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Article Review

Potential of Natural Based-Skincare Cosmetic Ingredients for Naturally Glowing Skin

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Abstract

The use of skincare products is the primary need in modern society. There is an increase in awareness of maintaining beauty and healthy skin, as well as the desire to have naturally glowing, healthy skin, which is in line with the rise in the use of cosmetics, especially skincare products. Nature provides many plants and marine resources (such as algae) that can be utilized as essential ingredients for cosmetics preparations with various benefits such as cleansers, toners, moisturizers, and sun protectors, a primary series of skincare products to gain naturally glowing, healthy skin. This review aims to provide information about plants and marine algae that can be used as skincare ingredients, their phytochemical contents, and their function in cosmetics to achieve naturally glowing skin. Various plants and marine algae categorized based on their benefits as skincare have great potential to be developed as ingredients in cosmetic preparations. The content of phytochemical compounds in these plants and marine algae supports these benefits. Each skincare category has major phytochemical compounds that play a role in providing these benefits.

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INTRODUCTION

Cosmetics are beauty and health products used for the external part of the body that aims to care for the body, change appearance, cleanse, and remedy body odor[1]. Cosmetic products are very diverse, such as skincare products, decorative cosmetics, hair care products, perfumes, and other[2]. Nowadays, the use of cosmetics has become a trend in society. The global pandemic has created a shift in lifestyle; thus, the tendency to use cosmetics to make healthy and beautify the skin is rising. Cosmetics have become the primary need for body care. Particularly skin care products currently used by women and men who are starting to realize the importance of maintaining beauty and healthy skin. In addition, they desire bright, smooth, acne-free, and hydrated skin known as glowing[3-5].

Glowing skin is healthy and awake skin (dull, not dry, and uneven texture). For some people, glowing skin is recognized as healthy skin that results in natural sheeny or glow[6,7]. Everyone has a different skin type. Some factors influence skin health and its ability to bring a glowing appearance, including genetics, hormones, health conditions and medications, environment, and lifestyle. Skincare is one of the lifestyles that affect skin health[8-11]. The essential skincare series that can obtain these benefits consists of cleansing, toner, moisturizing, and sun protection. Its routine use can help to maintain healthy and glowing skin[12-14].

Presently, skincare products are very diverse, not only simple basic skincare series, and all these products are essential to use; hence, people usually buy all kinds of products and use them for an extended period. This behavior creates a new problem. These skincare products can damage the skin due to chemical ingredients in cosmetics that are dangerous for long-term use[15,16].

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To overcome the problem, herbal cosmetics are increasingly used as an option for skin care compared to conventional cosmetic products derived from synthetic chemicals. These natural products can provide satisfaction for users with the benefits of having relatively lower side effects and supplying good nutrients for the body[17,18]. This review aims to provide information about plants and marine algae that can be used as skincare for naturally healthy skin with the benefits and phytochemical substances contained in the plants and marine algae. Therefore, this review can be used as a reference for making herbal-based skincare products.

PLANTS-BASED SKINCARE FOR NATURALLY GLOWING SKIN

Nowadays, the trend of using skincare cosmetics is growing in society[3]. These cosmetic products have become a daily necessity and play a significant role in skincare and health[13,19]. Skincare cosmetics contain substances that allow the skin to function correctly. These substances support the homeostatic function of the skin; thus, they are preserved in a healthy and beautiful condition or restore damaged skin conditions to be healthy again. Skincare cosmetics have several purposes, such as cleansing and refreshing the skin, maintaining the skin's moisture balance, stimulating skin metabolism, and protecting the skin from the danger of ultraviolet radiation, which can cause skin damage. Skincare products must be well designed regarding safety, usability, stability, and texture[20-22]. Natural ingredients are the most popular choice in the cosmetic industry. These ingredients provide essential nutrients for healthy skin and positively impact the skin's biological function, such as antioxidant and anti-inflammatory properties[23,24]. Several plants that have benefits, such as basic herbal skincare ingredients to get naturally glowing skin, are listed in **Table I**.

Table I. Plants that can be used as basic skincare ingredients based on the skincare category.

Category	Plant	Part	Phytochemical compounds	Experimental outcomes	References
Cleanser	Aloe vera (*Aloe barbadensis* Miller)	Leaf	Saponin glycosides, amino acids (isoleucine, leucine)	0.15 g facial cleansing formula containing 0.5% aloe vera could effectively clean 0.02 g foundation stains	[25]
	Bitter melon (*Momordica charantia*)	Leaf	Saponin and oil	Bitter melon ethanol extract provided good effectiveness as a cleanser through mechanisms such as surface tension reduction, heavy metal absorption, and antibacterial	[26]
	Tea seed oil (*Camellia oleifera* Abel)	Seed	Fatty acids (linoleic acids, palmitic acids, oleic acids, and stearic acids).	The formula of tea seed oil remover provided better cleansing efficacy in cleaning foundation stains and eyeliner compared to benchmark products	[27]
Toner	Green tea (*Camellia sinensis*)	Leaf	Polyphenols	Anti-sebum efficacy of the 7% green tea extract toner formula (31.57%) was better than the base (5%) within 28 days	[28,29]
	Guava (*Psidium guajava* L.)	Leaf	Tannins	Anti-sebum efficacy of the 6% guava extract toner formula (forehead 13.10%; nose 21.43%) was better than base within 28 days and more than the requirement (10%)	[30]
	Malaka (*Phyllantus emblica* L.)	Fruit	Tannins	Anti-sebum efficacy of the 3% malaka toner formula (23.5%) was better than the base (12%) within 3 hours after application	[31]
Moisturizer	Aloe vera (*Aloe barbadensis* Miller)	Leaf	Amino acids, polysaccharides (acemannan, glucomannan)	10% aloe vera cream formula was significant: ↓ trans-epidermal water loss (TEWL), ↑ water content of the stratum corneum, as well as ↑ elasticity and firmness of the skin	[32]
	Pegagan (*Centella asiatica* L. Urban)	Herb	Triterpene saponins (centelloid), sugars (glucose, rhamnose), polyphenols, terpene (asiatic acid, madecassic acid, asiaticoside)	5% pegagan cream formula was significant: ↓ TEWL, ↑ skin hydration	[33]
	Rose (*Rosa chinensis* & *Rosa rugosa*)	Flower	Polysaccharides	Rose extract was significant: ↑ Aquaporine-3 expression = ↑ skin hydration	[34,35]

	Kelor (*Moringa oleifera*)	Leaf	Ascorbic acids (vitamin C), phenolic acids (gallic, ellagic, chlorogenic, ferulic), flavonoids (quercetin, kaemferol, rutin), amino acids (histidine, serine, arginine, glycine, threonine, alanine), vitamin A, vitamin B, beta-carotene.	3% kelor cream formula was significant: ↓ TEWL, ↑ skin hydration	[36,37]
	Prickly pears (*Opuntia ficus-indica* (L.) Mill)	Cladode	Polysaccharides (rhamnose, galacturonic acid, arabinose, glucose)	1% and 3% opuntia cream formula were significant: ↓ TEWL, ↑ skin hydration up to 4 hours after application	[38,39]
	Papaya (*Carica papaya)*	Fruit	Polysaccharide (papain)	Papaya polysaccharides had significantly stronger moisture absorption and retention capabilities than glycerol and hyaluronic acid	[40]
	Hibiscus (*Hibiscus rosa-sinensis* L.)	Leaf	Polysaccharides (uronic acid, glucuronic acid, galacturonic acid)	The moisture efficacy of mucilage hibiscus extract 0.2% was better than hyaluronic acid 0.2%, butylene glycol 5%, and propylene glycol 5% after 30 min application	[41]
	Dendrobium orchid (*Dendrobium spp*.)	Flower	Polysaccharide (uronic acid)	Dendrobium extract was significant: ↑ skin hydration	[42]
	Prosopis juliflora	Leaf	Polysaccharide (α-glucan) and phenolic compounds	*Prosopis juliflora* granule formula was significant: ↓ TEWL, ↑ skin hydration	[43]
	Argan oil (*Argania spinosa* L.*)*	Seeds	Triglyceride	3% argan oil serum formula was significant: ↑ moisture content of 19.67% after 15 min application	[44]
Sun protection	Olive (*Olea europaea* L.)	Leaf	Phenolic compounds (oleuropein; luteolin-7-O-glucoside; apigenin-7-O-glucoside; verbascoside)	Sun Protection Factor (SPF) value reached 56 at extract concentration 3 – 5%	[45]
	Sambiloto (*Andrographis paniculata* L. Ness)	Leaf	Flavonoid (quercetin-3-glycosides)	SPF value 15.42 – 28.41 at extract concentration 12 – 20 µg/mL	[46]
	Rambutan (*Nephelium lappaceum* L.)	Peel	Flavonids (apigenin, quercetin, anthocyanins, catechin); tannins (ellagic tannins, corilagin, geraniin)	Base SPF value ↑ 2.5 times (26.3) at 1% extract addition	[47]
	Benitaka grapes (*Vitis vinifera* L.)	Peel	Flavonoids (rutin, resveratrol)	SPF value 18.56	[48]
	Coconut (*Cocos nucifera* L.)	Husk fiber	Phenolic compounds (quercetin, catechin, epicatechin, vanillic acid, caffeic acid)	SPF value 15.94 in 20% coconut husk fiber extract cream formula	[49]
	Guava (*Psidium guajava* L.)	Fruit	Flavonoids (quercetin, myricetin, catechin) and tannins	SPF value of synthetic photoprotective agent EHM ↑ 134% (8.1 to 18.9) with the addition of 7.5% guava extract	[50]
	Green tea (*Camellia sinensis* L.)	Leaf	Polyphenols	SPF value 14.59 at 10% extract concentration	[51]
	Marcetia taxifolia	Leaf	Flavonoid (quercetin)	SPF value 6.40 – 43.11 at extract concentration 5 – 30%	[52]

Notes: ↑ = increasing, ↓ = decreasing

CLEANSER

The first step in the basic series in the routine use of skin care products is a cleanser[53]. Cleaning products are essential because many impurities from cosmetics and the environment are not soluble in water, so simple washing with water is not enough to remove these impurities. Substances capable of emulsifying these impurities into finer particles make these fat-soluble impurities water-soluble. Skin cleansers are surface active agents, emulsifiers/soaps/surfactants/detergents that lower the

skin's surface tension and remove impurities, microorganisms, oil from cosmetic products, sebum, and exfoliated corneum cells in the form of an emulsion. The ideal cleanser should be able to do all of these actions without irritating or damaging the skin; conversely, it should keep the skin's surface moist[54]. Cleansing the face from oil, dirt, and other residues using a cleanser should be done routinely. It is recommended to use the type of facial cleanser that suits the skin type[14].

Plants rich in saponins and fatty acids can be an alternative to be used as cosmetic ingredients that function as cleansers, as seen in **Table I**. Saponins and fatty acids are phytochemical compounds shown to have cleaning abilities[55,56]. Saponins are active surfactant molecules that can reduce surface tension and increase the foaming ability of an aqueous solution so that it can effectively act as a cleaner[57]. In addition, saponins can also be potent antibacterial agents; thus, their activity can support saponins' function as cleansing agents[58]. Meanwhile, fatty acids also have excellent abilities as cleansing agents because of their properties as surfactants, especially playing an active role in the hydrophobic part[59].

Aloe vera leaves

Aloe vera (*Aloe barbadensis* Miller) can be used as a natural cleansing agent in cosmetic preparations. Facial cleansers containing aloe vera extract are known to remove cosmetic residues on the skin[25]. The cleanser ability is due to bioactive compounds, such as saponin glycosides and amino acids (isoleucine, leucine). Its antioxidant and antimicrobial properties contribute to its ability to cleanse the skin, especially microorganisms and other impurities[60]. Aloe vera extract has effective antimicrobial properties against bacteria, such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Staphylococcus epidermidis*, *Escherichia coli*, and *Staphylococcus pyogenes*[61,62]. Aloe vera extract also exhibited moderate antioxidant properties compared to gallic acid, with the lowest IC_{50} values for DPPH testing (0.73 mg/mL), ABTS (0.20 mg/mL), and the lowest EC_{50} for reducing power testing (0.9 mg/mL)[63]. In addition, skin cleanser containing aloe vera extract is safe for sensitive skin[25].

Bitter melon leaves

Bitter melon (*Momordica charantia* L.) leaves contain bioactive compounds such as saponins and oils that can cleanse the skin from pollutants such as dirt, dust, and cosmetic residues. These compounds work similarly to the active substance of coal in facial cleansing products[26]. In addition, bitter melon also contains phenolic compounds: flavonols, that act as antioxidants. These antioxidants can bind free radicals and harmful metals, preventing skin damage[64,65]. Research conducted by Andrianto *et al.*[26] proved that bitter melon extract has the potential to be an active ingredient in herbal-based facial cleansing cosmetics. In this study, antibacterial tests, heavy metal absorption tests, and surface tension tests were carried out to prove the potential of the bitter melon extract. Based on the antibacterial test results, bitter melon leaves ethanol extract could inhibit the growth of bacteria colonizing the skin: *E. coli*, *S. aureus*, and *S. epidermidis* with minimum inhibitory concentration (MIC) values of 1000, 2000, and 62.5 ppm. In addition, bitter melon leaves ethanol extract was reported to kill *E. coli* and *S. epidermidis* bacteria at a minimum bactericidal concentration (MBC) of 2000 ppm.

Meanwhile, heavy metal absorption testing results showed that 1% bitter melon leaves ethanol extract could absorb heavy metals from air pollution: Pb and Hg, with absorption abilities up to 48.2% and 30.2% metals. The absorption ability of bitter melon leaves ethanol extract is more effective than the positive control, 1% activated charcoal, which could absorb Pb and Hg metals as much as 41.5% and 27.4%. Moreover, bitter melon leaves ethanol extract at 0.1 – 0.4% could reduce skin surface tension[26]. Decreasing surface tension could expand the surface of the liquid so that the liquid/extract could penetrate deeper and clean dirt better[66].

Tea seed oil

Tea seed oil is extracted from the seeds of *Camellia oleifera* Abel. Besides its ability as a cleansing agent, the fatty acids in tea oil, such as oleic acid, palmitic acid, linoleic acid, and stearic acid, can also depress sebum secretion and hydrate effect on the skin[67]. Based on research conducted by Parnsamut *et al*[27], tea seed oil effectively removes makeup residues such as foundation and eyeliner. Based on an *in vitro* study, tea seed oil demonstrated a significant cleansing efficacy of 94.48% compared to commercial cleaning products with an efficacy of 92.32%. Meanwhile, the cleansing efficacy of eyeliner was 87.62%. This result was insignificant compared to commercial cleaning products, with an efficacy of 96%. Furthermore, tea seed oil has also been shown to be safe to use as a cleansing agent[27].

TONER

Toner is a skincare product used after facial cleansers as a second cleansing agent to remove makeup residues or excessive sebum secretion from facial skin to prepare the skin before nourishing treatment[14,68]. Currently, toner has more diverse purposes, such as balancing skin pH, moisturizing the skin, alleviating irritation, antisepsis, and tightening skin pores. Toner products are also widely developed as cosmeceutical products that utilize the therapeutic effects of plants to control oil on the skin[69].

Green tea leaves

Green tea (*Camellia sinensis* L.) contains polyphenolic compounds proven to have good efficacy and are safe to use as toners. The green tea toner reduces facial sebum levels better than base toner (glycerin, water, alcohol) after 14 and 28 days of use. Moreover, the polyphenols content in green tea can provide anti-aging properties by counteracting free radicals to make a face look better and younger[28,29].

Guava leaves

Guava leaves (*Psidium guajava* L.) with rich tannin content have excellent efficacy as an anti-sebum and are safe to use daily as a toner. The content of these tannins is astringent to reduce the skin's oiliness. This astringent property is related to suppressing surface lipid production and secretion. Toners containing guava leaves extract showed better efficacy in reducing sebum levels than toner bases (glycerin, water, alcohol). The anti-sebum effectiveness of using guava toner is more noticeable in the nose's skin area, which physiologically produces more sebum than the forehead[28,30,67,70].

Malaka fruits

Malaka (*Phyllantus emblica* L.) is an herbal ingredient that is safe to use as a toner and shows good efficacy as an anti-sebum on facial skin[31]. Malaka contains many phenolic compounds, especially tannins, which have an astringent effect and can reduce skin sebum secretion by inhibiting the 5α-reductase[71-73]. Using a toner containing malaka extract showed better efficacy in sebum recovery on the skin than only washing the face. This is because washing the face may only remove the lipid film that protects skin hydration, making the sebum glands generate more sebum to compensate for the hydration imbalance. Therefore, washing the face without toner afterward will stimulate more sebum secretion in the skin than skin using toner. The toner containing malaka extract showed better efficacy in reducing sebum on the cheeks than on the forehead because the forehead produces more sebum than the cheeks[31,74].

MOISTURIZER

Moisturizers are one of the basic skincare products. Moisturizers intend to enhance skin hydration, reduce fine lines, smoothen, repair the lipid barrier, and enhance the water content of the stratum corneum[75,76]. Moisturizers are essential to maintain the skin barrier, which keeps the stratum corneum moist by acting as humectants, emollients, and occlusives[75]. Adequately hydrated or moisturized skin can prevent dry skin, which can cause damage in the form of cracking or chapping, as well as irritation and inflammation of the skin so that the skin will stay healthy and look naturally glow[77-79]. The characteristics of these phytochemical substances contained in plants are advantageous in maintaining skin moisture. Phytochemical-rich extracts, such as polysaccharides, phenolic compounds, amino acids, vitamins, and natural oils, can decrease TEWL, increase water retention in the stratum corneum, increase water contents, and increase the amount of protein and collagen thereby increasing the epidermal thickness[80-82].

Aloe vera leaves

Aloe vera (*Aloe barbadensis* Miller) has been widely used in traditional medicine as a moisturizer and anti-inflammatory to treat wounds, burns, sunburns, and inflammatory skin disorders[83,84]. Aloe vera has also been used as a moisturizer in cosmetic products such as soaps, hand creams, suntan lotions, shampoo, makeup, and baby lotion[85]. Aloe vera has benefits as a moisturizer because of the content of polysaccharides in the form of sugar (acemannan and glucomannan) and amino

acids32. Aloe vera enhances skin moisture by acting as a humectant by increasing the water content in the stratum corneum84. Amino acids in aloe vera may intensify water retention in the stratum corneum to alleviate skin hydration. Moreover, acemannan in aloe vera extract can improve skin elasticity[86,87]. Therefore, aloe vera extract is an effective natural ingredient used as a moisturizer in cosmetics[32].

Pegagan herbs

Centella asiatica extract increases the stratum corneum hydration and improves the epidermal barrier's function. Thereby, it can potentially be used as a moisturizer in cosmetics[33,88]. The presence of phytochemical compounds: triterpene saponins, sugars, and polyphenolic compounds, which can bind water by forming a hydrophilic occlusive film, significantly affects its activity in enhancing stratum corneum hydration. These compounds also can reduce TEWL through the formation of an occlusive film and ameliorate the condition of the epidermal barrier, particularly on the barrier tightness[33].

Rose flowers

Roses (*Rosa chinensis & Rosa rugosa*) contain polysaccharides that are effective as skin moisturizers[34,35]. In recent years, polysaccharides have attracted attention due to their ability to retain moisture in cosmetics. Polysaccharides have carboxyl, hydroxyl, and other polar groups, which can configure intermolecular hydrogen bonds with water molecules to preserve moist skin content[89]. Rose polysaccharides, which have intense activity as moisture-preserving, are expected to be derived from the uronic acid content and space net structure[35]. Medium molecular weight (MW) of rose's polysaccharides, such as dextran, also plays a role as moisturizers and thickeners. It is because of the osmotic retention ability in the tissue that it will regulate skin hydration in homeostatic conditions[90].

Kelor leaves

Moringa oleifera leaves extract has the potential as a moisturizer in cosmetic preparations with various phytochemical compounds, which are ascorbic acid (vitamin C), phenolic compounds (phenolic acid and flavonoids), amino acids, vitamin A, beta-carotene, and vitamin B[36,37,91,92]. Moringa leaves extract has activity as a humectant and is occlusive in its role as a natural moisturizer. The content of phenolic compounds and ascorbic acid in moringa leaves can reduce TEWL. Water binding in the stratum corneum helps decrease TEWL by spreading the occlusive films[36,80,93]. Meanwhile, amino acids may promote water retention in the stratum corneum, thereby increasing skin hydration[36,94]. Vitamin A and beta-carotene enhance collagen and protein, thereby increasing epidermal thickness[81,95]. In addition, vitamin B contained in Moringa leaves functions as a humectant that can captivate water into the stratum corneum, thereby softening the skin, and vitamin B may increase the water content in the stratum corneum[81,82].

Prickly pears/Opuntia cladodes

Opuntia cladodes (*Opuntia ficus-indica* (L.) Mill) have a moisturizing effect through occlusion and humectant mechanisms. The high polysaccharide content in opuntia cladodes (rhamnose, galacturonic acid, arabinose, and glucose) is a phytochemical compound providing a moisturizing effect by increasing the water content in the stratum corneum and decreasing TEWL. When the humidity in the environment is extremely low, this moisturizing agent will prevent dehydration of the stratum corneum. When the water content is sufficient, the skin barrier function, flexibility, and healthy appearance are maintained[39]. In the study about *in vivo* skin moisture efficacy conducted by Damasceno *et al*[38], the group treated with an emulsion formula containing opuntia cladodes extract revealed an increased skin hydration value after 5 hours of application. In addition, the skin hydration value of opuntia cladodes extract emulsion was higher than the untreated and vehicle groups, which were 40.25%, 39.07%, and 37.53%, respectively. An emulsion containing opuntia cladode extract was also reported to provide a skin protection effect by decreasing TEWL within 1 hour after applying the formula. This effect lasted up to 4 hours. Meanwhile, the untreated group exhibited an increase in TEWL as time functioned and reached an increase in TEWL of up to 20.63% after 5 hours of application.

Papaya fruits

The polysaccharide contents in papaya are advantageous to use as a natural moisturizer in skincare cosmetics. These polysaccharides show a strong ability to absorb and retain moisture compared to glycerol and hyaluronic acid, which function as humectants. Based on in vitro moisture absorption and retention studies, the moisture absorption rate of papaya polysaccharides showed a rapid increase rate along with increased exposure time (96 hours). Moreover, the study demonstrated that the moisture retention capacity of papaya polysaccharides was stronger than glycerol and hyaluronic acid[40]. Generally, polysaccharides are strongly hydrophilic with carboxyl, hydroxyl, and other polar groups, which may configure hydrogen bonds with H_2O molecules to massively concatenate the water content. At the same time, polysaccharide chains can also be interwoven into the lattice, which plays a pivot role in maintaining the moisture content[40,96,97].

Hibiscus leaves

Hibiscus leaves (*Hibiscus rosa-sinensis* L.) have traditionally been used as emollients to treat skin diseases and burning sensations[98]. Based on research conducted by Kassakul *et al.*[41], hibiscus leaves mucilage extract was known to have an excellent moisturizing effect. The skin moisture efficacy value of hibiscus leaves mucilage extract 0.2% showed better results compared to hyaluronic acid (HA) 0.2%, butylene glycol (BG) 5%, and propylene glycol (PG) 5%. Its ability as a moisturizer was due to the content of polysaccharides (uronic acid, glucuronic acid, galacturonic acid). These polysaccharides could moisturize the skin by increasing dermal mucopolysaccharides and the skin barrier[99]. In addition, the presence of a high negative charge of hydroxyl and carboxyl groups of glucuronic acid and galacturonic acid allowed hibiscus leaves mucilage extract to have a higher water-holding capacity and preserve skin water content[100,101].

Dendrobium orchid flowers

Dendrobium orchid flowers are rich in polysaccharides, especially uronic acid, which increases skin hydration. Dendrobium polysaccharides have promising potential as natural moisturizing agents for skin care products. Dendrobium polysaccharides were reported to have short-term skin hydration efficacy, lasting 150 minutes, comparable to seaweed polysaccharides. Seaweed polysaccharides were a reference moisturizing agent widely used in skin moisturizing products. Furthermore, dendrobium polysaccharides have been shown to maintain better skin hydration than water and untreated skin. The polysaccharide dendrobium was also a safe ingredient to use as a potential natural moisturizing agent, according to the patch irritation test on 22 volunteers[42].

Prosopis juliflora leaves

Prosopis juliflora leaves extract is a potential cosmetic raw material that is safe to use. *Prosopis juliflora* leaves extract has good potential in short-term and long-term skin hydrating and improving skin microrelief and as an anti-aging agent. It is likely due to the polysaccharides (α-glucan) and phenolic compounds contained in the extract. Based on moisturizing clinical trials, *P. juliflora* leaves extract exhibited a significant improvement in the stratum corneum's water content to reach a value of more than 40% after 5 hours of applying a gel formula containing *P. juliflora* leaves extract. The percentage of water content in the stratum corneum in the group treated with the gel formula of *P. juliflora* leaves extract showed better results compared to the negative control group without moisturizer by 0.67% and the positive control group (commercial moisturizing gel) by -2.53%. In addition, the gel formula of *P. juliflora* leaves extract demonstrated a significant reduction in TEWL. The long-term skin hydration effect of *P. juliflora* leaves extract was able to maintain the water content of stratum corneum for 30 days with a decrease in water content of only 0.4%. Therefore, *P. juliflora* leaves extract can be considered a natural moisturizing agent in skin care products[43].

Argan seed oil

Argan oil is a plant-derived from Argan (*Argania spinose*), which is one of the ingredients that play a critical role in the dermo-cosmetics field because of its highly moisturizing contents. According to skin moisture tests using Scalar checkers on 15 volunteers, skin treated with argan oil serum showed increased skin moisture values. Argan oil contained triglycerides, the

main compounds that acted as moisturizing agents. The mechanism of argan oil as a moisturizer was an emollient that could provide occlusivity and repair the skin appearance by smoothing exfoliated skin cells[44].

SUN PROTECTION

Sunscreens are chemicals that block or absorb ultraviolet (UV) rays. The dermatologist recommends using sunscreens in the basic daily skincare routine due to most skin damage caused by ultraviolet exposure daily. Using sunscreens should be a critical final step in every basic skincare routine[14,102]. UV radiation exposure can produce reactive oxygen species (ROS) that harm the skin. UVB radiation (290 – 320 nm) that penetrates the skin can lead to erythema or sunburn, trigger oxidative stress, and skin premature aging. Meanwhile, UVA radiation (320 – 400 nm), which can penetrate the skin more profoundly into the epidermis and dermis layers, can produce free radicals that can damage lipids, proteins, and DNA in the skin[103-105]. In recent years, interest in using sun protection derived from natural ingredients has increased. Natural products have higher tolerability and negligible environmental impact[106]. Plants have been widely used to treat skin disorders because of their antioxidant properties, which can counteract free radical species. The antioxidant properties of these herbal ingredients can protect the skin from UV radiation exposure. As seen in **Table I**, the main compounds that play a pivotal role in sun protection are phenolic compounds (especially flavonoids and tannins). These bioactive compounds can potentially protect collagen and elastin's skin, epidermis, and dermis. Collagen and elastin are prominent components of the skin that are responsible for maintaining its structure and elasticity. Collagen and elastin damage can lead to wrinkles and other aging signs[107].

The protection effect of sunscreens against UV radiation can be seen from the SPF value, which indicates protection against UVB rays, as well as the UVA/UVB ratio and critical wavelength, which indicates protection against UVA rays. Based on Food and Drug Administration (FDA) regulation, SPF values are categorized into minimal (2 – <12), moderate (12 – <30), and high (≥30). Meanwhile, the UVA/UVB ratios are categorized into low (0 – 0.20), medium (0.21 – 0.40), good (0.41 – 0.60), superior (0.61 – 0.80), and maximum (>0.80) according to Boots Star Rating standards[108,109]. Furthermore, sunscreens with high critical wavelengths are highly protected against UVA radiation (320 – 400 nm). Sunscreen can be labeled as broad-spectrum if it has a critical wavelength minimum of 370 nm[110].

Olive leaves

Olive (*Olea europaea* L.) is one of the essential herbal ingredients for sun protection. The main components of olives are phenolic compounds consisting of oleuropein, luteolin-7-O-glucoside, hydroxytyrosol, apigenin-7-O-glucoside, and verbascoside. The highest content of phenolic compounds is found in the leaves. Olive leaves extract is a photoprotective agent, antioxidant, and antimutagenic, which shows a synergistic effect in increasing SPF value when added to sunscreen formulations containing organic UV filters. The addition of 3 – 5% olive leaves extract can enhance the SPF value of the basic formula significantly 2 – 3 times, with the highest SPF value reaching 56 (high SPF category). In addition, the sunscreens containing olive leaves extract show good protection against UVA radiation with a critical wavelength of 79 nm and a UVA/UVB ratio of 0.564[45]. Olive leaves extract is also known to have the effect of reducing inflammation and erythema due to the presence of oleuropein and hydroxytyrosol, which act as antioxidants[111,112].

Sambiloto leaves

The leaf of sambiloto (*Andrographis paniculata* L.) is known to have the potential as a photoprotective agent. The ethanol extract of *A. paniculata* showed an SPF value of 15.42 – 28.41 at a 12 – 20 µg/mL concentration range. These SPF values meet the requirement recommended by the FDA, which states that sunscreen preparations that have protection against UV radiation must have at least 15 or more SPF values. The photoprotective activity of *A. paniculata* is due to the rich content of flavonoids, especially quercetin-3-glycosides. Flavonoids are secondary metabolites that can absorb UV radiation efficiently, usually indicated by the appearance of two peaks in UV spectroscopy testing. *Andrographis paniculata* extract showed the presence of two peaks at 230 and 362 nm. Thus, it can be concluded that *A. paniculata* has excellent protective properties against UVB and UVA. Therefore, this plant can be an essential ingredient in herbal cosmetic formulations for sun protection[46,52,108].

Rambutan peels

Rambutan (*Nephelium lappaceum* L.) contains flavonoids and tannins that are effective photoprotective agents against UV radiation. In cosmetic formulations, these natural compounds act as antioxidants, anti-aging, and anti-inflammatory[113,114]. The highest content of flavonoids and tannins in rambutan is found in the peels. Rambutan fruit peel extract is known to show maximum UV absorption in the UVB region (290 – 320 nm), so it has the possibility of a positive synergistic effect in absorbing UV radiations when combined in cosmetic formulations. This synergistic effect enhances SPF value[47]. The chief compounds attributed to this synergistic effect are ellagic acid, corilagin, geraniin, catechin, apigenin, anthocyanins, and quercetin[115-117]. Anthocyanins and quercetins can absorb UV radiation directly, thereby inhibiting skin damage due to UVB radiation. In addition, catechins and ellagic acids are antioxidants that can minimize the harmful effects of free radicals due to exposure to UV rays. Apigenin can also prevent skin cancer promoted by UV rays and other compounds that can increase photoprotective activity[113]. Adding 1% rambutan fruit peel extract can improve the SPF value of the basic sunscreen formula by 2.5 times, with the highest SPF value reaching 26.3. Therefore, rambutan has good potential as a photoprotective agent added to cosmetic preparations as sun protection[47].

Grape peels

The flavonoid contents in the Benitaka grape cultivar (*Vitis vinifera* L.) are advantageous to use as a natural UV filter in skincare cosmetics. The cyclic and aromatic rings in the chemical structure of flavonoids can absorb light in the UV region, particularly in the wavelength range of 240 – 285 nm and 300 – 550 nm, making them ideal for photoprotective agents. The highest flavonoid content in this plant is found in the fruit peel. The grape extract has a good SPF value of 18.56, following the requirements recommended by the FDA. In addition, this sunscreen containing grapefruit peel extract shows good protection against UVA radiation with a UVA/UVB ratio of 0.9 (maximum protection) and a critical wavelength of 318 nm[48,118].

Coconut husk fibers

Coconut husk fiber extract (*Cocos nucifera* L.) has benefits as a natural photoprotective agent that is safe to use as an ingredient in sunscreen preparations. Coconut husk fiber extract showed a higher SPF value than the required value for sunscreen preparations, which was 15.94 in a cream formulation containing 20% coconut husk fiber extract[49]. Coconut husk fiber is rich in phenolic compounds that are essential to sun protection activity. These compounds have structural characteristics similar to chemical photoprotective agents. Hence, they can absorb the light in the UV region[119,120]. In addition, coconut husk fiber extract exhibits good antioxidant properties. The presence of antioxidants in sunscreen preparations can protect against the damaging effects of free radicals generated by UV rays and increase the UV filter activity[121,122].

Guava fruits

Guava fruits (*Psidium guajava* L.) contain tannins and flavonoids that can work synergistically with other photoprotective agents and improve the activity of synthetic photoprotective agents[123]. Furthermore, the absence of coumarin content in guava fruit extract can cause photosensitivity under UVA[50,124]. Based on UV spectrum test results, guava fruit extract showed maximum absorption in the range of UVB absorption area of 315 – 280 nm and UVA absorption area of 400 – 315 nm. The guava fruit extract exhibited a low SPF value of 1.00. However, guava fruit extract could increase the performance of synthetic photoprotective agents: 2-ethyl-hexyl-methoxycinnamate (EHM) by 134%, with SPF values from 8.1 to 18.9. The increase in SPF value was thought to be due to the interaction between phenolic compounds in guava fruit extract (quercetin, myricetin, and catechins) and EHM. Due to conjugate bonds in these compounds, these phenolic compounds could absorb electromagnetic radiation at different wavelengths, including UV radiation[125,126]. Using guava fruit extract in sunscreen formulas containing EHM synthetic photoprotective agents could reduce the use of additional synthetic photoprotective agents by 78%, decreasing the risk of skin irritation and toxicity. Therefore, guava fruit extract has good potential to be used as a supplement of natural photoprotective agents in sunscreen formulas[50].

Green tea leaves

Phytochemical compounds in green tea leaves extract (*Camellia sinensis* L.) have been known to have potential as antioxidants and SPF activity. Polyphenols contained in green tea leaves extract are the main compounds that play a role in their activity as photoprotective agents[51,127]. Batthacarya and Sherje[51] reported that a sunscreen formula containing green tea leaves extract had an SPF value of 14.59. The SPF value of green tea leaves extract was higher than the SPF value of sunscreen formulas containing resveratrol, which was 9.35. Meanwhile, combining the two ingredients in the sunscreen formulation revealed an increase in SPF value to 16.91. This sunscreen formula containing a combination of green tea leaves extract and resveratrol shows satisfactory results as a photoprotector, according to FDA and European Cosmetic guidelines (SPF ≥ 15).

Marcetia taxifolia leaves

Marcetia taxifolia leaves contain flavonoids (quercetin), which were known to absorb UV radiation with two maximum wavelengths of 240 – 280 nm and 300 – 550 nm. *Marcetia taxifolia* leaves extract. In addition, its antioxidant properties with EC_{50} of 5.132 µg/mL supported the potential of *M. taxifolia* leaves as a photoprotective agent. *Marcetia taxifolia* leaves extracts with different concentrations (125 and 250 µg/µL) showed SPF values of 8.35 and 15.52. The SPF value indicated satisfactory sunscreen activity following the Brazilian regulation, Agência Nacional de Vigilância Sanitária or Anvisa[128], which stated that only ingredients with an SPF value greater than or equal to 6 could be used for cosmetic products with photoprotector activity.

Moreover, sunscreen formulation containing *M. taxifolia* leaves extract (30, 20, 10, and 5%) at dilutions starting at 2 mg/µL showed SPF values greater than 6. At a dilution of 50 mg/µL, the sunscreen formula of *M. taxifolia* leaves extract had a high SPF value, equivalent to an SPF value of 5% benzophenone (SPF 39.84), making it suitable for susceptible skin due to sunburn. The SPF value of the sunscreen formulations was 30 – 50 according to the requirements of Anvisa[128]. Meanwhile, testing of good activity as a photoprotective agent against UVA radiation was proven through *in vitro* testing using the trans-resveratrol solution. When the trans-resveratrol solution was exposed to UVA radiation, it degraded as measured by a decrease in absorbance over time. Based on the test results, petri dishes containing trans-resveratrol solution coated with *M. taxifolia* leaves extract did not show photobleaching activity. Meanwhile, Petri dishes that were not coated with extract showed as much as 50.73% of photobleaching trans-resveratrol. Therefore, *M. taxifolia* leaves extract has great potential to be developed as an active ingredient in sunscreen products[52].

MARINE-ALGAE-BASED SKINCARE FOR NATURALLY GLOWING SKIN

Besides plants, marine resources also have the potential to be used as ingredients for skincare. Interest in algae as an ingredient for cosmetic skincare is increasing along with market demand for natural ingredients[129]. Among marine resources, algae are a source of raw materials rich in bioactive compounds that play a role in various biological activities. In addition, algae resources are also widely available[130]. Oceans cover two-thirds of the earth's surface, with its top layer inhabited by algae[131]. A total of 11,017 species of algae have been known[132]. Moreover, global algae production has over tripled, increasing from 10.6 million tons in 2000 to 32.4 million tons in 2018[133]. Currently, algae are a sustainable-renewable resource gaining popularity for cosmetics use. In recent years, many scientific studies have proven the potential of algae in skincare[130,134].

Toner that refreshes and cleanses the face can also be made from brown algae (*Turbinaria conoides*) and red algae (*Eucheuma cottonii*)[135,136]. *Turbinaria conoides* extract shows antibacterial and antioxidant activity that can support its function as a hydrating toner. The content of saponins and triterpenoids is essential in their function as active ingredients for skincare[135]. In addition, *E. cottonii* extract is also an excellent additional raw material used in toner formulas mixed with butterfly pea extract. This toner suits dry skin types[136].

Some algae have been shown to have benefits as moisturizers. The content of polysaccharides in algae, such as alginate, sulfated polysaccharides, monosaccharides, etc., plays an essential role as a moisturizer. In addition, the amino acid content of algae also contributes to the skin's moisture[137-140]. Wang *et al.*[138] have conducted research related to the moisture absorption and retention ability of five types of algae consisting of green algae (*Bryopsis plumose*, *Codium fragile*, and *Enteromorpha linza*), brown algae (*Saccharina japonica*), and red algae (*Porphyra haitanensis*). Among polysaccharides extracted from different types

of algae, polysaccharides derived from brown algae showed the best moisture absorption and retention abilities. Compared to hyaluronic acid, low molecular weight polysaccharides of *S. japonica* showed better moisture absorption and retention abilities. Other studies have also demonstrated that moisturizing formulas containing brown algae extract *Sargassum sp*. have also been shown to increase skin hydration. The high alginate content in brown algae supports this moisturizing effect[139]. Therefore, other brown algae containing alginate, such as *Turbinaria ornata*, *Padina australis*, *Dictyota ciliolata*, *Hormophysa cuneiformis*, and other, are likely to have the same moisturizer effect[141,142].

Meanwhile, the green algae tested showed the worst ability among the three types of algae[138]. However, in another study, polysaccharides extracted from green algae (*Ulva fasciata*) showed stronger moisture absorption and retention capabilities than glycerol. After 96 hours of testing, *U. fasciata* polysaccharides could absorb as much as 69% moisture. In comparison, glycerol could only absorb as much as 48%. Likewise, with its retention ability, the retention rate of *U. fasciata* polysaccharides was 42%, and glycerol was 34%[137]. Another type of green algae, *Rhizoclonium hieroglyphicum*, showed improved skin hydration and moisturizing effects comparable to glycerin and hyaluronic acid[140].

Algae have also been shown to have promising potential to be formulated in sunscreen preparations. For instance, the methanol extract of brown algae was known to have a high SPF value of 16.7. These SPF values meet the FDA's recommendation, which states that sunscreen preparations with UV radiation protection must have at least 15 SPF values. The content of phenolic compounds, flavonoids, and triterpenoids in *T. conoides* supported this photoprotective effect. Furthermore, *E. cottonii* extract also exhibited potential as a natural ingredient for sunscreens, with the highest SPF value of 8.8 in ethyl acetate extract[143]. Another study showed that methanol extract of green algae (*Caulerpa serrulata*) had activity as a photoprotector with an SPF value of 4.8. The content of phenolic compounds (especially flavonoids) in *C. serrulata* was able to act as a photoprotective agent by inhibiting tyrosinase activity[144]. Hermund *et al*.[145] have proven that brown algae (*Fucus vesiculosus*) have properties as an antioxidant and photoprotective agent. The presence of phlorotannins in *F. vesiculosus* helps to protect the skin from UV rays damage. The cream formula containing 10% *F. vesiculosus* water extract produced an SPF value of 31.79 and a UVA protection value of 24.67, so this algae can be used as a natural ingredient for sunscreen.

CONCLUSION

This review was written to get insight into plants and marine algae that can be used as skincare ingredients. We mentioned some plants and marine algae that impart proven benefits, categorized according to their function in the skincare essential series. The presence of phytochemical compounds supports the benefits of plants and marine algae as skincare ingredients. Natural resources rich in saponins and fatty acids effectively act as cleansers. Meanwhile, natural resources containing tannins and polyphenols can be used in toner formulations. The polysaccharide contents contained in the plants and marine algae play an important role as a moisturizer. In addition, natural resources rich in phenolic compounds, especially flavonoids, have good activity as sun protection. Therefore, natural ingredients have great potential to be developed as skincare cosmetic ingredients that allow naturally glowing skin.

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AUTHORS' CONTRIBUTION

Conceptualization: **D.J.O**. and **Y.S.**; data curation: **D.J.O**; writing – original draft preparation: **D.J.O**; writing – review and editing: **A.T**., **Y.S**., and **A.Z**.; supervision: **Y.S**. and **A.Z**. All authors have read and agreed to the publish version of the manuscript.

DATA AVAILABILITY

None.

CONFLICT OF INTEREST

All authors declare there is no conflict of interest.

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