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Review Article

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Orange Peel and Skin Health: An Exploratory Study on Potential Benefits

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Abstract

The discarded orange peel from the citrus fruit industry has recently been found to have potential benefits for skin health. Orange peel contains flavonoids, limonoids, and carotenoids, which possess antioxidant and anti-inflammatory properties. These compounds protect the skin from oxidative stress and inflammation caused by environmental factors like Ultraviolet (UV) radiation and pollution. This peel is also observed as a rich source of vitamin C which is beneficial in maintaining collagen synthesis, a protein that maintains skin elasticity and firmness. Using orange peel extract or essential oil in cosmetics reduces the appearance of wrinkles, fine lines, and age spots. The compounds present in orange peel also possess antimicrobial properties, which are beneficial for treating acne and other skin infections. Additionally, the extracts of orange peelcan lighten the skin, and have potential to treat hyperpigmentation and uneven skin tone. It suppresses the activity of tyrosinase, an enzyme involved in melanin synthesis. Overall, orange peel is considered a valuable source of bioactive compounds that can improve skin health. Its antioxidant, anti-inflammatory, collagen-stimulating, antimicrobial, and skin lightening properties make it a potential ingredient in skincare products. This review aims at exploring the potential benefits of orange peel for skin well-being. The major focus is on the antioxidant content, antimicrobial properties, and anti-inflammatory effect of orange peel extracts. Through this investigation, the goal is to get a better understanding of how orange peel can support healthy skin and potentially offer natural solutions for skin-related concerns. The findings from this study will serve as a basis for future research and the potential creation of skincare products incorporating orange peel extracts.

Keywords

Orange peel, Skin health, Bioactive compounds, Antioxidants, Anti-inflammatory, Anti-aging, Ultraviolet protection, Holistic wellness

Introduction

In the realm of skincare, the quest for nourished skin has evolved beyond traditional methods, leading to a heightened focus on investigating the potential of natural ingredients. Within the realm of potential contenders, the unassuming orange peel garners significant interest as asubject of study, presenting an intriguing opportunity to enhance our comprehension of skin health [1]. Besides, the thriving skincare industry is characterized by a growing need for sustainable and effective products that resonate with the values of modern consumers. With time, there has been a growing interest in exploring botanical sources as potential resources. One such source that has garnered attention is orange peel, which is believed to contain a wealth of bioactive compounds that have yet to be fully investigated [2].

Orange peel is considered a rich source of several bioactive compounds such as carotenoids, flavonoids, minerals, vitamins, polyphenols, and omegas, which exhibit properties like diabetic support, anti-cancer activity, allergy prevention, and antimicrobial effects. These properties contribute to improving skin tone, nails, hair, and preventing xerosis, a condition characterized by chronic skin dryness due to insufficient oil in the skin [3]. The compounds in orange peel that give antioxidant properties include catechol, dimethoxy phenol, cyclohexane, coumarin, acetic acid, stigmasterol, sitosterol, and vitamin E. Orange peel has a high level of antioxidant activity; an aqueous extract of powdered orange peel revealed a 71.2% antioxidant activity. Flavonoids and vitamin C are abundant in orange peels (110.4 – 127.70 mg/100 g of orange peel on a dry basis). Two flavanones that are mostly found in citrus peel, naringin and hesperidin, exhibit a range of bioactivities, including antioxidant, anti-inflammatory, and anti-carcinogenic actions that may be helpful for the cosmetics sector [4].

Despite being a rich source of several nutrients and bioactive compounds, the peel is often discarded as a waste [2]. The investigation into the potential of orange peel is driven by both aspects of historical significance and scientific inquisitiveness. Understanding the benefits and cosmetic capabilities of orange peel, the present review aims to explore several innovative aspects of orange peel including its nutritional composition by shedding light on the vitamins, minerals, and bioactive substances that make it a promising ingredient for supporting skin health. Moreover, a detailed analysis of the antioxidant and anti-inflammatory properties of orange peel is presented, providing insights into the mechanism by which its constituents might protect our skin from oxidative stress and inflammation. Further exploration leads us to delve into the intriguing field of potential anti-aging properties that orange peel may possess. Overall, the purpose of this study is to examine its impact on factors such as skin elasticity and wrinkles to uncover its latent capacity to combat the signs of aging other than investigating the potential of orange peel as a natural ingredient.

By amalgamating existing knowledge and empirical data, our aim is to illuminate the potential merits of including orange peel in skincare routines and product formulations. Ultimately, the essence of this review lies in establishing a groundwork for well-informed discussions, advancing further research, and fostering potential applications that bridge the gap between traditional wisdom and modern scientific comprehension in the realm of skincare barriers againstthe harmful effects of UV radiation.

Nutritional Composition of Orange Peel

The investigation into the nutritional composition of orange peel reveals a diverse range of elements such as vitamins, minerals, and bioactive compounds that may contribute to its potential positive effects on skin health [5].

Vitamins

Orange peels, though often overlooked, are a rich source of several vitamins and nutrients that can offer health benefits. Like the fruit itself, their peels are recognized for the significant contribution of vitamin C, scientifically referred to as ascorbic acid. Vitamin C, a potent antioxidant, has been widely recognized for its ability to safeguard cells against oxidative stress induced by free radicals [6]. Research suggests that this substance has the potential to provide support to the immune system. Additionally, it has been found to play a role in the synthesis of collagen, which is crucial for maintaining the health of the skin, joints, and connective tissues. Moreover, studies indicate that it may enhance the absorption of nonheme iron, particularly iron derived from plant sources. Overall, the available evidence suggests that this substance can contribute to the promotion of overall well-being. The consumption of orange peels has been found to potentially offer an additional source of an important vitamin [7].

According to a study conducted by Ghosh et al. [8] it has been determined that orange peelsare a source of vitamin A, specifically in the form of beta-carotene. Beta-carotene, a naturally occurring pigment found in various fruits and vegetables, serves as a precursor to vitamin A. Through a series of enzymatic reactions, beta-carotene is converted into active vitamin A within the human body. This conversion process enables the body to utilize beta-carotene as a source of vitamin A, which plays a crucial role in various physiological functions. This vitamin is also important in the maintenance of optimal vision, bolstering the immune system and enhancing healthy skin.

According to the research, orange peels have been exhibited to contain trace amounts of several B vitamins, such as thiamine (B1), riboflavin (B2), niacin (B3), vitamin B6, and folate (B9) [9]. The B-vitamins are known to have significant roles in various physiological processes, including energy metabolism, nerve function, red blood cell production, and DNA synthesis. Although the concentration of B vitamins in orange peels is not notably high, their presence doescontribute to the overall nutritional composition [5].

Orange peels are also considered a good source of vitamin E, a fat-soluble antioxidant. One potential benefit of this compound is its ability to safeguard cell membranes against oxidative damage, which can have detrimental effects on cellular function. Additionally, this compound may contribute to the maintenance of healthy skin [10].

Minerals

The presence of minerals in orange peels has been considered to have a positive impact on skin health. These minerals play a crucial role in supporting various physiological processes that are essential for maintaining the function and appearance of the skin. Minerals are observed to have significant implications in various biological processes, including collagen synthesis, antioxidant defense mechanisms, and overall maintenance of skin vitality [5].

To maintain the integrity of the skin barrier and to renew skin cells, calcium is considered an essential mineral. The contribution of this substance to the optimal functioning of skin cells and its role in facilitating their regeneration is crucial for maintaining a visually appealing and robust skin

appearance. By taking part in cellular activities that contribute to hydration, elasticity, and overall appearance of the skin, magnesium promotes skin health. It also serves a role in minimizing inflammation while maintaining an optimal skin tone. Potassium also plays a crucial role in skin health by maintaining fluid and electrolyte homeostasis within the cellular environment of the skin. Maintaining optimum fluid balance is of utmost importance in preserving skin hydration, a critical factor in attaining a smooth and soft facial appearance [11].

Copper plays a crucial role in the synthesis of collagen, a vital protein responsible for imparting structural integrity to the skin. Research suggests that maintaining appropriate levelsof copper in the body may play a role in promoting firmer and more resilient skin. In addition, copper has been exhibited to possess antioxidant properties, which plays a significant role in safeguarding skin cells against oxidative damage. Also, manganese plays a crucial role in facilitating the synthesis of collagen, a protein that is essential for maintaining the elasticity and firmness of the skin. Furthermore, it also aids in the metabolism of diverse nutrients that are believed to have an impact on the overall health of the skin. By promoting blood circulation, iron has a role in the oxygenation of skin cells and contributes to a healthier skin tone. Research suggests that maintaining sufficient levels of iron in the body may play a significant role in promoting a healthy and radiant complexion (Table 1) [12].

Table 1: Nutritional composition of orange peel.

Nutritional composition	Parameters	Ref.
Proximate composition (%)		
Moisture	80.5-80.6	[13, 14]
Ash	0.60-0.61	[13, 14]
Lipids	0.25-0.47	[13, 14]
Protein	0.70-1.56	[13, 14]
Carbohydrate	14.56-17.6	[13, 14]
Fibre	2.5-14.19	[13, 15]
Vitamins (mg/100 gm)		
Vitamin A	4.10-85.71	[16, 17]
Vitamin B1	4.10	[17]
Vitamin B2	0.11	[17]
Vitamin B3	0.08	[17]
Vitamin B9	26.67	[17]
Vitamin C	12.91-136.67	[16,17]
Vitamin E	0.21	[17]
Minerals (mg/100 gm)		
Calcium	26.24-49.05	[16, 18]
Magnesium	5.59-41.83	[16, 18]
Sodium	0.54-19.44	[16, 18]
Potassium	14.90-154	[16, 18]

Table 2: Bioactive compounds of orange peel.

Bioactive compounds	Parameters (mg/100 g)	Ref.
Hesperidin	20.11-47.339	[25]
Naringin	2.301-5.91	[25]
Polyphenol	0.07-105.96	[6, 17]
Phenolic acid	113.03-258.67	[6]
Carotenoids	0.63	[6]
Limonoids	0.5-21.2	[24]
Tannins	0.54-22.80	[17, 18]

Bioactive compounds

The bioactive compounds derived from orange peels have a potential impact on skin health (Table 2). These compounds possess antioxidant properties that protect the skin from oxidative stress. Additionally, these compounds have been known to promote collagen production, a vital protein that contributes to the skin's strength and elasticity. Overall, the presence of these bioactive compounds in orange peels suggests their potential role in promoting skin health. The compounds also possess significant properties in safeguarding the skin against oxidative damage and supporting the overall vitality of the skin [19].

Flavonoids, a class of polyphenolic compounds, exhibit a wide range of structural diversity and are predominantly derived from various plant sources. The prominence of two specific flavonoids, hesperidin and naringin, is present in orange peels. These compounds possess potent antioxidant properties, which aid in safeguarding the skin against detrimental effects induced by free radicals. The flavonoids present in orange peels contribute to maintaining a radiant complexion by effectively neutralizing free radicals. Another group of antioxidants, polyphenols, assume a pivotal function in maintaining the health of the skin. Due to their anti-inflammatory qualities, they can help calm irritated skin and lessen its redness. Collagen, which is necessary for maintaining skin's elasticity and firmness, is produced by polyphenols as well. The polyphenols found in orange peels also promote the synthesis of collagen, thereby enhancing the appearance of skin by making it smoother and fresh [20]. Limonoids are a class ofphytochemicals recognized for their potential therapeutic effects in reducing inflammation and combating cancer. In the realm of skin health, the anti-inflammatory properties of these substances hold major importance. Limonoids exhibit anti-inflammatory properties, which can effectively alleviate skin irritation and potentially promote an even complexion. This can provide notable advantages for individuals with sensitive and reactive skin. Essential oils with aromatic components found in orange peels provide a variety of skin-friendly properties. The oils possess antibacterial characteristics that contribute to the cleansing and purification of the skin. Moreover, the anti-inflammatory characteristics of these substances help in soothing inflamed skin and diminishing the appearance of redness. The essential oils derived from orange peels are manganese frequently observed in the domains of aromatherapy and cosmetics, with the primary objective of inducing an experience of relaxation and revitalization [21]. Although not classified as a bioactive ingredient, the presence of fiber in orange peels can indirectly contribute to the maintenance of skin health by facilitating the process of digestion and the elimination of toxins from the body. This process can contribute to the prevention of skin disorders such as breakouts and dullness, ultimately resulting in a more visibly clear and healthier complexion. Pectin is a form of soluble dietary fiber found in the peels of oranges.

Soluble fiber possesses the capacity to effectively eliminate toxins and waste materials from the body through its ability to bind to them and facilitate their excretion. The process of detoxification can potentially have an indirect impact on the appearance of healthier skin [22].

A carotenoid compound, such as beta-carotene is a precursor to vitamin A that has a critical role in the process of skin cell regeneration and healing. It facilitates the growth of new skin cells, aids in maintaining the skin's protective barrier, and helps to produce a smoother, more even skin tone [8]. Citric acid, an organic compound, classified as an alpha hydroxy acid occurs naturally in citrus fruits such as oranges. Alpha hydroxy acids are recognized for their exfoliative characteristics, as they facilitate the elimination of deceased epidermal cells from the outermost layer of the skin. This process of exfoliation facilitates the turnover of skin cells, thereby unveiling a layer of skin that is both fresher and more radiant in appearance. The presence of citric acid has the potential to enhance the appearance of the skin, resulting in a more luminous and vibrant complexion [23]. The unique fragrance of citrus fruits like oranges is brought on by terpenes, an aromatic component. Terpenes in skincare products are known to possess properties that provide a calming and revitalizing impact on the skin. These substances can alleviate skin irritation, diminish redness, and enhance the overall appearance of the skin. The sensory experience associated with terpenes is further enhanced by their fragrant qualities, hence potentially promoting relaxation and overall well-being [21]. Orange peels contain bioactive compounds that can benefit the skin in a variety of ways, but attaining optimal skin health requires a holistic approach. To maintain vibrant, glowing skin, as well as consuming a nutrient-rich diet, wearing sun protection, drinking enough water, and following a healthy lifestyle are crucial [24].

Mechanism of Antioxidant and Inflammatory Effects of Orange Peel

The potential health advantages of orange peel have garnered attention due to its antioxidant and anti-inflammatory properties (Figure 1). The orange peel is composed of a diverse spectrum of bioactive substances, including flavonoids, carotenoids, and essential oils. These constituents play a significant role in the orange peel's capacity to mitigate oxidative stress and inflammation. This section explores the complex mechanisms that underlie these qualities, providing a glimpse into the interactions between orange peel compounds and cellular processes that contribute to the promotion of health.

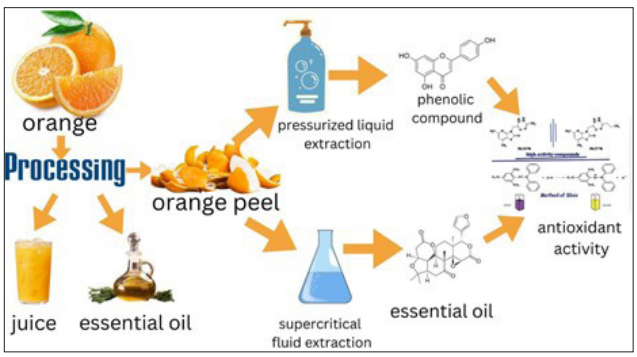

Figure 1: Antioxidant activity of orange peel.

Antioxidant mechanisms

Reactive oxygen species (ROS) are molecules characterized by their high reactivity, which can induce cellular damage and contribute to the occurrence of oxidative stress. Compounds present in orange peels, such as flavonoids and carotenoids, exhibit electron-donating properties that enable them to effectively counteract ROS. By donating electrons, these compounds quench ROS and prevent chain reactions that lead to oxidative damage [26].

The compounds in orange peels possess the ability to chelate metals, specifically transition metals like iron and copper. These metallic elements can catalyze the production of ROS through the Fenton and Haber-Weiss reactions. Orange peel compounds chelate these metals to prevent them from participating in the generation of ROS, further decreasing oxidative stress. These compounds can induce the synthesis of endogenous antioxidant enzymes, including superoxide dismutase and catalase which are essential for the process of neutralizing ROS and for the maintenance of cellular redox balance. Additionally, orange peel compounds lead to cellular defense against oxidative stress by boosting the activity of these enzymes [27].

Anti-inflammatory mechanisms

Orange peel compounds, namely flavonoids that include hesperidin and naringin, have been observed to impede the synthesis and functionality of pro-inflammatory cytokines, including interleukin-6 and tumor necrosis factor-alpha The cytokine expressionis regulated by important signaling pathways like NF-κB and MAPK, which are effectively inhibited by these compounds. These compounds can inhibit the production of certain substances, consequently mitigating the inflammatory response. Certain enzymes are crucial to the inflammatory process. Inducible nitric oxide synthase and cyclooxygenase-2 have both been demonstrated to be inhibited by substances found in orange peels. Pro-inflammatory prostaglandins are produced by cyclooxygenase-2, whereas nitric oxide, a signaling molecule involved in inflammation, is produced by inducible nitric oxide synthase. Orange peel compounds reduce inflammation at the enzymatic level by inhibiting these enzymes [28].

By controlling immune cell function, compounds from orange peels can influence immunological responses. While reducing the function of pro-inflammatory immune cells, they might promote the production of anti-inflammatory immune cells. This immune-modulatory action helps create an environment that is primarily anti-inflammatory [20].

These compounds may interfere with the cell signaling pathways that orchestrate inflammatory responses. The NF-κB and MAPK pathways are crucial in regulating inflammation. Orange peel compounds can stop these pathways from activating, which reduces the amount of pro-inflammatory molecules produced. Numerous complex processes work

together to control the antioxidant and anti-inflammatory properties of orange peel. Together, these bioactive substances boost endogenous antioxidant defenses, neutralize ROS, and alter inflammatory responses at various levels. Understanding these mechanisms will help researchers better utilize the therapeutic potential of orange peel compounds to treat inflammatory diseases and conditions linked to oxidative stress [29].

Anti-aging effect of orange peel

Growing interest in natural substances with possible health advantages has resulted from the search for efficient anti-aging strategies. Orange peel contains an abundance of bioactive substances with potential anti-aging benefits. These substances, which include flavonoids, carotenoids, and essential oils, have a variety of mechanisms that work to slow down the aging process [30]. This section explores the complex ways in which substances found in orange peels help maintain healthy skin and overall wellbeing.

Oxidative stress, which causes protein degradation, DNA mutations, and cellular damage,is a major factor in the aging process. ROS are scavenged by orange peel compounds, which are abundant in antioxidants such flavonoids and carotenoids, to reduce oxidative stress. These substances neutralize ROS by donating electrons, preventing cellular damage, and sustaining cellular integrity. This protein and lipid-based antioxidant defense aids in the maintenance of elastic and youthful-looking skin [31].

Hesperidin and naringin, two compounds found in orange peel, have been exhibited to promote collagen formation by increasing the activity of the enzymes necessary for collagen production. The outcome leads to improved skin firmness, fewer wrinkles, and a more youthful appearance. Due to DNA damage, collagen deterioration, and oxidative stress caused by UV radiation, skin aging is accelerated. Beta-carotene and cryptoxanthin are two carotenoids found in orange peel that absorb UV rays and neutralize the ensuing free radicals. This photoprotective action shields against DNA mutations, collagen deterioration, and early aging induced by UV exposure. Collagen and other extracellular matrix elements are broken down by enzymes called matrix metalloproteinases. Compounds from orange peels may prevent these enzymes from working, protecting the skin's structural integrity thus, providing softer and more youthful skin texture by preventing excessive collagen degradation [19].

By promoting tissue damage and impairing cellular function, chronic inflammation hastens the aging process. Flavonoids like hesperidin and naringin are among the substances found in orange peel that have anti-inflammatory properties. Pro-inflammatory cytokine production is decreased because of their modulation of signaling pathways like NF-κB and MAPK. This anti-inflammatory effect promotes a healthy immune response and delays the agingprocess related to chronic inflammation [20].

Skin aging and moisture loss are both accelerated by a damaged skin barrier. Orange peel compounds enhance the integrity of the skin's barrier defense by acting as antioxidants and anti-inflammatory agents. This preservation of the barrier function ensures the proper hydration of skin, thus mitigating dryness, and contributing to the youthful appearance [31]. Orange peel compounds possess DNA repair-supporting properties, aiding the skin's ability to rectify DNA lesions caused by various stressors, including UV radiation.

Overall, through a complex interaction of mechanisms that address oxidative stress, collagen formation, UV protection, inflammation management, and other issues, orange peel has been shown to have anti-aging properties. By harnessing such mechanisms, orange peel ingredients provide a holistic approach for tackling the underlying causes of aging, ultimately helping to maintain youthful skin appearance and overall health [32].

Orange Peel and UV Protection

Numerous bioactive substances found in orange peel have been investigated for their potential health advantages, including their ability to protect skin from damage caused by UV rays [20] as illustrated in figure 2. Orange peel contains a variety of important bioactivesubstances, such as flavonoids, carotenoids, and essential oils.

A group of polyphenolic substances known as flavonoids occur in a variety of plants, including citrus fruits like oranges. They have anti-inflammatory and antioxidant effects. These characteristics imply that they could help in reducing the oxidative stress and inflammation caused by exposure to UV radiation. It is well recognized that oxidative stress and inflammation contribute to skin damage driven by UV

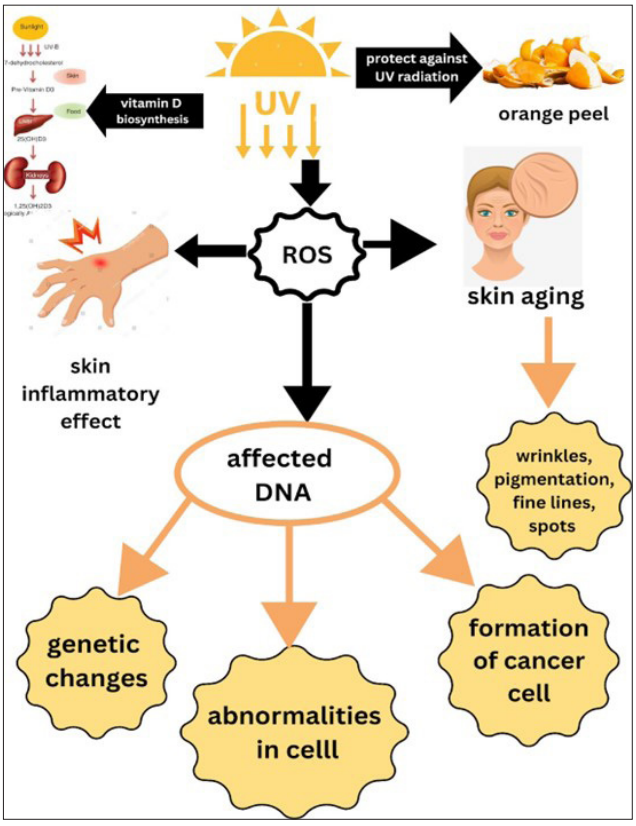

Figure 2: Impact of UV radiation on human health.

radiation, including sunburn as well as premature aging [31].

Orange peel contains significant concentrations of carotenoids, the pigments that give the fruit its orange hue. A well-known carotenoid that the body can transform into vitamin A is beta-carotene. The maintenance of healthy skin and the support of the skin's natural defense mechanisms rely on vitamin A. Additionally, carotenoids have antioxidant qualities that can aid in scavenging free radicals produced by UV radiation [8].

Orange peel essential oil has been found to include components such as limonene that exhibit promising properties in promoting skin health. Limonene has been the subject of scientific investigation due to its potential anti-inflammatory and antioxidant properties. According to Borghi and Pavanelli, the topical application of essential oils containing certain compounds may potentially have a protective effect against skin damage caused by exposure to UV radiation. The orange peel is comprised of several polyphenolic chemicals, such as flavonoids, phenolic acids, and tannins. These chemicals have been linked to exhibiting antioxidant and anti-inflammatory properties, both of which are advantageous in reducing the detrimental effects caused by UV radiation [31].

Although the bioactive compounds found in orange peel have exhibited potential in laboratory and animal investigations, it is crucial to acknowledge that their efficacy in safeguarding human skin against UV radiation remains a subject of ongoing research. The application of orange peel extracts, essential oils, or formulations containing these compounds on the skin surface may offer a certain level of protection. However, it is important to note that these measures should not be regarded as a substitute for conventional sun protection practices,including the use of sunscreen, wearing appropriate clothing for sun protection, and minimizing prolonged exposure to sunlight.

Application of Orange Peel

The numerous bioactive substances present in orange peel have uses beyond the culinary realm. Due to its potential advantages for treating a variety of skin diseases, extracts and essential oils made from orange peel have drawn interest in skincare products [33]. This section explains how orange-peel extracts and essential oils are used topically for skincare and examines their potential benefits for treating several skin disorders as illustrated in figure 3.

The bioactive compounds flavonoids and polyphenols, which naturally have antibacterial and antimicrobial activities, are abundant in orange peel extracts. Orange peel extracts are efficient against bacteria which trigger acne, particularly *Propionibacterium* acnes, because of their characteristics. They also help lessen the frequency of new acne outbreaks by inhibiting the growth and proliferation of these bacteria. Acne may begin and get worse because of inflammation. Orange peel contains flavonoids and other bioactive substances that have anti-inflammatory properties. They aid in reducing the irritation, redness, and swelling linked with pimples and pustules. Orange peel extracts aid to a calmer and less sensitive complexion by reducing the inflammatory reaction. Acne and clogged pores are both caused by excessive sebum production.

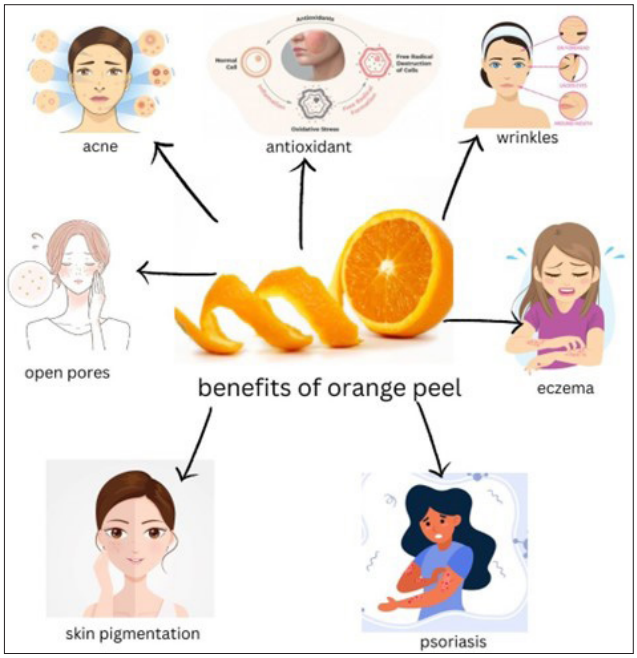

Figure 3: Potential benefits of orange peel in treating skin disordersacne treatment and prevention.

Orange peel extracts may control the production of sebum by balancing the skin's oil production. Orange peel extracts lessen the possibility of developing new acne lesions by maintaining a healthy sebum balance [33].

Eczema relief

Orange peel contains natural oils that effectively moisturize and hydrate dry and eczema-prone skin. The dryness and roughness that are indicative of eczema are reduced by these oils by aiding in the formation of a barrier that seals in moisture. Consistent use of skin care items with orange peel extracts can increase skin moisture and comfort overall. Intense itching is often associated with eczema, which may cause skin irritation and discomfort. The bioactive substances found in orange peel, such as flavonoids and limonene, which is a component of essential oils, have anti-itch attributes. These compounds calm irritated skin and lessen the urge to scratch, which provides eczema sufferers with much-needed relief from the constant itching they endure [34].

In its simplest form, eczema is an inflammatory skin disorder that causes redness, swelling, and occasionally even painful lesions. Compounds found in orange peel have strong anti-inflammatory properties that can reduce inflammation. Orange peel extracts aid people facing prominent and discomfort symptoms of eczema by lowering redness and swelling [35].

Psoriasis management

Skin cells rapidly build up in psoriasis, resulting in thick, scaly areas of skin on the surface. Natural exfoliating qualities in orange peel extracts make it easier to get rid of these scales. Orange peel extracts help psoriasis-affected areas appear and feel better by encouraging healthier skin cell renewal and eliminating accumulated scales [36].

Psoriasis is an autoimmune disease with a significant inflammatory component. Anti-inflammatory compounds present in orange peels help to control the immunological reaction that leads to psoriasis.

Skin affected by psoriasis frequently becomes abnormally dry and flaky, necessitating regular and intense moisturization. Orange peel extracts' hydrating qualities offer vital hydration, reducing the dryness and scaling typical of psoriasis. Regular use of skincare products with orange peel extracts can enhance skin comfort and attractiveness [37].

Skin brightening and hyperpigmentation

Vitamin C and flavonoids, two naturally occurring substances with skin-lightening attributes, are present in orange peel extracts. These substances can prevent the action of the enzymes that produce melanin, hence preventing the excessive production ofmelanin that causes hyperpigmentation and dark patches. A more even skin tone and a reduced appearance of pigmented spots can result from frequent use of products infused with orange peel extracts [38]. Vitamin C in orange peel increases skin cell turnover and results in a more radiant complexion. This turnover aids in the removal of dull and damaged skin cells, revealing healthierskin beneath. Therefore, orange peel-based products can support a youthful and radiant appearance [38].

Antioxidant protection and environmental stress

Antioxidant substances that shield the skin from environmental stresses including pollution and UV radiation are present in orange peel compounds, particularly flavonoids and carotenoids. These antioxidants stop oxidative damage by scavenging free radicals generated by exposure to harmful UV radiation and pollutants. Individuals can strengthen their skin's defensesagainst external aggressors by incorporating orange peel extracts into skincare regimens. By inducing oxidative stress and collagen breakdown, environmental stressors hasten the aging process of the skin. By scavenging free radicals and maintaining collagen integrity, the antioxidants in orange peel extracts mitigate these effects. This slowing down of aging results in smoother skin texture and less wrinkle development [27].

Natural exfoliation

Orange peel extracts can help unclog pores and gently exfoliate the skin by removing dead skin cells. These ingredients offer a natural alternative to harsh physical exfoliants for getting smoother skin. Orange peel extract exfoliation on a regular basis can enhance skin textureand lessen the incidence of acne outbreaks. Orange peel ingredients help exfoliate the skin, which improves the absorption of other skincare products. Dead skin cells act as a barrier, preventing serums, moisturizers, and treatments from working as efficiently and providing a broad spectrum of benefits. This may result in better results when addressing different skin issues [39].

Aromatherapeutic benefits

The uplifting and stress-relieving properties of orange essential oil, extracted from orangepeel, have been researched extensively. Orange essential oil can provide aroma therapeutic advantages to skincare products, providing relaxation and a sense of well-being during skincare processes. Orange essential oil's pleasant and energizing aroma has mood-lifting properties. Its aroma is believed to enhance mood, decrease anxiety, and create an optimistic atmosphere, boosting the overall skin care experience [40].

The use of orange peel extracts and essential oils in skincare products is a potential strategy for treating a variety of skin disorders. These substances provide a variety of advantages, such as antibacterial, anti-inflammatory, moisturizing, and exfoliating properties. However, because every individual's skin can react differently, patch testing and expert advice are advised while using new skincare products [3].

Conclusion and Future Perspectives

The current review has provided valuable insights into the intriguing domain of orange peel and its possible implications for enhancing skin health. This study has explored the nutritionalcomposition, antioxidant and anti-inflammatory effects, anti-aging potential, UV protection capabilities, and practical applications of orange peel other than highlighting their importance as a natural resource for holistic skin care. The nutritional composition of orange peel, which includes a variety of vitamins, minerals, and bioactive substances, plays a significant role in promoting skin health and overall well-being. The complex interaction of these components highlights the potential of orange peel as a feasible option for augmenting skin health.

The investigation into the antioxidant and anti-inflammatory properties of orange peel hasprovided insight into its potential as a protective agent against oxidative stress and inflammation,which are significant contributors to skin aging and damage. Bioactive substances like flavonoids and carotenoids control these effects, which makes a strong case for their inclusion in skincare regimens. The claimed anti-aging properties associated with compounds found in orange peel are based on their capacity to reduce the appearance of wrinkles and improve the flexibility of the skin. This characteristic is in congruence with the broader narrative of promoting the development of youthful and resilient skin.

Additionally, the study has highlighted the potential value of orange peel in UV protection. The bioactive compounds present in orange peel possess the capacity to attenuate the adverse impacts of UV radiation, enhancing the range of options available to protect the skin against damage caused by the sun. Moreover, the use of orange peel in skincare formulations, encompassing extracts and essential oils, exhibits potential in the treatment of various dermatological diseases, including acne, eczema, and psoriasis. This also highlights the multifunctionality of orange peel and its capacity to function as an organic remedy for various skin conditions.

In a nutshell, the integration of many aspects of the study strengthens the concept that orangepeel is not only a secondary product, but rather a repository of bioactive substances that have significant effects on skin health. The findings from this study serve as a cornerstone for future research and the development of skincare products that

harness the power of orange peel as the beauty and wellness sectors continue to embrace the possibilities of natural solutions. In essence, this study serves as a pivotal milestone on the path towards holistic and nature-inspired skincare, as it offers insights into the potential benefits of orange peel for skin health.

Acknowledgements

None.

Conflict of Interest

None.

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