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Effects of Natural Polyphenols Against Skin Aging

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Abstract – Aging is a natural process in humans that causes changes in the immune response, increased frailty and malignancy, and reduced skin elasticity. The ever-increasing global average age significantly affects the economic structure of countries by increasing expenditures on health and other social activities to ensure individual welfare. Therefore, it is important to determine the mechanisms of action of environmental factors that cause health problems that have negative effects on quality of life at the molecular level in order to determine effective treatment and prevention strategies. Interest in the use of natural products in the battle against age-related neurological and dermatological asthma has recently increased. Polyphenols are natural products that show many beneficial biological activities when taken into the body in appropriate amounts. Regular intake of polyphenols from food and beverages shows antioxidant, anticarcinogenic, antimutagenic, antitumor, antiobesogenic, antimicrobial, neuroprotective, and cardioprotective effects. At the same time, polyphenols have a high potential for the prevention of age-related dermatological problems, and therefore further studies on dietary polyphenols are important to better understand these protective effects.

Keywords – Aging, Skin Aging, Polyphenols, Skin Wrinkles

I. INTRODUCTION

The skin, which is the most important determinant of appearance and identity, is the largest organ in humans and acts as a barrier between the external environment and the internal parts of the body. It protects the organism by preventing the entry of many harmful exogenous substances into the body and maintains internal homeostasis by preventing excessive water and heat loss [1]. The skin consists of three different layers: dermis, epidermis, and hypodermis. The dermis is composed of dermal fibroblasts and extracellular matrices (ECMs) such as collagen and elastin, which are associated with cell firmness and elasticity [2].

As in other organs, the structure and function of the skin change depending on both time and cumulative oxidative damage. Various external stimuli such as UV radiation, air pollution, and cigarette smoke increase the rate of skin aging through signaling pathways mediated by reactive oxygen species (ROS) and cause the development of some aging-related diseases.

A. Skin Aging

Skin aging is divided into two main categories: intrinsic and extrinsic aging.

Intrinsic aging encompasses the physiological changes that occur naturally as a result of aging [3]. Fibroblast cells in the skin are responsible for the production of collagen, and this production slows down and decreases as the skin ages. This reveals the effects of skin aging, such as sagging, loss of elasticity, wrinkle formation, delayed wound healing, and making the skin look old [4]. Clinical findings as a result of intrinsic aging are fine lines, dryness, and loose skin [5].

Extrinsic aging includes changes in the skin as a result of external aging, sunlight, nutritional factors,

air pollution that reduces the amount of vitamin E in the skin, cigarette smoke, rapid weight loss, temperature, stress, and lack of sleep. The increase in DNA damage as a result of UV can be given as an example [6], [7]. Coarse wrinkles, uneven pigmentation, and age spots are mostly associated with extrinsic aging.

Both intrinsic and extrinsic factors can induce aging in skin cells and cause cell cycle arrest as a result of telomere shortening, mitochondrial degradation, oxidative stress, and the accumulation of irreversible DNA damage [8].

With aging, the fragility of the skin increases, its elasticity and healing ability decrease, skin problems due to toxicity occur, the development of various skin diseases is facilitated, and aesthetically undesirable effects such as wrinkles and irregular pigmentation occur [9]. Although the aesthetic changes that occur in the skin as a result of aging are expected to occur in the natural process, these changes cause an increase in the burden of depression in the person and have a potentially devastating effect on the person's general well-being and self-esteem. Therefore, as the elderly population and life expectancy increase in developed countries, appropriate care of aged skin emerges as a dermatological priority [9], [10].

B. *Effects of Polyphenols on Skin Aging*

Many studies have been carried out in the fields of cosmetology and dermatology on the prevention of aging caused by eccentric and intrinsic factors. In this regard, first of all, it is necessary to find some useful active ingredients in order to suppress the harmful effects of factors affecting aging and thus delay skin aging.

Until today, it was known that fruits, vegetables, plants, flowers, and other natural materials were used by people for cosmetic purposes [11]. Studies show that plant polyphenols regulate age-related signaling pathways in aged dermal fibroblasts, improve aged skin dermis, and thus delay the aging rate [12].

Polyphenols are aromatic alcohol compounds found in fruits, vegetable seeds, spices, red wine, coffee, and cocoa that, when taken into the body in appropriate amounts, show many beneficial biological activities. Plant-derived polyphenols are found in nature as concentrated tannins, and their dietary intake has been observed to be higher than that of other phytochemicals. Polyphenols, which prevent cardiovascular diseases, cancers, neurodegenerative diseases, tumor formation, and diabetes, are the most abundant antioxidants in the diet [11]. Studies show that polyphenols have beneficial effects on proliferating aging skin cells. Treatment with polyphenols can prevent and delay cellular aging. Thanks to these properties, polyphenols have beneficial effects on skin aging and skin diseases related to aging [13], [14].

Collagen, elastin, elastic fibrils, and matrix metalloproteins (MPP) are important in strengthening muscles, tendons, and joints. Damage or deterioration of these tissues causes the skin to lose its tightness, and as a result, wrinkles occur [15]. Many herbal polyphenols, such as catechin, epicatechin, myricetin, quercetin, and alloin, are anti-aging ingredients and play an active role in reducing the speed and intensity of wrinkle formation. They can prevent or delay aging-related pathologies of the skin by affecting the molecular pathways of aging.

Natural polyphenols are yellow, red, or purple pigmented and act as sunscreen on the skin due to their ability to absorb some of the UVA, UVB, and UVC radiations and reduce the DNA-damaging effects of radiation [16]. Excessive UV exposure causes oxidative stress and oxidative damage, thus causing skin disorders and premature aging of the skin. The skin has a complex antioxidant system that protects against UV-induced oxidative stress. Plant polyphenols are also known to strengthen the antioxidant system.

C. *Some Herbal Polyphenols with Anti-Aging Effects*

Turmeric: Curcumin, which gives turmeric (Curcuma longa Linn) its bright yellow color, is a fat-soluble polyphenolic pigment. Curcumin, the active ingredient of turmeric, is known to interfere with the expression of vascular endothelial growth factor (VEGF), and therefore, oral intake of turmeric extract prevents the appearance of fine

lines and wrinkles, reduces UVB-induced damage, and prevents aging [17], [18].

Calendula: Calendula (Calendula officinalis) is a plant rich in flavonoids. In a previous study, calendula cream was applied to the cheek skin of 21 male volunteers for 8 weeks. It has been found that this application delays the aging process and tightens the skin [19].

Aloe Vera: Aloe vera (Aloe vera Linn) has proven anti-viral, anti-bacterial, healing, anti-inflammatory, and antifungal properties [20]. It contains tannins that keep the skin moist, heal, regenerate, and stay young [21]. Aloe vera also increases fibroblast cells in the skin. This suggests that aloe vera may be a more preferable source of collagenase than many cosmetics [22].

Cocoa: Cocoa (Theobroma) and cocoa products are one of the foods that contain the most polyphenolic antioxidants. In a study of 86 Korean women over 40 years of age, consumption of 25 mg of cocoa per day for 320 weeks significantly reduced skin wrinkles after 12 weeks [23], [24].

Astragalus: Astragalus (A. Membranaceus), which contains many polyphenols that increase hyaluronic acid and fibroblast levels, including calicosine and formononetin, is a potential herb that can be used to prevent the loss of hyaluronic acid that occurs with aging [4], [25].

Soybeans: Genistein is a polyphenol found in soybeans (Glycine max) and prevents UV-induced skin aging. It is known that regular soy extract application provides protection for DNA and increases epithelial thickness, collagen, and elastic fiber concentration [4], [26], [27].

Grape: Grape (Vitis vinifera Linn) is one of the most consumed fruits in the world and is rich in polyphenols. 90–95% of the polyphenols contained in grapes are found in the seed and peel [28]. Grape skin contains resveratrol polyphenol, which has an inhibitory effect on aging-related disorders. In studies, it has been observed that the polyphenols in grapes have photoprotective properties, protect the skin against UVB-induced damage, and show anti-aging and anti-wrinkle properties [29]. However, it has been reported that the proanthocyanidins contained in grape seed inhibit the oxidative stress caused by UV exposure in human epidermal keratinocytes [30].

Green Tea: Sun lotions containing green tea (Thea sinensis) are known to protect against UV-induced photoaging [31]. It is known that orally administered green tea extract increases skin elasticity, prevents UV-induced inflammation, oxidative stress, and DNA damage with the help of green tea polyphenols (epicatechin, epigallocatechin, epigallocatechin-3-gallate, and catechin) in its content [32].

Hydrangea: Hydrangea (Hydrangea serrata) is a plant originating from East Asia and is known to help collagen formation in hairless mice, reduce skin wrinkles, and prevent water loss in the skin. [33].

Thistle: It is known that silibinin polyphenol, which is abundant in the thistle (Silybum marianum) plant, inhibits UVB-induced tumor initiation and progression. Studies have concluded that it prevents UVB-induced DNA damage in skin epidermal cells and prevents photoaging by moisturizing the skin [4], [34].

Mango: Mangoes contain many polyphenols such as gallic acid, chlorogenic acid, and vanillic acid. It has been determined that the consumption of mango reduces wrinkles in light-skinned postmenopausal women and thus has an anti-aging effect [35].

Blueberry: Blueberry (Vaccinium corymbosum) is a plant containing many polyphenols such as catechin, epicatechin, myricetin, quercetin, and kaempferol [36]. These polyphenols reduced UVB-induced epidermal thickening and showed anti-aging effects. They also inhibited oxidative stress and lung inflammation [4].

Coffee: Coffee, which is consumed very frequently in daily life, is the largest source of polyphenols with an antioxidant effect [37]. In a study conducted to investigate the effects of the consumption of polyphenols in coffee on skin health, it was observed that UV-induced pigment

spots were lower in subjects with high coffee polyphenol consumption. As a result of the study, it was estimated that coffee protects the skin from photoaging [38].

Olive oil: It is known that hydroxytyrosol obtained from olive oil has a protective effect against UVA-induced cellular aging and effectively reduces the number of senescent cells [39].

Bergamot: Some polyphenols in bergamot play an effective role in the recovery of telomere length and telomerase activity. Due to these properties, bergamot polyphenols are thought to prevent wrinkle formation by prolonging the cellular aging process [40].

In addition to all these, supplementation of procyanidin, flavan-3-ols, and hydroxycinnamic acid polyphenols found in apples (Applephenon) reduces UV-induced pigmentation differences [41], apigenin stimulates type I and type III collagen synthesis, increases dermal density, and improves skin elasticity [42], curcumin and myricetin reduce UVA-induced negative effects [43], [44], luteolin reduces ROS production, IL-6, COX-2, TNF-a secretion, and UVB-induced wrinkle formation [45], and rutin reduces UV-induced ROS production, improves skin elasticity. It is also known that genistein modulates cell viability and mitochondrial membrane potential [47], and kaempferol blocks ROS production in damaged dermal fibroblasts [48].

II. CONCLUSION

The phenotype changes associated with aging generally include skin wrinkling, sagging, pigmentation problems, malignancies, and blemishes [46]. These undesirable changes are caused by the accumulation of aging cells in the skin tissue. Studies have revealed the beneficial effects of polyphenols, such as stimulating collagen synthesis, maintaining skin elasticity, preventing the harmful effects of UV rays, and preventing skin wrinkles. In general, polyphenols appear to be effective against mechanisms such as autophagy, cellular senescence, telomere activity, and DNA damage. [49]. In addition, new biomarkers of aging should be identified to better understand skin aging, new formulations should be developed and optimized for the application of polyphenols, and more clinical studies should be conducted to make the most of the anti-aging efficacy of the identified polyphenols.

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