



The Effects of Vitamin B6, Vitamin D and Antioxidants on Hyperpigmentation

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ABSTRACT

A growing body of evidence reveals that a healthy, well-balanced diet substantially impacts skin ageing. The compounds that maintain and restore the epidermal barrier, which lowers TEWL, ensures an optimal skin moisture level, and protects against external causes and inflammation-induced damage, deserve special attention (e.g., omega-3 and omega-6 fatty acids). Antioxidants and other phytonutrients that scavenge ROS and reduce oxidative skin damage, as well as compounds that protect the skin from the harmful effects of U.V. radiation, play an essential role in the prevention and care of ageing skin (including vitamins A, C and E; selenium; zinc; copper; silicon; polyphenols; and carotenoids). Antioxidants taken orally can supplement chemical and physical UV-filtering agents, reducing DNA damage that causes skin ageing and cancer. Incorporating these nutrients into one's everyday diet could be an excellent way to combat the effects of ageing. Finally, encouraging healthy eating habits can improve skin look, slow down the ageing process, and lower the risk of skin cancer.

Keywords: Ascorbate; dermis; epidermis; skin barrier function; vitamin C status; skin ageing; wound healing; collagen; U.V. protection.

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Types of Hyperpigmentation

Melasma, sunspots, and post-inflammatory Hyperpigmentation are the most frequent kinds of Hyperpigmentation.

Melasma:

Melasma is a type of melasma that develops during pregnancy and is caused by hormonal changes. Hyperpigmented areas can arise anywhere on the body, although the stomach and face are the most prevalent.

Sunspots:

Sunspots are sometimes known as liver spots or solar lentigines. They're linked to a long period of excessive sun exposure⁵. They usually manifest themselves as sunspots on sun-exposed areas such as the hands and face. Hyperpigmentation following an inflammatory process. This happens when the skin is injured or irritated. Acne is a common reason for this⁶.

What are Vitamins?

Vitamins are chemical compounds that can be classed as fat-soluble or water-soluble. Vitamins that dissolve in fat (vitamin A, vitamin D, vitamin E, and vitamin K) tend to accumulate in the body. Water-soluble vitamins (vitamin C and B-complex vitamins including vitamin B6, B12, and folate) must dissolve in water before being absorbed by the body and so cannot be stored. Any water-soluble vitamins not utilized by the body are primarily excreted in the urine⁷.

INTRODUCTION

What is hyperpigmentation?

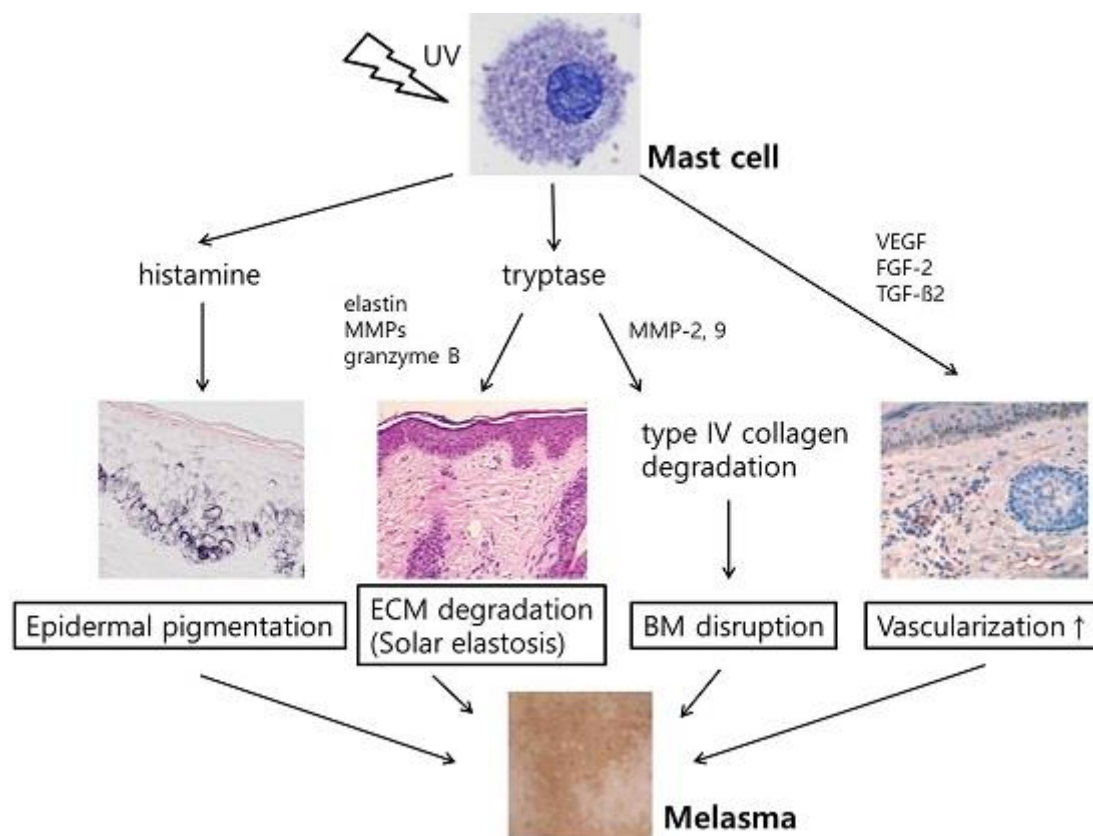
Sun damage, inflammation, and other skin lesions, such as those associated with acne vulgaris, can all contribute to Hyperpigmentation¹. Hyperpigmentation is more common in those with darker skin tones, particularly when exposed to too much sunlight. Excess melanin production is responsible for several kinds of Hyperpigmentation. Hyperpigmentation affects the face and the backs of the hands and can be diffuse or localized². Melanocytes in the epidermis' bottom layer create melanin. Melanin is a pigment that gives the eyes, skin, and hair their colour. Melanocyte distribution becomes less diffuse as people age, and the body's ability to regulate them decreases. U.V. light promotes melanocyte activity, resulting in Hyperpigmentation where the number of cells is higher³. Hyper-pigmentation that occurs after an inflammatory process is another type of Hyperpigmentation. Following the healing of acne, these dark and discoloured areas form on the skin. Hyperpigmentation can come in a variety of shapes and sizes and types of Hyperpigmentation⁴.



Types and Symptoms of Hyperpigmentation³¹

Type	Symptoms	Where on Body
Age spots, also called liver spots or solar lentigines.	Brown, tan, or black spots that appear on skin with sun overexposure	They commonly appear on the face and hands, or on sun-exposed areas of the body
Melasma, also called chloasma or “the mask of pregnancy”	Large patches of darkened skin	They often appear on the forehead, face, and stomach
Post-inflammatory hyperpigmentation	Spots or patches of darkened skin that appear after an inflammatory skin condition, such as acne or eczema	They usually appear on the face or neck

Heterogenous Pathology of Hyperpigmentation:



Since their discovery in the late 1800s and early 1900s, vitamins and their precise needs have been a source of debate. Epidemiologists, physicians, chemists, and physiologists worked together to develop our current understanding of vitamins and minerals. After years of observation, tests, and trial and error, they determined that several ailments were caused by vitamin deficiencies rather than viruses or poisons, as was widely assumed at the time⁸. Chemists tried to identify the molecular structure of vitamins so that I might duplicate it. Researchers soon discovered the precise amounts of vitamins required to avoid deficiency illnesses. Casimir Funk, a biochemist, was the first to invent the term "vitamin" in a research paper that was approved by the medical profession in 1912, derived from "vita", meaning "life" and "amine", referring

to a nitrogenous component required for living. Vitamins were only available through food until the 1930s when commercially produced vitamin supplements became available^{9,10}. The U.S. government began fortifying foods with specific minerals to prevent deficiencies that were prevalent at the time, such as adding iodine to salt to prevent goitre and folic acid to grain products to avoid birth abnormalities during pregnancy. Most vitamins and multivitamins were sold to the general population in the 1950s to prevent deficiency. Some received extensive advertising in popular periodicals, such as presenting cod liver oil containing vitamin D as bottled sunlight^{11,12}.

How do vitamins work in the body?

Vitamins are chemical molecules required in small amounts by humans. Must obtain most vitamins from food because the body either does not create them or generates just a small amount. Vitamins are nutrients that are required by the body for a variety of tasks. One of the functions is to maintain the health of the cells. When the body gets the proper vitamins in the right amounts, it can help the cells stay healthy, especially the skin cells. Vitamins applied directly to the skin have also been demonstrated to benefit the skin in studies^{13,14}. Because the skin absorbs the vitamins, they are immediately accessible for the skin cells to use. This type of targeted application aids in the rapid improvement of the health of the skin cells, resulting in healthier, brighter, and more beautiful skin.

Vitamins: A Closer Look:

There are currently 13 vitamins that have been identified.

Fat-soluble vitamins: Fat-soluble vitamins include A, D, E, and K. Trusted Source fat-soluble vitamins are stored in fatty tissue and the liver, and reserves of these vitamins can last for days, if not months. Dietary fats aid in the absorption of fat-soluble vitamins in the intestine^{15,16}.

Precisely what they do:

Although water-soluble vitamins serve various functions in the body, one of the most significant is assisting in releasing energy from the food habit. Others aid in tissue health. Here are a few instances of how vitamins can help the body stay healthy: Allow the energy to flow. Several B vitamins are essential components of coenzymes (molecules that help enzymes) that aid in the energy release from food¹⁷.

Make energy. Thiamin, riboflavin, niacin, pantothenic acid, and biotin are all involved in creating energy.

Proteins and cells are created. Vitamins B6, B12, and folic acid help cells multiply by metabolizing amino acids (the building blocks of proteins). Can make collagen. Vitamin C aids in the formation of collagen, which knits wounds together, supports blood vessel walls and serves as a foundation for teeth and bones.

Vitamins that are soluble in water: Water-soluble vitamins do not persist in the body. It is impossible to store a trusted source in the body for a long time. They are expelled from the body through the urine. As a result, people require more water-soluble vitamins than fat-soluble vitamins regularly. Water-soluble vitamins include vitamin C and all of the B vitamins.

What they are up to:

This vitamin quartet works together to keep the eyes, skin, lungs, gastrointestinal tract, and nervous system healthy. Here are a few more important roles that these vitamins play. Make sure the bones are strong. Without vitamins A, D, and K, bone production would be impossible¹⁸.

Keeps the eyes safe. Vitamin A also protects the vision and keeps the cells healthy.

Interact positively the body would have difficulty absorbing and retaining vitamin A if the body didn't have vitamin E.

Must protect the body. Vitamin E is an antioxidant as well (a compound that helps protect the body against damage from unstable molecules)¹⁹.

The following are the vitamins which include:

The 13 vitamins are listed. Retinol, retinal, and "the four carotenoids," including beta carotene, are chemical names for vitamin A. It's a fat-soluble substance. Its purpose is to keep the eyes healthy. Deficiency can lead to night blindness and keratomalacia, a condition in which the transparent front layer of the eye becomes dry and hazy.

Liver, cod liver oil, carrots, broccoli, sweet potatoes, butter, kale, spinach, pumpkins, collard greens, eggs, apricots, cantaloupe melon, and milk are all good sources. Thiamine is the chemical name for vitamin B1. It's a water-soluble substance. It is required for the production of several enzymes that aid in the breakdown of blood sugar. Beriberi and Wernicke-Korsakoff syndrome can result from a deficiency in this vitamin. Yeast, pork, cereal grains, sunflower seeds, brown rice, whole grain rye, asparagus, kale, cauliflower, potatoes, oranges, liver, and eggs are excellent sources. Riboflavin is the chemical term for vitamin B2. It's a water-soluble substance. It aids in the metabolism of food and is required for the growth and development of bodily cells. Inflammation of the lips and cracks in the mouth are symptoms of deficiency. Good sources are asparagus, bananas, persimmons, okra, chard, cottage cheese, milk, yoghurt, meat, eggs, fish, and green beans. Niacin, niacinamide are the chemical names for vitamin B3. It's a water-soluble substance. Niacin is required for the body's cells to grow and function properly. Deficiency: Low levels cause pellagra, a health problem characterized by diarrhoea, skin abnormalities, and digestive distress. Chicken, beef, tuna, salmon, milk, eggs, tomatoes, green vegetables, broccoli, carrots, nuts & seeds, tofu, and lentils are all good sources. Pantothenic acid is the chemical name for vitamin B5. It's a water-soluble substance. It is required for the production of energy and hormones. Paresthesia, or "pins and needles," is a symptom of deficiency. Meats, whole grains, broccoli, avocados, and yoghurt are all good sources. Pyridoxine, pyridoxamine, and pyridoxal are the chemical names for vitamin B6. It's a water-soluble substance. It plays an important role in the production of red blood cells. Low levels might result in anaemia and peripheral neuropathy. Chickpeas, beef liver, bananas, squash, and almonds are all good sources. Biotin is the chemical name for vitamin B7. It's a water-soluble substance. Its job is to help the body break down proteins, lipids, and carbs. It also helps make keratin, a structural protein found in the skin, hair, and nails. Deficiency: Low levels might induce dermatitis or intestinal inflammation. Egg yolk, liver, broccoli, spinach, and cheese are all good sources. Vitamin B9 is also known as folic acid or folinic acid. It's a water-soluble substance. It is required to produce DNA and RNA. Deficiency: This can impair the fetus's neurological system during pregnancy. Doctors recommend



folic acid supplements before and during pregnancy. Leafy vegetables, peas, legumes, liver, fortified grain products, and sunflower seeds are good sources. Several fruits also have moderate quantities²⁰.

The chemical names for vitamin B12 are cyanocobalamin, hydroxocobalamin, and methylcobalamin. It is a water-soluble substance. It serves as a vital component of a healthy nervous system. Deficiency: Low levels might cause neurological issues and anaemia in some cases. Fish, shellfish, pork, chicken, eggs, milk and other dairy products, fortified cereals, fortified soy products, and fortified nutritional yeast are all excellent sources. Ascorbic acid is the chemical name for vitamin C. It's a water-soluble substance. It aids in the development of collagen, wound healing, and bone growth. It also functions as an antioxidant and strengthens blood vessels. It also boosts the immune system, aids iron absorption, and strengthens blood vessels. Scurvy can develop from a deficiency, which causes bleeding gums, tooth loss, and poor tissue growth and wound healing. Fruit and vegetables are good sources, but heating degrades vitamin C. Ergocalciferol and cholecalciferol are the chemical names for vitamin D. It's a fat-soluble substance required to mineralize bone health. Deficiency: This can result in rickets and osteomalacia or bone softening. Sources to consider: The body produces vitamin D when exposed to UVB rays from the sun or other sources. The vitamin can also be found in fatty fish, eggs, beef liver, and mushrooms. Tocopherol and tocotrienol are chemical names for vitamin E. It's a fat-soluble substance. Its antioxidant activity aids in the prevention of oxidative stress, which increases the risk of extensive inflammation and a variety of disorders. Deficiency: Although uncommon, this condition can cause hemolytic anaemia in infants. This illness causes the death of blood cells. Wheat germ, kiwis, almonds, eggs, nuts, leafy greens, and vegetable oils are good sources. Vitamin K is a type of vitamin that is found. Phylloquinone and menaquinone are chemical names for the same compound. It's a fat-soluble substance. Its function is to aid in the coagulation of blood. Deficiency: Low levels might lead to an increased risk of bleeding, often known as bleeding diathesis. Natto, leafy greens, pumpkins, figs, and parsley are also good sources^{21,22}.

Role of Vitamin B on Hyperpigmentation

While all of these B vitamins work with enzymes to support the body's activities in various ways, from carrying nutrients throughout the body to generating energy from carbohydrates and fats, they also have their own set of advantages.

Thiamine (vitamin B1) is beneficial to red, irritated, acne-prone, or dry skin. It also reduces the appearance of wrinkles and fine lines.

Vitamin B2 (riboflavin): Vitamin B2 helps improve skin tone, make it more luminous, and regulate natural oils, making it an excellent vitamin for dry or acne-prone skin.

Vitamin B3 (nicotinic acid or niacinamide): Vitamin B3 aids in the skin's natural defences. It enhances the look and feels

of older, dry, and sensitive skin while protecting it from external assaults.

Vitamin B5 (pantothenic acid): If a person has dry skin, dullness, or elasticity loss? B5 is an excellent choice for keeping skin soft and nourished. Pantothenic acid also helps to regulate skin and reduces redness and inflammation.

Vitamin B6 (pyridoxine): This B vitamin aids in the reduction of the consequences of hormonal imbalances, which can cause acne breakouts. Take on hormonal acne, inflammation, and redness with B6.

Biotin (vitamin B7) offers skin a naturally renewed appearance, making it ideal for dull, aged skin.

B9 (folic acid or folate) gives skin a refined appearance. If a person has acne or congestion regularly, give it a shot.

B12 (cobalamin) is a vitamin that improves the brightness of dull and aged skin. This B vitamin also aids in the reduction of the appearance of dark spots and uneven skin ton.

Vitamin B6

Vitamin B6, also known as pyridoxine, is one of the eight B vitamins that the body requires to function properly. This nutrient is required for nearly 200 chemical reactions in the body, including brain development and the transport of oxygen through the bloodstream. Vitamin B6 also aids in the maintenance of a healthy nervous and immune system²³.

Vitamin B6 Health Benefits

Because vitamin B6 affects so many systems in human body, it has numerous health benefits, including:

Improved circulation:

Homocysteine is one of 21 amino acids found in the human body. Homocysteine levels in the bloodstream can cause heart problems. Vitamin B6 aids in the maintenance of a normal level of this amino acid in the blood.

A stronger immune system:

Vitamin B6 aids chemical reactions in the immune system, allowing it to function more effectively. Consuming vitamin B6-rich foods will help the body fight infection. Low levels of vitamin B6 have been linked to poor immune response in studies with older adults.

Less morning sickness:

Studies have found that taking vitamin B6 during pregnancy may help alleviate nausea, but it does not help with vomiting.

Better mood:

Vitamin B6 is required by the body to produce serotonin, a hormone that elevates the mood. According to some studies, a lack of vitamin B6 in the diet can contribute to depression.



Reduced cancer risk:

Maintaining healthy vitamin B6 levels in the blood may also help reduce the risk of cancer. If the body already has cancer, vitamin B6 has been shown in studies to slow tumour growth.

Improved brain function:

Homocysteine levels above a certain threshold have been linked to dementia, Alzheimer's disease, and cognitive decline. Vitamin B6 aids the body in regulating homocysteine levels in the blood.

Role of Vitamin D on hyperpigmentation

Vitamin D regulates the immune system, as well as the proliferation and development of keratinocytes and sebocytes. It possesses anti-comedogenic and antioxidant effects. As a result, vitamin D insufficiency has a favourable function in acne vulgaris aetiology. Although vitamin D is necessary for skin health, its primary function is to promote the creation of melanin, which can lead to increased skin darkening. Keep in mind that a custom-made composition will yield the most satisfactory outcomes. Vitamin D is a necessary hormone produced in the skin through a photochemical reaction after exposure to sunlight's ultraviolet B (UVB) wavelength. Provitamin D is converted to vitamin D in the skin by solar UVB light, more prevalent during the summer months. Age, pigmented skin, sunscreen use, and clothes all limit vitamin D production. Because melanin, which is responsible for skin pigmentation, filters UV-radiation, it is a known risk factor in people with hypovitaminosis D.

Antioxidants

Antioxidants are molecules (found in vitamins and minerals) that fight free radicals and protect cells from oxidative damage. To comprehend the true power of antioxidants, we must first comprehend the nature of free radicals. Free radicals are unstable molecules that cause cell damage, resulting in diseases, illnesses, cancers, inflammation, and premature skin ageing. Because of their unequal electron-to-proton ratio, free radicals are unstable. (A stable molecule contains an equal number of electrons and protons.) When a molecule splits and an unpaired electron is left, the molecule becomes unstable. An unstable molecule will attempt to balance itself by searching for and stealing an extra electron from another molecule (in the atoms of the skin). This causes a chain reaction of electron theft, which harms the cells. Antioxidants replace missing electrons in unstable molecules, preventing them from stealing an electron from another molecule. This process halts the domino effect of electron-stealing, which heals the cells and prevents free radical damage. Our bodies produce powerful antioxidants like glutathione on their own. Human body also absorbs antioxidants from a variety of healthy foods, such as fruits, vegetables, and nuts. Antioxidants occur naturally in our bodies and in some foods, but they are also synthesised as skincare products to benefit the

skin. They are also found as supplements in some foods and beverages.

What are the Advantages of Antioxidants in Skincare?

Antioxidants have a plethora of known skin benefits. The transformative benefits include skin moisturization and brightening, fine line and wrinkle reduction, and relief from inflammation and rosacea. Oxidative stress (free radical-caused cellular damage) is a major cause of skin ageing. Our skin is subjected to oxidative stress as a result of environmental factors such as pollution and UV rays from the sun, as well as unhealthy habits such as smoking and eating processed foods. Antioxidants protect the skin from oxidative stress by stabilising free radicals, allowing skin cells to heal and regenerate at a much faster rate. Free radicals are notorious for destroying the natural collagen and elasticity in our skin, which is why we age so quickly^{24,25}.

Antioxidants have anti-aging properties:

After years of sun and pollutant exposure, our skin begins to show signs of oxidative stress. Antioxidants work to counteract this damage by balancing the unstable molecules that reduce natural collagen and elasticity and damage skin tissue. This stabilisation process aids in the reduction of fine lines and wrinkles as well as the restoration of the skin's natural youthfulness.

Antioxidants can help to control hyperpigmentation caused by hormonal changes, sun damage, acne, and irregular melanin production. Vitamin C, a potent antioxidant, inhibits the enzyme tyrosinase, which is responsible for the production of melanin. Vitamin C stabilises melanin production by inhibiting tyrosinase, resulting in an even skin tone, reduced dark spots and hyperpigmentation, and a balanced and bright complexion.

Sources of Antioxidants:

1. The first antioxidant on our list is vitamin A. Retinol, a vitamin A derivative, has numerous skincare benefits. This antioxidant stimulates collagen production, resulting in firmer skin by reducing fine lines and wrinkles. Vitamin A also promotes cellular turnover, which means it helps the skin shed old, dead skin cells and regenerate new, revitalised skin cells²⁶.

2. Vitamin C:

For a variety of reasons, vitamin C should be in the skincare cabinet. Vitamin C, well-known for its brightening properties, helps to even out skin tone by reducing and lightening hyperpigmentation.

This antioxidant is essential for good skin and overall health. In fact, a vitamin C deficiency can cause scurvy and skin lesions. A sufficient intake of vitamin C can reduce inflammation, reduce free radical damage to the skin, hydrate the skin, and aid the body in wound healing.

3. Vitamin E:



Vitamin E is an excellent skincare ingredient to include in the daily regimen if one is suffering from acne, psoriasis, or dry skin. This antioxidant is a common component in many moisturisers and serums for good reason, as it can treat sun damage, reduce inflammation, moisturise the skin, and prevent sunburn²⁷.

4. Resveratrol

An antioxidant that can get from red wine? Please include us. Resveratrol, an antioxidant found in wine, grape skins, peanuts, cranberries, and blueberries, has been shown to reduce inflammation in the body and reduce the risk of developing heart disease, cancer, and diabetes. Resveratrol mitigates the effects of harmful environmental factors that we are exposed to on a daily basis. This antioxidant brightens the skin and reduces the appearance of ageing.

5. Niacinamide

Niacinamide, also known as nicotinamide, is a type of vitamin B that protects the skin from environmental damage, reduces fine lines, diminishes the appearance of enlarged pores, and brightens the skin for a more youthful appearance. This antioxidant complements skin care ingredients such as retinol, vitamin C, and hyaluronic acid. When used in conjunction with a hydrating hyaluronic acid serum, niacinamide helps the skin retain moisture and treats wrinkles with a plumping effect.

6. Tocopherol

Tocopherol, a type of vitamin E, is one of the most important antioxidants to include in the daily diet. Tocopherol, like other antioxidants, protects the skin from free radical damage and boosts cellular activity by counteracting the effects of oxidation on the skin. This ingredient also reduces inflammation and hydrates the skin, allowing it to retain a firm and full appearance²⁸.

7. Polyphenols from Green Tea

Green tea is one of the healthiest—and most delicious—teas can be included in the diet. Polyphenols (naturally occurring micronutrients in green tea) contain a potent compound known as catechin, which protects cells from damage and has anti-inflammatory properties for the skin. Green tea cleanses the body of free radicals, protects the skin from sun damage, and even aids in weight loss, making it one of the best antioxidants for the skin and body.

8. Curcumin

Curcumin, a chemical compound found in turmeric, is another potent ingredient that protects the skin from oxidative damage. This antioxidant has been shown to reduce inflammation, prevent the development of cancers, protect the body from heart disease, and keep collagen from breaking down in the body. Curcumin

also acts as an antimicrobial, killing acne-causing bacteria and treating skin diseases.

Skin's Production

Provitamin D3 is produced in the skin from 7-DHC when exposed to UVB radiation, predominantly in keratinocytes of the stratum basale and stratum spinosum layers of the epidermis. Provitamin D3 is converted to vitamin D3 (cholecalciferol), absorbed into the bloodstream by a binding protein. Provitamin D3 can also isomerize to produce the photoproducts of tachysterol3 or lumisterol3; the latter is reversible. Both isomers are physiologically inert (i.e., do not improve intestinal calcium absorption), do not reach the blood in large amounts, appear to serve as a mechanism to prevent vitamin D intoxication from prolonged sun exposure, and are most likely sloughed off as skin cells shed naturally. Vitamin D3 can be degraded into various photo products such as 5,6-trans-vitamin D3, suprasternal I, and suprasternal II when exposed to sunshine. Some of the photoproducts discussed, including the active form of vitamin D, may control epidermal proliferation and differentiation, but further research is needed to determine their biological significance²⁹.

Latitude, season, time of day, degree of skin pigmentation, age, amount of skin exposed, and sunscreen use are all factors that influence vitamin D production in the skin. The solar zenith angle is determined by latitude, season, and time of day, and it determines the intensity of sunlight. People living there are more at risk for vitamin D insufficiency because the sunshine intensity is lower at higher latitudes than at more tropical latitudes. The ability to synthesize vitamin D3 in the skin is affected by the time of year for persons living in temperate latitudes. From November to early March, UVB light is insufficient for vitamin D synthesis at latitudes approximately 40 degrees north or south (Boston is 42 degrees north). The "vitamin D winter" lasts from October to April if a person lives ten degrees north or south (Edmonton, Canada). The ability to produce vitamin D in the skin is also affected by the day, with noon sunlight being the strongest. Melanin, the dark pigment in the skin, competes with 7-DHC for U.V. light absorption, acting as a natural sunscreen and limiting vitamin D production in the skin. As a result, people with dark skin need more time (up to ten times longer) to synthesis the same quantity of vitamin D3 in their skin as people with light skin³⁰.

Role of Antioxidants on Hyperpigmentation

Oxidative stress is a critical factor in a wide range of biochemical reactions in the body, including melanogenesis. Exogenous oxidative stress triggers such as ultraviolet radiation (UVR) and visible light (V.L.) cause pigment formation in slightly different ways. Still, both have the potential to cause cosmetically undesirable Hyperpigmentation as a side effect. Organic and inorganic sunscreens exist to protect against the UVR portion of the electromagnetic spectrum, but coverage for the V.L. spectrum is limited. The stages of tanning, melanogenesis



pathways triggered by UVR and V.L., and the impact of oxidative stress are all discussed in this paper.

Antioxidants are found throughout the body and help to combat oxidative stress. Antioxidant levels in the skin are higher in the deeper basal layers than in the more superficial layers. The skin's susceptibility to photodamage increases as it ages and as a result of cumulative UVR exposure. In topical and oral formulations, a plethora of synthetic antioxidant replacement therapies is now available. However, only a few studies have looked at the antioxidants' ability to protect against UVR-induced IPD, PPD, and D.T. in vivo or in vitro. There appear to be few studies on the effect of antioxidants on VL-induced skin pigmentation. Carotenoids, polyphenols, and oral *Polypodium leucotomos* extract (PLE) have all been linked to preventing UV-induced skin pigmentation.

Carotenoids

Carotenoids are prized for their ability to protect against oxidative and free radical damage caused by high-energy sources like ultraviolet radiation.

Beta-carotene, alpha-carotene, lycopene, lutein, zeaxanthin, and alpha- and beta-cryptoxanthin are among the most common types available in topical and oral forms. Lutein and zeaxanthin are carotenoid isomers obtained through the diet and differ in a single, double bond location.⁶⁸ Lutein is a major carotenoid found in skin cells. The inhibition of lipid peroxidation and scavenging of singlet oxygen is thought to be the mechanisms by which they act as antioxidants. These powerful antioxidants are thought to prevent pigment deposition by inhibiting tyrosinase, reducing inflammation, and interfering with the formation of free radicals. The systemic effect of carotenoids can reach the dermis and epidermis through oral formulation, resulting in less pigment migration from the epidermis to the dermis.

Polyphenols

Polyphenols are antioxidant-rich plant-derived compounds that can be used topically or orally. Tannins (gallic acid esters of glucose and other sugars) and phenylpropanoids are two examples of polyphenols (lignins, flavonoids, and condensed tannins). Newer compounds, such as ellagitannins have resulted from esterification, methylation, or polymerization of polyphenols. Because of its potent antioxidant activity, ellagic acid is frequently used as a depigmenting agent and. Ellagic acid can react with and neutralize toxic quinolone intermediary products by substituting L-tyrosine and L-dopa substrate. The flavonoids are the most well-studied polyphenols, and they're thought to have an antioxidant effect by inhibiting tyrosinase-catalyzed oxidation of L-dihydroxyphenylalanine (L-DOPA) and scavenging free radicals.

Extract of the *Polypodium leucotomos* (PLE)

Polypodium leucotomos is a topical and oral tropical fern native to Central and South America. PLE has long been known for its anti-inflammatory and anti-tumour

properties, but its photoprotective and antioxidant properties have recently attracted attention. After UVR, 78 PLE quenches free radicals, prevents membrane-lipid peroxidation, and neutralizes superoxide anions, hydroxyl radicals, and singlet oxygen. Following UVR exposure, it has also been shown to lower glutathione oxidation in the blood and epidermis. The associated reductions in pigmentation after oral use were due to a reduction in DNA damage caused by ROS quenching, which would have facilitated melanogenesis otherwise. PLE has been shown to reduce oxidative stress, inflammation, and DNA damage in the aftermath of UVA and UVB irradiation.

DISCUSSION

Vitamins are required for the proper functioning of the body. A person who is vitamin deficient can experience a variety of issues. Because it affects the appearance of the skin, a deficit can sometimes be apparent. Vitamins A, C, and E are essential for skin health. Our skin is a fingerprint of what's going on inside our bodies, and all skin conditions are a reflection of that. Taking a multivitamin or slathering the face in vitamin-infused skincare products, on the other hand, does not guarantee that they will have a glowing skin. Genetics determines a large portion of our skin's look. While a vitamin shortage may make the skin appear less healthy, taking vitamins won't help unless the quantity is severely low. Vitamins do not all affect skin health. However, other vitamins, such as vitamin E and vitamin C, are critical for the skin's capacity to repair itself.

This B vitamin aids in the reduction of the consequences of hormonal imbalances, which can cause acne breakouts. Take on hormonal acne, inflammation, and redness with B6.

Vitamin D regulates the immune system, as well as the proliferation and development of keratinocytes and sebocytes. It possesses anti-comedogenic and antioxidant effects.

Antioxidants have a plethora of known skin benefits. The transformative benefits include skin moisturization and brightening, fine line and wrinkle reduction, and relief from inflammation and rosacea. Oxidative stress (free radical-caused cellular damage) is a major cause of skin ageing.

Hyperpigmentation, poor wound healing, hair loss, nail irregularities, rough, scaly spots, and extreme dryness are all indicators of vitamin insufficiency. This is not, however, an exhaustive list. Taking care of the skin should be a priority in the daily routine. After all, it is the largest organ in the body. What is consumed as food has a significant impact on the skin's health. To protect the skin, make sure the body is obtaining enough essential nutrients. The foods on this list are excellent choices for maintaining healthy, robust, and attractive skin. The sun, on the other hand, isn't all harmful. The first thing most doctors will encourage is to maintain the skin healthily is to limit the exposure to the sun's damaging ultraviolet (U.V.) radiation and using protective sunscreen whenever outside will help. Vitamin D is produced throughout the skin with just 10–15 minutes of



daily exposure. Vitamin D, along with vitamins C, E, and K, is one of the finest vitamins for the skin.

CONCLUSION

Most effective approach for improving the skin's state is to provide it with needed nutrients through a diversified diet, both topically and—more importantly—internally. A growing body of evidence demonstrates that a well-balanced diet has a substantial impact on skin ageing. The compounds that maintain and restore the epidermal barrier, which lowers TEWL, ensures an optimal level of skin moisture and protects against external causes and inflammation-induced damage, are worth noting (e.g., omega-3 and omega-6 fatty acids). Several vitamins and supplements have been shown to help with skin appearance. Carotenoids and vitamins C and E have been demonstrated to protect skin from UV-induced photodamage, while collagen supplements reduce wrinkle appearance.

Vitamin B6, Vitamin D and various types of antioxidants has been proven to show anti-hyperpigmentation activity, by their different protecting mechanisms, in which antioxidants prevent skin damage by fighting against free radicals. Vitamin B6 and naturally available Vitamin D are known to reduce/prevent skin damage, as well as kills cancer causing cells by their natural properties.

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