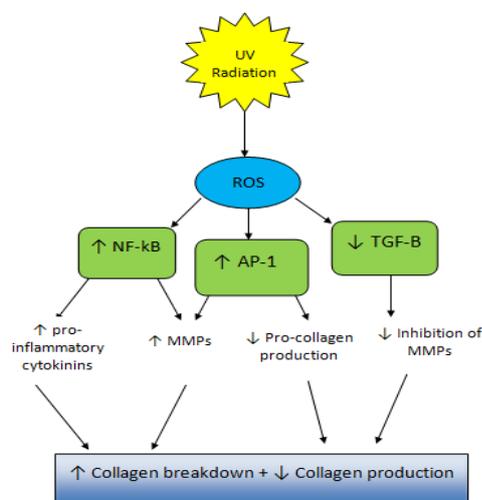
Cosmetics are readily available goods that are used to enhance the skin's look.<sup>[1]</sup> Cosmetics are items designed to be rubbed, poured, sprinkled, sprayed, injected into, or otherwise applied to the human body for washing, beautifying, boosting attractiveness, or altering the look without affecting structure or function, according to the Food, Drug, and Cosmetic Act.<sup>[2]</sup> More than 25 years ago, Albert Kligman of the University of Pennsylvania coined the term "cosmeceutical" to designate products containing active ingredients but not being either pharmaceuticals or cosmetics.<sup>[3]</sup> Products with active substances that can change structure or function are referred to as cosmetics or pharmaceuticals, respectively.<sup>[4,5]</sup> Cosmeceuticals may be chemically made or biologically derived. The ideal ingredients for cosmeceuticals should be those that can be digested by skin and are safe, effective, new, stable, economical to produce, and all of the above.<sup>[6]</sup> People want to seem young for as long as possible, which is why there is an

increasing desire for products that lessen the cosmetic signs of ageing.<sup>[7]</sup>

The medications included in cosmeceutical treatments still have a lot of hot-button issues, including their modes of action, ideal concentrations, physiologically active forms, formulation stability, penetration, and retention in the skin.<sup>[8]</sup> These substances are represented by vitamins, peptides, growth factors, and botanical extracts and can be found in a variety of formats.<sup>[7]</sup> Vitamins are necessary substances for a variety of bodily processes. While certain vitamins can be produced, others must be obtained from a balanced diet. The most crucial ones are folic acid, vitamins A, B, C, D, E, and K.

It is hypothesized that the molecular mechanisms of photo-aging, which also affect all other organs, are the same for chronologic skin ageing.<sup>[9]</sup> Chronologic ageing is connected to two significant pathways. One is the gradual shortening of the telomere, which is followed by its disruption from low-grade oxidative damage. This is a result of aerobic cellular mitochondrial metabolism and also has an impact on other cellular components. Reactive oxygen species (ROS), often known as free radicals, are what start damage.<sup>[10]</sup> Consequences include oxidation of membrane lipids, which affects transport and transmembrane signaling, damage to DNA leading

to mutations, reduction in protein functions, and decline in protein functions over time.<sup>[11]</sup> The daily and continuous application of sunscreen that blocks both UVB and UVA is the most crucial precaution to take in order to prevent photo damage.<sup>[12]</sup> The potential impact of topically applied and systemically administered antioxidants that improve ROS neutralization is another strategy.<sup>[11]</sup> (Fig.1)



**Fig 1. Effects of UV radiation on skin. Reactive Oxygen Species (ROS), which are driven on by UV, can damage DNA and have an impact on variety of transcription factors in the nucleus. Collagen production is adversely affected, and it is extensively destroyed. AP: - Activator protein; MMP: - Matrix Metalloproteinase; NF: - Nuclear Factor; TGF-B: - Transforming Growth Factor-b.**

Some of these effects can be produced by growth hormones, hydroxy acids, and topical vitamins. When these items are utilized prior to and following the completion of procedures offered by cosmetic dermatology, the outcomes are better.<sup>[13]</sup> Cosmeceutical products are expected to be as safe as cosmetics and not behave like drugs. They exhibit performance traits that point to possible pharmacological effect, although they are registered (as required) and offered for sale as cosmetics.<sup>[14]</sup>

They frequently cost a lot of money, have little to no effect, and offer the myth of permanent beauty. On the other hand, there is a lot of evidence to support the use of topical vitamins, particularly vitamin A, in the treatment of acne vulgaris. Pharmaceuticals employ vitamin A more commonly than cosmeceuticals do. Acne is a multifactorial disease characterized by excessive sebum production by the sebaceous glands in response to an increase in androgen levels at the beginning of puberty, ductal hyper cornification of the follicles, and proliferation of *Propionibacterium acnes* and other bacteria that activate the toll like receptors, attracting lymphocytes, neutrophils, and macrophages.<sup>[15,16,17]</sup>

Niacinamide, also known as vitamin B<sub>3</sub>, is an additional treatment for some types of acne and ageing skin. It is a component of cosmetic and cosmeceutical products. Because of its mild anti-inflammatory properties, potential role in the decrease of sebum production, and potential improvement of the skin barrier, nicotinamide is valuable as a supplemental medication.<sup>[18,19,20]</sup>

## 2. Role of Different Vitamins

### 2.1. Vitamin A

Beta-carotene (pro vitamin A), vitamin A and its derivatives, and other ingredients have long been used as cosmetic additives. Beta-carotene can be found in foods like tomatoes, carrots, and other yellow vegetables. The main sources of vitamin A are animal products like liver and egg yolk. A powerful lipid-soluble antioxidant that serves as a precursor to vitamin A, beta-carotene can quench the highly reactive free radical singlet oxygen. Singlet oxygen has the ability to cause DNA damage and is mutagenic.<sup>[21,22]</sup> It has been demonstrated that beta-carotene has topical photo protective properties. It has been shown through research on the skin of mice and guinea pigs to offer UVA radiation protection.<sup>[23, 24]</sup> Beta-carotene and vitamin A were also discovered to be photo protective by reducing the amount of lipid peroxyl radicals in UV-exposed murine skin.<sup>[25]</sup>

Since many years ago, retinyl palmitate, a vitamin A ester, has been included in cosmetics. It is stable in formulation and has a high molecular weight. However, it is regarded as the least potent topical retinoid.<sup>[26]</sup> There is evidence that topical retinyl palmitate has some benefits for the skin. It has been reported to boost epidermal thickness in human skin.<sup>[27]</sup> In a different study, hairless mice received topical retinyl palmitate for fourteen consecutive days, which raised the amount of protein, collagen, DNA, and thickened the epidermis.<sup>[28]</sup>

For almost 40 years, topical retinoids have been used to treat acne. A retinoid was originally a substance with properties that resembled those of retinol. Three generations of topical and systemic retinoids—the non-aromatics (retinol, tretinoin, and isotretinoin), the mono-aromatics (etretinate and acitretin), and the poly-aromatics (arotinoid, adapalene, and tazarotene)—have been produced as a result of variations in this molecule.<sup>[29]</sup>

The preferred vitamin A component in cosmetics nowadays is retinol. It is a clinically effective addition to skin care products when stabilized in the mix by guarding it from disintegration from oxygen and light. According to one study, applying retinol to human skin in-vivo boosted epidermal thickness and the mRNA levels of the proteins that bind retinoic acid and retinol in cells.<sup>[30]</sup>

All-trans-retinoic acid, often known as tretinoin, is unquestionably the gold standard for retinoid action on the skin. Tretinoin was first used to treat acne, and

Kligman was the one to identify and document its advantages for photo damaged skin.<sup>[31,32,33]</sup> When applied to photo damaged skin, tretinoin's clinical effects on wrinkles and roughness were improved, and lentigines and melasma were lightened.<sup>[34,35,36]</sup> Reduced corneocyte adhesion and epidermal hyperplasia, increased Langerhan cells, and enhanced collagen, elastin, and angiogenesis are some of the objective histologic alterations brought on by tretinoin.<sup>[37]</sup>

Two more topical retinoid agents, isotretinoin and tazarotene, have shown some advantages, although the degree of evidence is less strong.<sup>[38]</sup> The optimal concentrations of tretinoin cream (0.025%, 0.05%, and 0.1%), as well as isotretinoin (0.1%), and tazarotene (0.1%), usually cause moderate to severe skin irritation. Additionally, because they are still considered prescription medications, there is rising interest in using other retinoids (retinol, retinaldehyde, retinyl propionate, and retinyl palmitate), which are approved as ingredients in cosmeceutical products, to achieve the same results.<sup>[39,40]</sup> Another effective topical medication for the treatment of photoaged skin is retinaldehyde (0.05%). Though less effective than tretinoin, it causes irritation less frequently. Sadly, hardly many clinical trials have examined this intriguing drug.<sup>[41,42]</sup>

## 2.2. Vitamin B

When applied topically, the vitamin B<sub>3</sub> form, niacinamide, also known as nicotinamide, has been proven to offer some fascinating advantages. Acne has been demonstrated to improve as a result of niacinamide's anti-inflammatory characteristics.<sup>[43,44]</sup> Niacinamide's pyridine ring is thought to be the source of its anti-inflammatory properties.<sup>[45]</sup> Additional research on the anti-inflammatory properties of niacinamide has revealed suppression of antigen-induced lymphocyte transformation and inhibition of inflammation caused by potassium iodide.<sup>[46]</sup>

Additionally, topical niacinamide showed promise for the treatment of rosacea, pityriasis rubra pilaris, psoriasis, and isonizid-induced pellagra-like skin eruptions.<sup>[47,48,49]</sup>

Vitamin B<sub>3</sub> also protected immunosuppression and skin cancer in UV irradiated mice, like some other topically applied vitamins.<sup>[50]</sup> Such a discovery points to some photo protection, possibly via antioxidant action. The ability of niacinamide to function as both a protease inhibitor and a stimulant of DNA repair may be one of its other anti-carcinogenic properties.<sup>[51,52]</sup>

## 2.3. Vitamin C

L-ascorbic acid, also known as vitamin C, is the most prevalent antioxidant in human skin. The majority of creatures and plants are able to produce vitamin C. Humans are an exception to this rule because humans are no longer able to generate the enzyme required for its creation, L-gulonogamma-lactone-oxidase.<sup>[53]</sup> The rise in skin vitamin C content, even with extensive oral supplementation, is modest.<sup>[54]</sup>

The capacity of vitamin C to immediately squelch UV-induced free radicals and renew vitamin E, another effective antioxidant, is one reason for its interest as a cosmetic element.<sup>[55,56]</sup> Due to its capacity to promote collagen formation, vitamin C is also regarded as a component of anti-aging products.<sup>[57]</sup> In the aqueous compartment of the cell, water-soluble vitamin C works by giving electrons, dissipating free radicals, and shielding intracellular structures from oxidative stress.<sup>[58]</sup>

Recent research has shown that vitamin C affects collagen production by increasing its transcription and stabilizing pro-collagen messenger ribonucleic acid, acting independently of hydroxylation.<sup>[59]</sup> Inhibiting the biosynthesis of elastin is another way that ascorbate aids in the treatment of photo damaged skin.<sup>[60]</sup>

In one research, topical ascorbyl palmitate was found to be thirty times more efficient than ascorbic acid at inhibiting some of the biochemical factors linked to the development of skin tumours in mice.<sup>[61]</sup> After UV burning, application of ascorbyl palmitate reduced redness 50% faster than untreated areas on the same patient.<sup>[62]</sup> Ascorbyl palmitate therapy has demonstrated clinical improvement in other dermatologic disorders such psoriasis and asteototic dermatitis, which involve inflammation as a part of the disease process.<sup>[63]</sup>

Magnesium ascorbyl phosphate was discovered to shield hairless mice from UVB radiation-induced lipid peroxidation.<sup>[64]</sup> Magnesium ascorbyl phosphate was shown to be equal to ascorbic acid in stimulating collagen synthesis and to be stable at a neutral pH in an in-vitro examination of monolayer human fibroblast cells.<sup>[65]</sup> An additional in-vitro experiment using fibroblasts from human skin in culture showed improved collagen synthesis and cell proliferation.<sup>[66]</sup> When using a 10% magnesium ascorbyl phosphate cream, melasma and senile freckles showed a clinical improvement in an in-vivo study conducted on human skin.<sup>[67]</sup> Another ascorbate derivative that stimulated cultured human skin fibroblasts in-vitro and enhanced collagen synthesis was 2-alpha-D-glucopyranosyl-L-ascorbic acid, which is also stable in solution and throughout a wide pH range.<sup>[68]</sup>

The most bioactive form of vitamin C, L-ascorbic acid, has been demonstrated to have several positive effects on the skin. Although this type of vitamin C is water soluble, it needs to be made at low pH in order to be stable. It enhances the mRNA for type I and type III pro-collagen in cultured human skin fibroblasts.<sup>[69,70]</sup> Ascorbic acid levels were 20 times higher after 3 days of daily treatment of a 15% solution of L-ascorbic acid, and tissue levels of the vitamin were saturated.<sup>[71]</sup> As a free radical scavenger, ascorbyl-6-palmitate is superior to L-ascorbic acid in various ways.<sup>[72]</sup>

## 2.4. Vitamin E

Due to its capacity to lower lipid peroxidation, vitamin E is said to provide several systemic health advantages for the eyes and cardiovascular systems.<sup>[73,74]</sup> Due to its

physical characteristics, vitamin E absorbs UV light in the part of the solar spectrum that causes the majority of the harmful physiological impacts of the sun.<sup>[75]</sup>

The word "protector" has been used to describe the effects of vitamin E and its derivatives because of their capacity to squelch free radicals, particularly lipid peroxy radicals. Numerous studies have demonstrated their capacity to lessen the erythema and edoema, sunburn cell development, and lipid peroxidation caused by UV radiation.<sup>([76,77,78,79,80,81])</sup> Reduced skin wrinkling and skin tumour growth have been linked to clinical improvement in the obvious indications of skin ageing.<sup>[82,83,84,85,86]</sup>

Although vitamin E's main active form is tocopherol, studies have demonstrated that when given topically, vitamin E esters can also permeate the epidermis.<sup>[87]</sup>

### 2.5. Vitamin K

Phytonadione, a form of vitamin K<sub>1</sub>, is required for the liver to produce a variety of clotting factors. It was discovered that using topical vitamin K at a concentration of 1% twice daily was useful in both hastening the healing of existing bruises and preventing new ones.<sup>[88]</sup>

For under-eye circles, a similar product containing retinol has been tested and is readily available.<sup>[89]</sup> Topical vitamin K can be used to treat and prevent some of the vascular symptoms of ageing since parental vitamin K reduces extended bleeding time.

**Table1. Summary of functions of vitamins in prevention of photo-aging.**

Vitamins	Functions
Vitamin A	<ul style="list-style-type: none"> <li>UV induced collagen breakdown may be prevented</li> <li>Promotes the growth of fibroblast and collagen</li> <li>Increases thickness of epidermal lining</li> <li>Reduces level of MMP</li> <li>Reduces keratinocytes and melanocytes cell atypia preventing promotion of skin cancer</li> </ul>
Vitamin B	<ul style="list-style-type: none"> <li>Reduces hyperpigmentation of skin</li> <li>Increases production of collagen</li> </ul>
Vitamin C	<ul style="list-style-type: none"> <li>May protect skin from damage caused by UV radiation</li> <li>Promotes collagen production</li> </ul>
Vitamin E	<ul style="list-style-type: none"> <li>Shows good antioxidant properties protecting the skin from from UV induced photo-damage</li> </ul>
Vitamin K	<ul style="list-style-type: none"> <li>Reduces photo-aging's vascular symptoms</li> </ul>

### 3. CONCLUSION

The market of cosmetics and cosmeceuticals is growing at a much faster rate at this time due to the fact that people are becoming more and more conscious of their looks and their appearance. The fact that a lot of cosmeceuticals provide the much needed care required by the skin while enhancing the appearance of the skin backed by considerable scientific data makes them even more desirable.

The incorporation of vitamins in cosmeceuticals due to their various beneficial effects has been a popular subject of study for over half a century now. With the advancements in technology it is safe to say we will see much more of these products with improved skin care and anti-aging properties. Vitamins such as A and E work as excellent additives in the smoothening of the skin and also in the treatment of skin conditions such as acne, psoriasis, etc. Vitamin C has remarkable antioxidant properties and is regularly incorporated in the preparations. The topical application of all these vitamins incorporated into a suitable combination provides desirable effects on the skin and its benefit in the protection of skin and prevention of photo-aging. (Table.1)

The exciting world of cosmeceuticals offers much more to us and further research and evaluation of different compounds will ultimately help in creating the perfect product to be used by us.

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