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Review Article

A REVIEW ON ANTIOXIDANT VITAMIN C AND ITS IMPACT ON SKIN HEALTH

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ABSTRACT

Vitamins are essential nutrients that are required for various biochemical and physiological processes in the body. It is well known that most of the vitamins cannot be synthesized in the body and hence their supplementation in the diet is essential. Vitamin C plays an important role in a number of metabolic functions, including the activation of the vitamin B, folic acid, the conversion of cholesterol to bile acids, and the conversion of the amino acid, tryptophan, to the neurotransmitter, serotonin. It is an antioxidant that protects the body from free radical damage. It is used as therapeutic agent in many diseases and disorders. Vitamin C protects the immune system, reduces the severity of allergic reactions, and helps to fight off infections. However, the significance and beneficial effect of Vitamin C in respect to human disease such Melanocytes, which are cells that generate the pigment melanin, which gives skin its color and offers some protection from ultraviolet rays, are found in the epidermis, the outermost layer of skin, which also provides a waterproof barrier and determines our skin tones, however remains equivocal by Vitamin C.

Keywords: Skin, Vitamin C, Supplement, Anti-oxidant, Application.

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INTRODUCTION

In the current era, people have been focusing more on alternatives and actions that preserve valuable resources, such as the environment and individual health (Godfrey and Richardson, 2002). The topic of this review is closely related to human health.

The biggest organ in the human body, the skin, acts as a sophisticated barrier and interface between the body and the outside world. Although it has a variety of purposes, its primary one is to act as a barrier between the body's tissues and the outside world, protecting against viruses, ultraviolet (UV) rays, mechanical and chemical dangers, and even dehydration [1]. Melanocytes, which are cells that generate the pigment melanin, which gives skin its color and offers some protection from UV rays, are found in the epidermis, the outermost layer of skin, which also provides a waterproof barrier and determines our skin tone. The epidermis is mostly composed of cells, primarily keratinocytes, and performs the majority of the skin's barrier activities [2]. Another is the dermis, which lies beneath the epidermis and is made up of collagen and elastin fibers, which support the structure and resilience of the skin, as well as connective tissue, blood vessels, nerve endings, hair follicles, and glands. The innermost layer, known as the hypodermis (subcutaneous layer), is composed of connective tissue and fat. It serves as insulation, shock absorption, and a structural anchor for the skin, including muscles. The vascular, lymphatic, and neural systems are found in the dermal skin layer, which, on the other hand, offers strength and suppleness. Comprising complex extracellular matrix proteins, it is relatively acellular and especially abundant in collagen fibers, which account for around 75% of the dermis' dry weight [3]. Layer of skin is shown in Fig. 1.

Vitamin C is a low molecular weight, unstable hydrophilic molecule. The development of cosmetic formulations is significantly hampered by the presence of oxygen, light, humidity, high temperatures, and heavy metals.

VITAMIN C

Although it is needed in smaller quantities than macronutrients, Vitamin C is generally regarded as a micronutrient that is as important for preserving health (Nall, 2019; Taylor, 2017). Humans lack the enzyme L-glucono-gamma lactone oxidase, which prevents them from synthesizing Vitamin C, in contrast to plant and certain animal [4].

These days, Vitamin C is essential when it comes to skin care. The most prevalent antioxidant in human skin is Vitamin C [5]. Therefore, to preserve the stability of Vitamin C, an efficient antioxidant system must be used. The most well-researched and physiologically active is L-ascorbic acid [6]. The most widely utilized type of L-ascorbic acid, Vitamin C, is excellent for skincare because of its antioxidant and brightening qualities.

Although Vitamin C degrades quickly when exposed to air, light, and water, its formulation instability is the most difficult element. One efficient way to increase the stability and permeability of L-ascorbic acid is to lower its acidity to a pH below 3.5.

Vitamin C levels in normal skin are high, equivalent to those in other bodily tissues, and significantly higher than those in plasma, indicating active circulation-based accumulation. With concentrations probably in the millimolar range, the majority of Vitamin C in the skin seems to be found in intracellular compartments [7-9] (Fig. 2).

VITAMIN C SOURCE

The amount of Vitamin C in different foods is generally higher than that of many other vitamins (10–100 mg/100g), and in certain instances, it can reach grams/100 g of fresh weight. This may have something to do with the fact that sugars, which are prevalent substances in many organisms, are the building blocks of Vitamin C. All plant species, including algae and photosynthetic protists, have been shown to synthesize Vitamin C thus far [10].

The richest sources of Vitamin C are a variety of fruits from around the world, such as the South American acerola, the Australian kakadu plum, and the Australian camu-camu [11-13]. Sea buckthorn and rose hips are regarded as the best sources of this vitamin in both Europe and Asia. The majority of people regularly consume fruits and fruit juices, which provide a significant amount of their daily Vitamin C intake. Each region has a different species composition. Guava, black currant, kiwi,

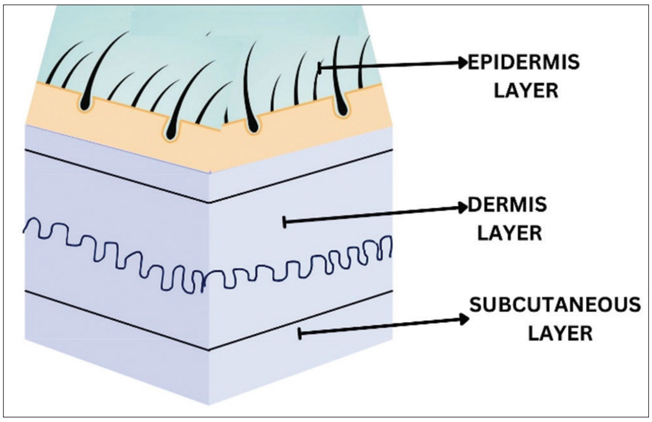

Fig. 1: Layer of skin

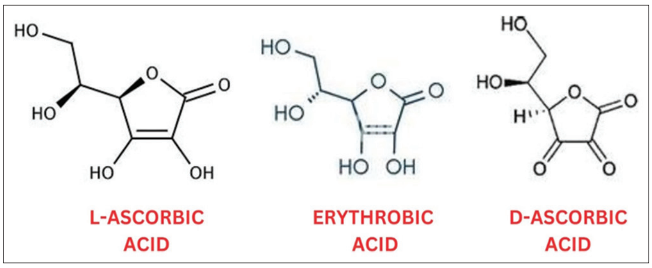

Fig. 2: Different form of Vitamin C

strawberry, and star fruit are all good sources worldwide. Citrus fruits have a much lower but adequate amount of Vitamin C than the vitamin's greatest sources [14-17] (Table 1).

Cruciferous plants, particularly peppers, kale, and broccoli, are also abundant in these nutrients [18,19]. Sauerkraut, or fermented cabbage, has a significantly higher Vitamin C concentration than most fresh vegetables (Nutrients 2021, 13, 615 3 of 34). On the other hand, when they are eaten in big amounts, potatoes contribute significantly to Vitamin C intake while having a relatively low level. They are a good source of Vitamin C, even though they are normally eaten boiled. 5–40 mg of Vitamin C can be found in one serving of potatoes. They have contributed, on average, 8% of the daily intake of Vitamin C in European nations in recent years [20,21] (Table 2).

Aside from a few additional minor roles, L-ascorbic acid plays three primary roles in plants: it is an enzyme cofactor, a radical scavenger, and a donor/acceptor in electron transport in the plasma membrane or chloroplasts [22]. Nowadays, fruits and vegetables—which are more readily available throughout the year in many nations than in the past—provide the majority of the daily intake of Vitamin C. In addition, potatoes and soft beverages, such as juices, provide a significant portion. With the exception of some fish eggs and sheep livers, which are rarely eaten, animal sources of Vitamin C do not significantly contribute to the intake, even though the majority of vertebrates are capable of synthesizing it.

Due to the decomposition caused by oxygen and other oxidizing agents, high pH, high temperature, and metal ions, aqueous Vitamin C solutions are unstable. Vitamin C leaches into the water as a result of prolonged cooking, especially boiling with a lot of water. The vitamin can be sufficiently preserved by frying. On the other hand, steaming or boiling with a tiny amount of water appears to be gentler methods for preserving Vitamin C. Because ascorbic acid oxidase causes oxidation reactions to occur inside the material, losses can still occur even if all external influences are minimized. The stability of storage is also significantly influenced by temperature. Significant losses happen as the temperature

Table 1: Fruit containing Vitamin C

S. No.	Plant source	Amount (mg/100g)
1	Kakadu plum	1000-5300
2	Camu camu	2800
3	Acelora	1677
4	Guava	228.3
5	Kiwi fruit	144
6	Loganberry	80
7	Red current	80
8	Wolfberry	73
9	Lychee	70
10	Strawberry	60
11	Orange	53
12	Lemon	53
13	Pineapple	48
14	Grape fruit	30
15	Raspberry	30
16	Passion fruit	30
17	Lime	30
18	Mango	21
19	Banana	9
20	Apple	6

Table 2: Vegetable containing Vitamin C

S. No.	Plant source	Amount (mg/100g)
1	Chilli pepper	244
2	Red paper	190
3	Broccoli	90
4	Cauliflower	48
5	Kale	41
6	Spinach	30
7	Potato	20
8	Tomato	10
9	Pawpaw	10
10	Onion	7.4
11	Carrot	6
12	Cucumber	3

rises. However, even if conditions are maintained where only minor losses occur during short-term storage, the amount of Vitamin C falls dramatically during long-term storage. The Reichstein process and the two-step fermentation process are the two fermentation methods now used in industry to manufacture L-ascorbic acid. The foundation of the Reichstein process is the catalytic hydrogenation of D-glucose to D-sorbitol, followed by the bioconversion of L-sorbose to 2-keto-L-gulonic acid using Gluconobacter spp. Lactonization reorganizes this to L-ascorbic acid. In the second production step, bioconversion employing different bacteria takes the place of chemically producing 2-keto-L-gulonic acid from L-sorbose [23-25].

VITAMIN C AS A POTENT ANTIOXIDANT FOR TOPICAL USE

Through the creation of "oxidative stress," environmental variables including pollution, smoking, and sun exposure can hasten skin damage. Due to its potent antioxidant qualities, Vitamin C is particularly good for the skin. Vitamin C serums are widely used topically because they provide the skin with high quantities of the vitamin. It is still up for debate whether Vitamin C functions as an endogenous antioxidant, such as a scavenger of reactive oxygen species (ROS). *In vitro*, its function has been frequently and convincingly shown; nevertheless, *in vivo*, the situation is less apparent [26-30]. A fetus lacking the SVCT2 transporter is a prime example [31]. These fetuses have reduced levels of Vitamin C in the placenta and no Vitamin C in the cortex or lungs. It is evident that the placenta and brain have higher levels of lipid peroxidation indicators than the lungs do. The impact of Vitamin C Since these actions are linked to protection against endothelial dysfunction, nutrients on the recovery of tocopherol and the recovery/sparing of tetrahydrobiopterin are mostly studied in the literature as having biological importance. For a non-enzymatic antioxidant. Since it is easily accessible to release two electrons in succession to carry out the reduction process on other compounds to hinder the oxidation process, the antioxidant action is accomplished by the donation of electrons. Semi-dehydroascorbic acid (C6H7O6), an ascorbate radical, is created when one electron is released from Vitamin C. It is a stable and non-reactive free radical with a brief half-life of ten to 3 s to a few minutes. Free radical scavenging is the process of giving electrons from Vitamin C, which serves as a reducing agent to lessen oxidative stress brought on by an excess of ROS production [32].

Double bonds at the second and third carbons, along with hydroxyl groups at the second, third, fifth, and sixth carbons, provide Vitamin C its potent reducing effect (Gęgotek and Skrzydlewska, 2022). Case studies can be used to demonstrate this. For example, skin exposed to less UV radiation has a higher Vitamin C concentration than skin exposed to more UV radiation (Darr *et al*., 1992, Michels, 2021). Furthermore, dehydroascorbic acid and ascorbate radicals can transform irreversibly into 2,3-diketogulonic acid, which can then be further converted into substances like oxalate, xylose, and xylonate, while also converting reversibly back to ascorbic acid.

Higher Vitamin C dosages have the ability to act as pro-oxidants [33-35], a trait that may be helpful in the treatment of cancer and will be covered in the chapter on cancer.

CLINICAL APPLICATION OF VITAMIN C IN PERSONAL CARE AND COSMATIC

Antiaging

The term “anti-aging” describes the skin’s natural ageing process, which is brought on by a confluence of environmental and genetic variables. The two proteins that give our skin its structure and flexibility, collagen and elastin, are produced in smaller amounts as we age. Age-related structural and functional changes are evident in all layers of the skin [36,37], and like other bodily systems, these changes may make people more vulnerable to a range of illnesses and conditions, including dermatoses and skin cancer [38-40]. As a result, drooping skin, fine lines, and wrinkles appear. The function and appearance of skin can be significantly impacted by lifestyle variables, including smoking and exposure to pollutants, which also accelerate environmental ageing [41-43]. The natural ageing process causes anti-aging, but UV light exposure causes photoaging. Our genetic heritage and other factors may play a significant role in the mostly inevitable process of intrinsic ageing [44,45]. Some ways to lessen these effects include: reducing exposure to environmental risk factors that induce premature skin ageing, such as smoking, poor diet, and prolonged sun exposure. Either topical or systemic therapies aid in the regeneration of collagen and the elastic fiber system in an attempt to potentially reverse skin damage [46]. Aged skin may also have compromised immunological function, antioxidant capability, and melanin synthesis [47].

Protaction against photoaging and UV radiation

Exposure to UV light from the sun can result in photoaging, a form of accelerated ageing. Wrinkles, age spots, and other ageing symptoms appear as a result of UV radiation’s destruction to the skin’s collagen and elastin. Skin cancer risk can also be raised by photoaging. ROS brought on by UV light also start the signal transduction cascade, which causes transforming growth factor-β to be downregulated and activation protein-1 (aP-1) and nuclear factor-b to be upregulated. Together, these proteases boost matrix metalloproteinases (mmPs), which break down collagen, decrease its synthesis, and promote the buildup of elastin [48]. Clinical signs of photoaging pigmentation, telangiectasias, deep wrinkles, coarse texture, and solar elastosis result from this.

There is growing evidence that long-term exposure to UV radiation from the sun or tanning beds is the biggest environmental threat to skin health [49-51]. Acute UV radiation exposure can result in sunburn, which is characterised by a significant inflammatory response that produces heat, redness, and edema. Damage to the skin extracellular matrix, immunological suppression, and changed pigmentation can also happen [52-56]. Chronic UV exposure can affect the skin’s epidermal and dermal layers, but the dermis’ extracellular matrix undergoes the most significant alterations [57]. It has been demonstrated that Vitamin C inhibits aP-1 activation, which lowers mmP synthesis and damages collagen [58]. Vitamin C also suppresses the formation of elastin, according to *in vitro* investigations [59]. A mechanism that produces radicals directly mediates natural ageing, and its antioxidant activity is mostly responsible for protection. Using both topical and dietary Vitamin C intake, this has been shown with cells both *in vitro* and *in vivo* [61-64].

Inhibition of melanogenesis

Melanogenesis, the process by which the skin produces melanin (pigment), is significantly influenced by Vitamin C. It has been demonstrated that Vitamin C derivatives, such as the magnesium phosphate acerbly derivative, reduce the creation of melanin in both *in vivo* and in cultured melanocytes [65]. It has been suggested that this function results from its capacity to obstruct the activity of tyrosinase, the enzyme that limits the pace of melanogenesis. Tyrosinase is the enzyme that initiates melanogenesis by catalyzing the initial stages of melanin synthesis. Tyrosinase activity is inhibited by Vitamin C, which slows down the creation of melanin and lessens age spots, sun spots, and hyperpigmentation.

Antipigmated

In addition, Vitamin C functions as an anti-pigmentation agent. Vitamin C’s potent antioxidant and anti-tyrosinase qualities make it a very efficient pigmentation reducer. By interacting with copper ions at tyrosinase active sites, it reduces the formation of melanin by blocking the activity of tyrosinase, the primary enzyme that converts tyrosine into melanin [66,67]. Skin cells experience increased oxidative stress due to environmental stresses, especially UV radiation, which causes an excess of melanin to be produced. By neutralizing free radicals, Vitamin C’s antioxidant qualities stop oxidative stress from causing excessive pigmentation. Vitamin C offers the skin a natural radiance by inhibiting melanin and brightening it, which lessens dullness and creates a radiant complexion overall. Post-inflammatory hyperpigmentation, age spots, and melasma can all be resolved with regular use.

Wrinkles

Vitamin C’s antioxidant qualities and function in collagen formation make it a very potent anti-wrinkle and anti-fine-line agent. It is believed that wrinkles are caused by alterations in the skin’s lower dermal layer, although little is understood about the precise molecular processes at play. The degeneration of collagen and elastic fibers, loss of collagen, and alterations to the dermal–epidermal junction are believed to be contributing factors [68-71]. Collagen and elastin fibers are broken down by free radicals from pollution, UV exposure, and other environmental stresses, which speeds up ageing. Strong antioxidant Vitamin C combats these free radicals, lowering oxidative stress and delaying the onset of wrinkles. Retaining moisture requires the function of the skin barrier, which Vitamin C can enhance. Because hydrated skin looks plumper, fine lines and creases may appear less noticeable (Fig. 3).

OBSTACLES TO VITAMIN C MAINTAINANCE FOR SKIN HEALTH AND VITAMIN C POTENTIAL

Environmental, physiological, and lifestyle variables make it difficult to maintain good skin. With its various advantages, Vitamin C helps with many of these issues and encourages healthy skin. Despite being a potent antioxidant with several advantages for skin health, Vitamin C’s efficacy may be limited by a number of reasons.

Oxidation is a common occurrence for Vitamin C, particularly when it is exposed to heat, air, and light. Its effectiveness and potency may decline as a result. The optimum stable pH for Vitamin C is slightly acidic. A too high pH can cause the substance to deteriorate and lose its effectiveness [72].

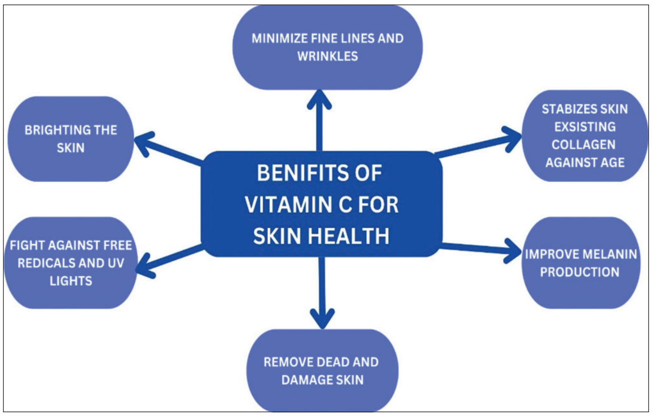

Fig. 3: Benefits of Vitamin C for skin health

Vitamin C may have trouble penetrating the skin's barrier. The product's composition and skin health are two examples of factors that can affect how well a product is absorbed [73].

Vitamin C's usefulness may be diminished by adverse interactions with certain substances. For instance, its function may be hampered by specific preservatives or other antioxidants. A Vitamin C product's stability and absorption may be impacted by its administration method. Certain formulations, such as encapsulated forms or liposomes, can aid in enhancing penetration.

Vitamin C may have varying effects on different skin types, such as smooth and dry skin. For example, if the product is not appropriately designed, people with sensitive skin may become irritated. The effectiveness of Vitamin C may be impacted by pre-existing skin problems like acne or hyperpigmentation.

Choosing correctly prepared solutions, using them regularly, and taking into account any unique skin characteristics that can affect their efficacy are all crucial steps in optimizing the health advantages of Vitamin C for skin.

According to recent research, techniques such as laser resurfacing, iontophoresis, ultrasound, nanoparticles, multi-layered microemulsions for graded administration, and microdermabrasion can all improve Vitamin C penetration [74,75]. These studies are still limited, though, and no comparative research has been done to identify the best delivery strategy. In addition, larger research is required to validate the synergistic effect of Vitamin C with other growth factors and antioxidants. Although strategies to administer large amounts of Vitamin C orally and intravenously have been investigated, their efficacy on the skin is still debatable [76,77].

CONCLUSION

To conclude and summarize, Vitamin C is a naturally occurring drug with multiple desirable effects. It is primarily focused on discovering growing applications in tissue inflammation, hyperpigmentation, photoaging, and tissue healing, and it has an outstanding safety profile. Ongoing research has been directed toward improving its delivery into the dermis for stimulating collagen production and scavenging free radicals. Vitamin C thus holds promise as a mainstream drug in future dermatology practice.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest

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