

Potential Effect of Goji Berry (*Lycium barbarum*) Extract on Skin Photoaging: A Literature Review

ABSTRACT

Being a tropical country, Indonesia is exposed to sunlight continuously throughout the year. This can impact the skin health of Indonesian's people due to chronic exposure to UV rays, which results in excessive ROS (reactive oxygen species) production and triggers oxidative stress. This leads to extrinsic skin aging, or photoaging. Sunscreen, as a primary photoprotection, is commonly recommended to protect the skin from sunlight. However, even sunscreens with high SPF cannot provide 100% protection from damage caused by free radicals generated by UV rays. Therefore, secondary photoprotection such as natural antioxidants are needed. Goji berry is a natural antioxidant known as a superfruit because it contains many compounds with high antioxidant activity, such as lycium barbarum polysaccharides, flavonoids, carotenoids, and phenols. The different compounds in goji berries are recognized for their protective properties against oxidative skin damage, particularly damage caused by UV radiation exposure. This literature review utilized electronic databases on Google Scholar, PubMed, ScienceDirect, and SpringerLink using the keyword "Goji Berry", "Lycium barbarum", "Photoaging", "Skin Aging" and "Photoprotection". We found six studies on the treatment using goji berry extract related to skin aging caused by UV radiation (photoaging). In conclusion, the studies suggest that goji berry extract has great potential as an antioxidant in combating photoaging. Further research is needed to determine the best method of administration and the optimal dosage as an anti-photoaging agent.

Keywords: Goji Berry, Photoaging, Skin Aging, Lycium barbarum, Photoprotection

1. INTRODUCTION

Indonesia, being a tropical country which is located along the equator, experiences consistent UV radiation from the sun year-round (1). For example, the UV-index study in one of the cities in Indonesia showed extreme ultraviolet index values (≥ 10) 46% of the time, and there were no days with a maximum ultraviolet index below two (2). Consequently, its population is continuously exposed to UV-rays and is at risk of photoaging (3). Photoaging symptoms on the face were most frequently observed in individuals of Javanese ethnicity (30,5%) and in the 30-39 age group (59,1%). Additionally, 62% experienced over 34 hours of sun exposure per week and 65% had a Fitzpatrick IV skin type (moderate brown skin) (4,5).

Photoaging, or extrinsic skin aging, refers to early damage to the skin resulting from exposure to sunlight (UV-radiation) (6). Sunlight releases ultraviolet (UV) rays which are divided into three categories: UVA with wavelengths ranging from 320-400nm, UVB with 280-320nm, and UVC between 100-280nm (7). Unlike UVA and UVB radiation, UVC radiation is nearly entirely absorbed by the ozone layer. In contrast, UVA and UVB rays penetrate through to the earth's surface in amounts that can harm skin structures (8). UVA penetrates deeply into the dermis and subcutaneous layer, and it can trigger the production

of reactive oxygen species (ROS) as free radical, leading to photoaging (7). UVB radiation can lead to skin redness, DNA damage, photoaging, and suppression of the immune system (9). UV radiation is the primary factor responsible for DNA damage in stem cells. This damage can result in a reduction of stem cell numbers and harm to the stem cell niche, ultimately contributing to skin aging caused by exposure to sunlight (10).

Free radicals are small, diffusible molecules that are highly reactive due to their unpaired electron. Initially, they were believed to be primarily oxygen-centered radicals known as reactive oxygen species (ROS) (11). Exposure to ultraviolet light can indirectly result in the generation of various reactive oxygen species (ROS), such as superoxide, singlet oxygen, hydroxyl radicals, and hydrogen peroxide, through two main mechanisms, namely direct absorption and photosensitization. The mechanisms can be seen in Figure 1. (12).

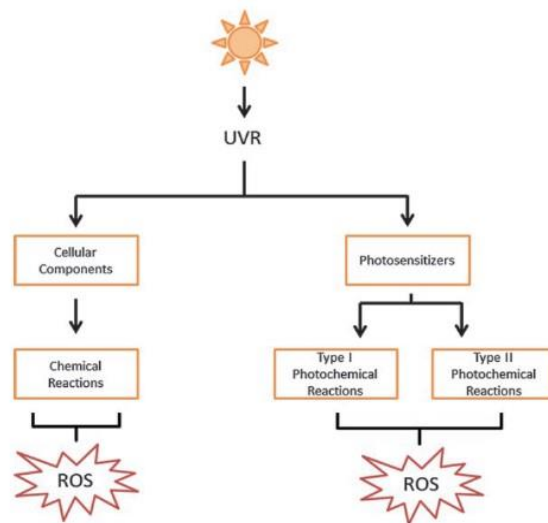


Fig 1. Ultraviolet Light Mechanism Produces ROS (12)

Photoprotection is recommended to help minimize skin damage and the risk of skin cancers caused by ultraviolet (UV) radiation. Photoprotection encompasses both primary and secondary protective measures (13). The primary includes wearing protective clothing, hats, sunglasses, and apply sunscreen (14). Sunscreen should be applied to the skin 15 minutes prior to sun exposure and should be reapplied every two hours, as well as after swimming or sweating (15). But no sunscreen available can completely block 100% UVB rays, and products with an SPF higher than 100 do not offer extra protection (16). Thus, secondary protection is needed, such as the administration of natural antioxidants to prevent the damaging effect from free radical caused by UV-radiation (10). Natural antioxidants are

compounds found in foods and plants, particularly in red or orange fruits and vegetables, which exhibit strong antioxidant activity. Key groups of natural antioxidants include tocopherols, tocotrienols, ascorbic acid, flavonoids, carotenoids, and phenolic acids (17). Increasing the consumption of natural antioxidants can help sustain an acceptable level of antioxidant activity, as these compounds engage in one-electron reactions with free radicals in vitro, thereby preventing oxidative damage (18).

Goji berries, originating from China, are called a superfruit due to their high nutrient content and significant biological antioxidant activity (19). Goji berries presented more antioxidant capacity than other fruits such as kiwifruit, raspberry, apple, and orange. This is supported by a study that states the ORAC value of goji berries is 188,52 $\mu\text{mol TE/g}$ of dry weight (higher than other fruits) (20). Goji berries are oval-shaped, reddish-orange in color, and are typically dried for consumption or processed into food, desserts, or mixed into other dishes (can be seen in Figure 2). The components in goji berries that exhibit high biological activity include polysaccharides, carotenoids, and phenolic compounds such as phenolic acids and flavonoids (21).



Fig 2. The fresh and dried of *Lycium barbarum* fruit (22)

Goji berries have a range health benefits, including antioxidant, anti-inflammatory, antimicrobial, immune-boosting, anti-diabetic, neuroprotective, anti-cancer, prebiotic, and anti-obesity effects. The antioxidant properties of goji berries are closely linked to their content of polysaccharides, carotenoids, ascorbic acid, and flavonoids which can act as a radical scavenging via electron transfer and increase endogen antioxidant levels (20). This superfruit markedly raise serum levels of SOD and GSH-Px while lowering MDA levels. Moreover, goji berries boost macrophage nitric oxide production, phagocytic ability, and acid phosphatase activity, demonstrating strong antioxidant properties in vitro (22). The various contents in goji berries are known to have a protective effect against oxidative damage to the skin, especially that caused by exposure to UV radiation (21,22). This literature review aims to analyze the potential effect of goji berry extract on skin photoaging.

2. METHODS

The methods used for this literature review involve gathering information and theories from the internet, extensive journal research, journal reviews, and publications. The search engines employed include Google Scholar, PubMed, ScienceDirect, and SpringerLink. The search utilized the keywords: "Goji Berry", "*Lycium barbarum*", "Photoaging", "Skin Aging" and "Photoprotection", focusing on literature from 2014 to 2024 (or the last ten years). The article eligibility criteria used for the results are described as follows: research articles written in English, published in the last ten years and in academic journal, and also that examine goji berry extract on skin photoaging. Exclusion criteria such as: scientific articles that are

not fully accessible, conference proceedings, and case report or case series. Articles that did not meet the criteria were excluded from this study. Results and information were compiled by summarizing details about participants, interventions, control groups, outcome measurements, results, and the assessment of study quality.

3. RESULTS AND DISCUSSION

The initial literature search for research paper, utilizing the specified keywords, yielded 57 articles. After removing duplicate entries and screening the abstract, 17 full-text articles were assessed for eligibility. Ultimately, the final review comprised five (5) articles, as shown in Table 1. The fifth scientific article evaluates the effect of goji berry extract on skin photoaging.

Table 1. Research investigates the effects of goji berry extract on skin photoaging

Author	Sample	Intervention	Result	Conclusion
Neves, et al.,2020 (23)	Female hairless mice, six weeks old, were split into six groups (n= eight/group): (i) PA-photoaged (ii) PA+LBP- photoaged + polysaccharide-rich hydrogel formulation (LBP) (iii) PA+La- photoaged + laser (iv) PA+LBP+La, (v) PA+La+LBP, (vi) untreated control (UC) All treatments were administered following the induction of photodamage.	All experimental group (except UC group), were exposed to 100mJ/cm ² for seven sessions a week (16 minutes per session) during first week, followed by exposure to 200mJ/cm ² for three sessions a week (33 minutes per session) over the course of five weeks, total of six weeks of photo exposure. The treatments were conducted after the induction of photoaging (six weeks), three times a week, totaling three weeks of treatment across nine sessions. On each treatment, 50mg of the polysaccharide-rich hydrogel formulation—LBP was applied using the tip of the	<ul style="list-style-type: none"> The skin in the group treated with LBP showed decreased fragmentation and disorganization of collagen fibers in the dermis, when compared to all other groups. Both LBP and laser application treatments, whether used separately or in combination, significantly reduced the expression of c-Jun and c-Fos transcription factors and also the level of MMP-1, MMP-2, and MMP-9 in treated group. PA+La+LBP group promoted a significantly increase in the expression of collagen I and II, as well as FGF2, when compared to the photoaged group. 	The administration of LBP, whether used alone or in combination with PBM (red laser), shows promise as an effective approach for repairing photodamaged skin, indicating its potential for clinical use in skin rejuvenation.

		index finger until fully absorbed, covering an area of 3 cm × 2 cm (6 cm ²) on the dorsal region of the animals.		
Huang, et al.,2020 (24)	HaCaT cells in the logarithmic growth phase were inoculated in a DMEM containing 10% FBS and cultured in an incubator at 37°C with 5% CO ₂ . The cells were then divided into a control group (no treatment) and LBP groups (which were treated with 12.5, 25, 50, and 100 µg/mL of LBP for four hours).	Following the treatments, the control and LBP groups received UVB exposure at doses of 0, 20, 40, and 60 mJ/cm ² for 24 hours, and were then cultured for two hours. The irradiation dose (mJ/cm ²) is calculated by multiplying the irradiation intensity (W/cm ²) by the duration of exposure.	<ul style="list-style-type: none"> • At the same radiation dose, the survival rate or cell viability of the LBP groups was higher than that of the control group. • At the same radiation dose, the SOD activity in the LBP groups was higher than that in the blank group. • mRNA level with RT-PCR analysis in LBP groups was decreased than the control group. • The protein expression levels of HIF-1α and VEGF was significantly reduced at a concentration of 50 µg/mL of LBP. 	LBP significantly enhanced the survival rate of HaCaT cells and SOD activity under UVB irradiation, and it effectively reduced mRNA and protein expression with statistical significance. Consequently, LBP could serve as a potential pharmaceutical and cosmetic agent for preventing UVB damage.
Neves, et al.,2021 (25)	HRS/J female mice, eight weeks old were divided into six subgroups (n=8 per group). (i) CTRL-control (ii) PC-photoaged (iii) LBPF-photoaged and treated with LBPF (iv)PBM-photoaged + photobiomodulation (v) LBPF+PBM	The first two weeks, the animals only given UV-irradiation. Treatments were conducted three times a week following each session of photoaging induction over a period of four weeks (the third to the sixth week). A dosage of 50 mg of the LBPF	<ul style="list-style-type: none"> • The group treated with LBPF exhibited a thinning of the epidermis and more organized collagen fibers in the reticular dermis, featuring parallel bundles aligned with the epidermis and longer, less fragmented fibers. • The LBPF + PBM group showed a reduced quantity of birefringent 	LBP provide a photo-protective effect on the skin of hairless mice, preventing epidermal thickening and reducing collagen density. Both approaches (LBP or PBM), whether used

	(vi)PBM+LBPF	5% was applied to a 3x2 cm area of the dorsal skin of the animals, then gently spread without rubbing, until fully absorbed.	collagen fibers in comparison to the control group.	separately or together, can effectively reduce cutaneous photoaging caused by UV radiation.
Fan, et al.,2024 (26)	Human foreskin fibroblast cells (HFF-1) were cultured in high-glucose DMEM. Treatments began once the cells achieved 80% to 90% confluence. The cells were categorized into four groups: control group, LBP group, UVB group, and LBP + UVB group.	<p>The cells were pretreated with LBP at different concentrations or 3-TYP (a selective inhibitor of SIRT3) for 24 hours before being exposed to UVB radiation.</p> <p>HFF-1 were categorized into groups and subjected to UVB radiation at varying doses over a period of five consecutive days. Radiation was delivered using UVB phototherapy devices that emitted UVB light within a wavelength range of 295–320 nm.</p>	<ul style="list-style-type: none"> • At a concentration of 100 µg/mL, LBP significantly increased cell viability ($P < 0.05$) compared to the control group. • When HFF-1 cells were pre-treated with LBP before UVB radiation, the percentage of senescent cells significantly decreased • The group receiving pretreatment LBP had lower ROS level than UVB group. • The cells pre-treated with LBP showed decrease in γ-H2AX expression. • LBP group showed a significant decrease in senescence-related proteins and pro-inflammatory cytokines, along with a notable increase in intracellular collagen compared to the UVB group. • LBP shields HFF-1 from UVB-induced photoaging by boosting SIRT3 expression and 	LBP is a natural compound capable of reducing oxidative stress and combating the effects of photoaging.

			enhancing SOD activity, rather than increasing SOD2 expression.	
Jung, et al., 2023 (27)	<p>Hs68 human skin fibroblasts and HaCaT human skin keratinocytes for examination of collagen, hyaluronic acid, and matrix metalloproteinase (MMP-1) production.</p> <p>Skh:HR-1 hairless male mice, five week old, were adapted for 1 week, then divided into four group (10 mice per group): (i) Control group (ii) UVB-group (iii) UVB+AB20 group (iv) UVB+AB200 group</p> <p>AB is an AGEs Blocker made up of a mixture of korean mint extract (KE), fig fruits extract (FE), and Goji Berry extract (GE).</p>	<p>Hs68 cells were exposed to UVB radiation (30 mJ/cm², 312nm), then incubated for 24 hours in DMEM, with or without the addition of 200 µg/ml of KE, FE, GE, or AB.</p> <p>HaCaT cells were exposed to UVB radiation (5 mJ/cm², 312nm), then incubated for 24 hours in DMEM, with or without the addition of 200 µg/ml of KE, FE, GE, or AB.</p> <p>All mice, except in control group, were given UVB irradiation three times per week for 12 weeks with variation doses, as follows :</p> <ul style="list-style-type: none"> • 60 mJ/cm² (week 1-2) • 120 mJ/cm² (week 3-4) • 180 mJ/cm² (week 5-6) • 240 mJ/cm² (week 7-12) 	<ul style="list-style-type: none"> • AB significantly increased collagen levels and reduced the secretion of MMP-1. • Goji berry extract, either alone or in an AB, significantly increased hyaluronic acid content. • The AB group had a significantly lower erythema index and higher skin moisture than UVB group. • Skin elasticity index were significantly higher in AB group than UVB group. • The level of skin roughness in the AB group was lower than UVB group, which indicates that AB can reduce the formation of wrinkles. • AB group showed had decreased MDA level and increased catalase and GPx level in skin tissue. 	<p>Goji berry extract as one of the ingredients of AGEs Blocker (AB) prevents wrinkle formation in UVB-irradiated hairless mice, increases collagen content and moisturizes the skin by stimulating hyaluronic acid production. Consequently, AB may serve as a promising antiphotaging and moisturizing ingredient in skin functional foods.</p>
Liang, et al., 2018 (28)	Human skin fibroblast (HSF) cell lines were cultured with DMEM containing 10% FBS and incubated at 37°C	The cells were treated with 0 (control), 100, 300, and 600 µg/ml LBP. After 24 hours, the supernatant was	<ul style="list-style-type: none"> • LBP enhances the phosphorylation and nuclear translocation of Nrf2, which is essential for its protective 	This study highlighted the crucial role of LBP in activating Nrf2 to safeguard HSF cells

	with 5% CO ₂ for 24 hours.	<p>removed, and the cells were washed with PBS. They were then incubated for 6 hours with DMEM at 37°C and 5% CO₂.</p> <p>For UV irradiation, UVA and UVB lamps emitted light in the ranges of 320–430 nm and 290–320 nm, respectively, with dosages of 30 J/cm² and 400 mJ/cm². The exposure time was determined by dividing the UV irradiation dose by UV intensity. After irradiation, PBS was replaced with fresh medium.</p>	<p>functions.</p> <ul style="list-style-type: none"> • LBP treatment increases levels of important antioxidants, specifically superoxide dismutase (SOD) and glutathione peroxidase (GSH-PX), leading to a reduction in reactive oxygen species (ROS) and lipid peroxidation (LPO). • Silencing Nrf2 results in decreased cell viability, increased ROS levels, and elevated lipid peroxidation, indicating that Nrf2 is crucial for mediating LBP's protective effects against UV damage. • The optimal concentration of LBP for protective effects was determined to be 300 µg/ml for 3 hours. 	from UV damage.
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As we age, the normal chronological aging process of skin occurs. The levels of collagen and elastin decline and become fragmented, along with changes in glycosaminoglycan and proteoglycan levels in the dermis, diminished blood circulation, lower fat content, and a loss of rete ridges (29). The alterations in the amount of extracellular matrix components as we age, lead to various visible signs of aging skin, including wrinkles and reduced elasticity (30). Prolonged or repeated exposure to sunlight can accelerate the aging process, especially of the skin because it is the largest and outermost organ that is most easily exposed (31). Skin aging or photoaging results from a combination of genetic and environmental influences, primarily shaped by the accumulated damage caused by exposure to ultraviolet (UV) radiation (32). Prolonged sun exposure is well-established as a cause of photoaging, which involves alterations in skin structure, such as changes in epidermal thickness, increased pigment variation, dermal elastosis, collagen breakdown in the dermis, the formation of dilated blood vessels, and heightened mutagenesis in keratinocytes and melanocytes (30). There is strong evidence that exposure to UV radiation exacerbates the process that can accelerate the natural aging of the skin (31).

The wavelength and intensity of radiation, such as sunlight, play a crucial role in influencing the responses triggered by UV radiation. Repeated exposure to UVA (320-400 nm) and UVB (280-320 nm) can harm the skin, including its DNA and extracellular matrix (ECM), leading to immunosuppression (31). UV radiation also induces oxidative stress in the skin due to an imbalance between antioxidants and free radicals. One of the mechanisms involves the formation of reactive oxygen species (ROS) which causes oxidative stress, leading to collagen degradation and DNA strand breaks (32,33). ROS can activate NF- κ B, resulting in the production of various proinflammatory cytokine, including TNF α , IL-1, IL-6, VEGF, and EGF, which can increase MMP-1 expression, and also trigger the senescence-associated secretory phenotype (SASP) independently of DNA damage and cellular senescence pathways. Oxidative damage to proteins and lipids accelerates the aging process, resulting in alterations to dermal structure and observable signs of skin aging, such as collagen degradation, epidermal thickness, etc (33).

As previously known, UV radiation can produce excess free radicals and trigger oxidative stress in the skin, so antioxidants are needed to balance the levels of excess free radicals. Antioxidants can be categorized into 2 types, namely endogenous antioxidants (which are produced within the body) and exogenous antioxidants (which are obtained from outside) (11). Antioxidants can balance or neutralize free radicals and ROS in the cell and it can scavenge these free radicals and thus protect cells from damage (32,34). If endogenous antioxidants are not enough to balance excess free radicals, there will be a deficit/imbalance which will trigger oxidative stress and damage to the epidermis and dermis layers of the skin. To make up for this deficit of antioxidants, the body can utilize external sources of antioxidants obtained from food, dietary supplements, or medications (35).

Natural antioxidants are compounds found in foods, primarily sourced from plants especially red, orange, or purple colored fruits and vegetables that exhibit strong antioxidant properties. The primary groups of natural antioxidants include tocopherols and tocotrienols, ascorbic acid, flavonoids, carotenoids, and phenolic acids (34). Research by Popoola, et al showed ten flavonoid-related structures has potent antioxidant that can help prevent the buildup of free radicals in the body and may be effective in preventing skin-related issues, such as photoaging (36). The findings are supported by the theory that states that flavonoids are recognized for their ability to absorb ultraviolet radiation, which is attributed to the chromophores present in their structure (37). The photoprotective effects of several carotenoids have been studied for their potential to reduce the size of erythema following exposure to UV radiation (10). Recent studies have shown that carotenoids offer photoprotection against UVA-induced pigmentation and inhibit markers of oxidative stress at the molecular level (38). Polyphenol compounds have been proven to protect the skin from photoaging due to UV radiation with anti-melanogenic, anti-wrinkle and antioxidant mechanisms (34). In this case, secondary metabolite compounds produced by plants can serve as natural antioxidants that help protect the skin from photoaging (10).

Goji berries, also known as wolfberries or gouqizi, are a fruit that has been used as a traditional Chinese medicinal plant and food supplement for more than 2000 years in various Asian countries (39). Goji berry (*Lycium barbarum*) comes from a shrub plant that belongs to the Solanaceae family. Its tree can reach a height of 1-2.5 meters, with green leaves on the upper surface and grayish-green on the lower surface, measuring 2-3 cm in length. The plant has pale purple flowers. The fruit produced by the goji berry is oval or elliptical in shape, with a length between 8-18 mm and a diameter of 5-10 mm, and is orange or dark red in color. The goji berry seeds are yellowish, kidney-shaped, and 2.5-3 mm in diameter. Goji berry plants typically flower from June to September, and the fruit ripens from July to October (40).

Goji berries are also called “superfruit” because they contain many active compounds with high biological activity and antioxidant potential, such as Lycium barbarum polysaccharide (LBP), carotenoid, flavonoid, phenolic compounds, and ascorbic acid (19,21). The most important and abundant compounds in Goji Berry fruits are Lycium barbarum polysaccharides (LBP) which make up 5-8% of the total dry matter in the fruit. Their structure consists of six kinds of monosaccharides: arabinose, rhamnose, xylose, mannose, galactose, glucose, galacturonic acid, along with eighteen amino acids. Carotenoids found in Goji are the second most important group of biologically active compounds, contributing to the distinct orange-red color of the berries and make up 0.03–0.5% of the fruit's dry matter. Dipalmitin zeaxanthin is a form of carotenoid, and goji berry is considered the best natural source of dipalmitin zeaxanthin. Studies on various Chinese medicinal herbs have confirmed the presence of phenylpropanoids with a concentration of 22.7 mg and has a strong antioxidant properties. The presence of vitamin C, betaine, and taurine has also been confirmed. The vitamin C concentration was measured at 42 mg per 100 g (19).

There are many health benefits that can be obtained from goji berries, such as anti-aging, as an antioxidant, improving visual health, having hypolipidemic and hypoglycemic activity, as an immunomodulatory, and preventing from cancer (41). In addition, goji berries are also known to have a protective effect on skin cells exposed to UV radiation due to its high antioxidant properties, anti-inflammatory and immunomodulatory activities. A study evaluated the potential of consuming Goji Berry (GB) juice to mitigate sun damage caused by ultraviolet (UV) radiation in rats. The results showed that drinking 5% GB juice helped reduce edema caused by sunburn (42). Other study showed that protective effect of LBPs, through the activation of Nrf2, likely helps protect the skin from ultraviolet radiation by neutralizing active radicals, reducing DNA damage, and suppressing the UV-induced P38 MAP pathway (43). This is in line with the research by Liang, et al which states that lycium barbarum polysaccharides protect cells from UV damage through the regulation of Nrf2 (28).

UVB radiation can cause an excessive buildup of intracellular ROS, leading to cellular dysfunction, oxidative stress, inflammation, cell apoptosis, and aging (44). A study by Fan et al. showed that LBP, as a natural compound, has the ability to reduce oxidative stress and combat the effects of photoaging by activating the mitochondrial SIRT3-SOD2 pathway (26). This aligns with the study conducted by Huang et al which stated that LBP significantly increased SOD activity which has the ability to scavenge ROS directly (24). Other study by Huaping Li, et al showed that pretreatment with goji berry notably reduced UVB-induced p38 phosphorylation, caspase-3 activation, and MMP-9 expression in HaCaT cells. The p38 MAPK pathway is strongly activated by solar UV exposure and plays a crucial role in UVB-induced skin carcinogenesis. Phosphorylation of p38 triggers the activation of caspases and the upregulation of MMP expression. Caspase-3, which interacts with caspase-8 and caspase-9, is a key mediator of apoptosis, leading to chromatin condensation, DNA fragmentation, and the formation of apoptotic bodies. The association of MMP with collagen degradation contributes to photoaging, which is marked by the buildup of abnormal elastin and a loss of skin tone and elasticity (45). The study by Neves et al. also presented similar results, indicating that goji berry has protective effects against UVR-induced damage. It provided protection against epidermal thickening, collagen fiber fragmentation in the dermis, and biomodulated the synthesis and degradation of birefringent collagen fibers in the reticular dermis (25). There is also research that uses a combination of Goji Berry, Fig, and Korean Mint extracts, also known as AGE's Blocker extract/AB, which shows significant effects on skin quality. According to a study by Yo et al., skin elasticity and hydration levels improved with the AB extract. In addition, there was an increase in antioxidant enzymes, a decrease in inflammatory cytokines, and a suppression of MMP expression in the skin (46). Similar results were shown in a study by Jung et al., where the AB/AGEs blocker extract was able to inhibit the formation of skin wrinkles, the reduction of collagen, and skin hydration in

mice exposed to UV radiation. It was also explained that the Goji Berry extract in the combination was dominant and provided significant results, making it a potential agent for anti-photoaging in the future (27).

In addition, other components in Goji Berry, such as phenolic acids, flavonoids, carotenoids, and betaine, are also known to act as antioxidants that can neutralize free radicals in the body. Phenolic compounds serve as a protective mechanism, helping the skin adapt and survive in harsh environmental conditions, such as shielding it from ultraviolet (UV) radiation (47). Phenolic compounds, such as flavonoids and phenolic acids, can block the penetration of radiation into the skin. Furthermore, they help reduce inflammation, oxidative stress, and affect various signaling pathways to protect the skin from UV damage (10). Zeaxanthin, one form of carotenoid, is also known to have cytoprotective effects on the skin (48). β -carotene and lycopene have also been shown to protect the skin from UV damage, such as reducing erythema and lipid peroxidation (49). Additionally, betaine compounds also prevents UVB-induced skin damage by reducing the elevated expression of MMP-9 (50).

4. CONCLUSION

In conclusion, it shows that Goji Berry (*Lycium barbarum*) extract has a great potential as anti-photoaging. It can act as a powerful antioxidant, reducing oxidative stress caused by free radicals from excessive UV exposure. It also maintain skin thickness, increase collagen levels, reduce secretion of MMP-1, also improve skin hydration and elasticity. Further research is needed to determine the best method of administration and the optimal dosage as an anti-photoaging agent.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

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