

bend
BEAUTY



THE ULTIMATE GUIDE TO SKIN HEALTH & LONGEVITY

Section 3

The Top Foods and Nutraceuticals to Benefit Skin Health & Longevity

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About this eBook Series

This series is divided into three separate sections to make it easier to enjoy.



— Section 1 —

How Diet, Lifestyle, and the Environment Impact Your Skin

Focuses on skin health and longevity, and what influences both.



— Section 2 —

More than Skin Deep: The Latest Science of Skin Health & Aging

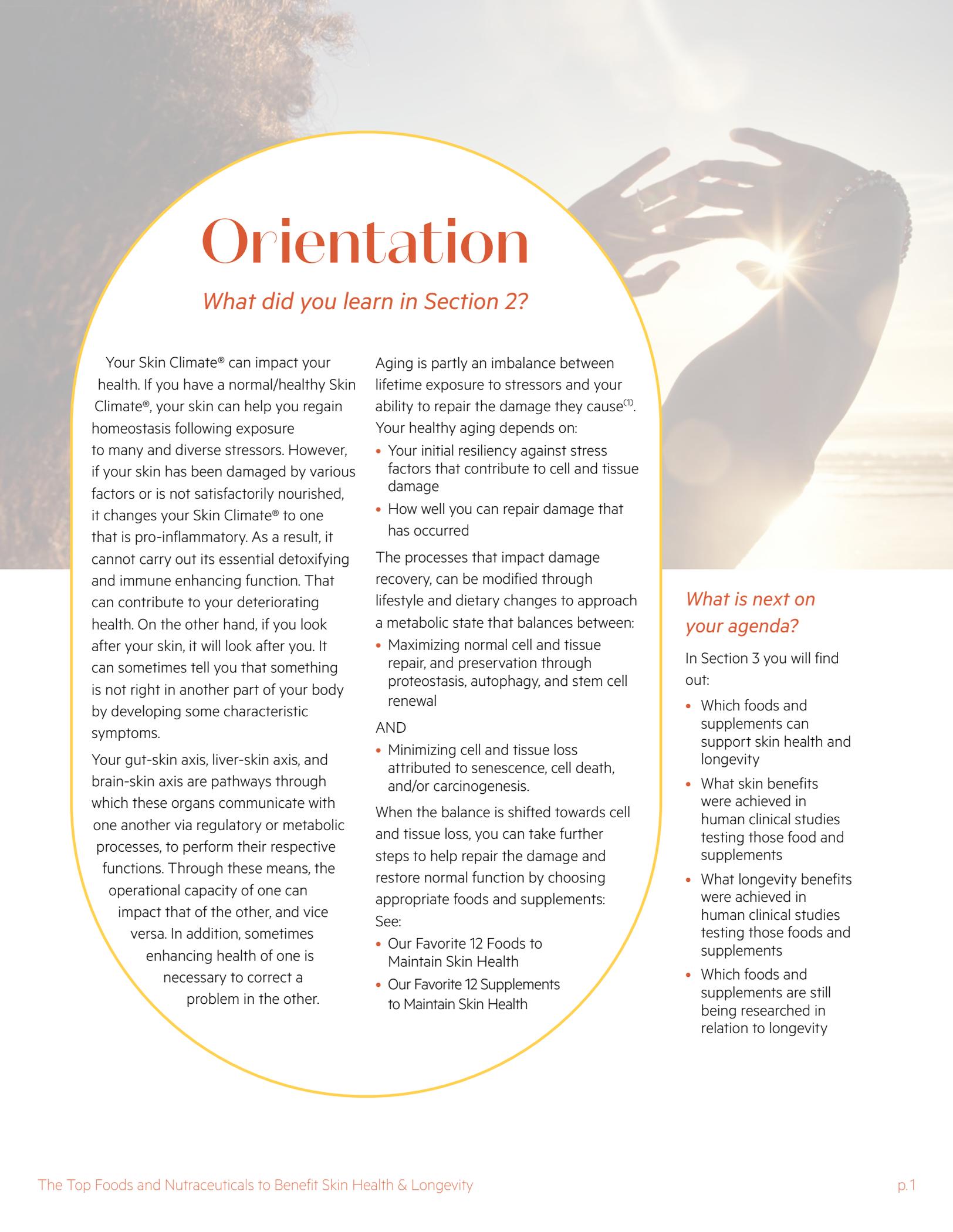
Describes what your skin reveals about your health, and how it impacts your health.



— Section 3 —

The Top Foods and Nutraceuticals to Benefit Skin Health & Longevity

Presents the clinical research supporting the benefits of our favorite foods and supplements to maintain your skin health and longevity.



Orientation

What did you learn in Section 2?

Your Skin Climate® can impact your health. If you have a normal/healthy Skin Climate®, your skin can help you regain homeostasis following exposure to many and diverse stressors. However, if your skin has been damaged by various factors or is not satisfactorily nourished, it changes your Skin Climate® to one that is pro-inflammatory. As a result, it cannot carry out its essential detoxifying and immune enhancing function. That can contribute to your deteriorating health. On the other hand, if you look after your skin, it will look after you. It can sometimes tell you that something is not right in another part of your body by developing some characteristic symptoms.

Your gut-skin axis, liver-skin axis, and brain-skin axis are pathways through which these organs communicate with one another via regulatory or metabolic processes, to perform their respective functions. Through these means, the operational capacity of one can impact that of the other, and vice versa. In addition, sometimes enhancing health of one is necessary to correct a problem in the other.

Aging is partly an imbalance between lifetime exposure to stressors and your ability to repair the damage they cause⁽¹⁾. Your healthy aging depends on:

- Your initial resiliency against stress factors that contribute to cell and tissue damage
- How well you can repair damage that has occurred

The processes that impact damage recovery, can be modified through lifestyle and dietary changes to approach a metabolic state that balances between:

- Maximizing normal cell and tissue repair, and preservation through proteostasis, autophagy, and stem cell renewal

AND

- Minimizing cell and tissue loss attributed to senescence, cell death, and/or carcinogenesis.

When the balance is shifted towards cell and tissue loss, you can take further steps to help repair the damage and restore normal function by choosing appropriate foods and supplements: See:

- Our Favorite 12 Foods to Maintain Skin Health
- Our Favorite 12 Supplements to Maintain Skin Health

What is next on your agenda?

In Section 3 you will find out:

- Which foods and supplements can support skin health and longevity
- What skin benefits were achieved in human clinical studies testing those food and supplements
- What longevity benefits were achieved in human clinical studies testing those foods and supplements
- Which foods and supplements are still being researched in relation to longevity

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5.0

Our Favorite 12 Foods to Maintain Skin Health



Healthy eating is one of the greatest contributors to a glowing and radiant complexion.

By ensuring you eat more fruit and vegetables, reduce your sugar and salt intake, include healthy fats from marine sources and nuts, and choose whole foods rather than processed ones, you will be eating more antioxidant-rich foods that can provide protective effects for both your skin and overall health.

However, research on the best foods for healthy skin is growing. This section highlights which foods are packed with nutrients that can feed your skin and help it stay soft, supple and wrinkle- and blemish-free longer. Your radiance on the outside will reflect your health and resiliency on the inside!



5.1 Teas

5.1.1 Green Tea

Green tea, made by steeping *Camellia sinensis* leaves in hot water, contains polyphenols that provide strong antioxidant protection for skin⁽²⁾. Epigallocatechin-3-gallate (EGCG) is the main component that accounts for its photo-aging protective effects⁽³⁾. Experimental studies show it reduces inflammation⁽²⁾ and prevents formation of enzymes that break down collagen and elastin⁽³⁾.

Skin related randomized (R), double-blind (DB), placebo controlled (PC) trials report that:

- Green tea polyphenols infused with milk increase antioxidant and antioxidant enzyme levels, while improving skin integrity and texture, and reducing skin wrinkles and roughness in elderly subjects⁽⁴⁾.
- Two year's treatment with green tea polyphenols significantly improved overall sun damage within 6 months, and redness and spider veins by 12 months⁽⁵⁾
- Combining topical and oral green tea use for 8 weeks improved elastic tissue content in skin in women with moderate photo-aging⁽⁶⁾.

Longevity effects of green tea are well documented. A controlled trial where exercising young men drank 3 cups

of green tea daily for a week, found their oxidative stress was reduced following exercise compared to when they did not drink the tea⁽⁷⁾. In addition, a systematic review of 31 studies found that daily intake of green tea reduced ROS and increased antioxidant capacity in 22 of those studies⁽⁸⁾. Those antioxidant effects likely contribute to results of other studies showing that chronic tea intake (of any kind) reduced the risk of dying from CVD⁽⁹⁾, stroke, diabetes, or depression, improved blood sugar/ glucose and cholesterol levels, and reduced abdominal fat, and blood pressure⁽¹⁰⁾.



PRO TIP

THE GOLD STANDARD:
R, DB, PC clinical studies are the best designed trials to determine how well a treatment works.

5.1.2 Gynostemma tea

Gynostemma tea is made by steeping the roots of *Gynostemma pentaphyllum* in hot water. The active ingredients in this tea are plant saponins known to induce antioxidant enzymes and protect cells from oxidative damage. It also causes the formation of substances that mimic calorie restriction, which beneficially decrease blood sugar/glucose⁽¹¹⁾, and improve insulin sensitivity⁽¹²⁾, thereby helping to regulate blood sugar. In addition, a R, DB, PC trial including obese-but-otherwise healthy people, supplemented with a standardized extract of Gynostemma tea active ingredients, found that total abdominal fat area, body weight, body fat mass, percent body fat, and body mass index (BMI) significantly decreased, without any significant changes in food intake. The most impressive

fat loss was an 11.7% drop in the visceral region compared to only a 2.9% drop in the placebo treated subjects⁽¹³⁾.

Visceral fat which surrounds internal organs within the belly can be a significant contributor to inflammation, and can increase the risk of type 2 diabetes, cardiovascular disease, and several types of cancers⁽¹³⁾.

Although to date, no clinical trials have directly tested the impact of Gynostemma tea on skin health or longevity, the above reported metabolic enhancing effects would be expected to help preserve longevity. In addition, its capacity to protect against oxidative damage, would be expected to contribute to similar effects by other antioxidant rich foods and supplements shown to promote healthy skin and longevity.



5.2 Cocoa

Cocoa products made from the dried and fermented fatty seeds of the cocoa tree, *Theobroma cacao*, such as dark chocolate and cocoa drinks, can improve blood pressure, insulin resistance, blood lipids, obesity, and mental performance⁽¹⁴⁾.

Cocoa's potential to prevent and treat skin diseases is attributed partly to its antioxidant, anti-inflammatory and immune modifying effects that can protect skin from the inside by neutralizing oxidative stress. It has shown promise for skin conditions, including cancer, psoriasis, acne, wound healing⁽¹⁵⁾, and atopic eczema^(16, 17). Its effects are attributed primarily to its flavonol content that can increase photo-protection by inhibiting UV-induced DNA oxidation⁽¹⁸⁾, enhancing DNA repair, and improving microcirculation to supply nutrients that contribute to metabolism within, and maintenance of, the extracellular matrix⁽¹⁵⁾.

Skin associated R, PC, clinical studies confirm that cocoa products including cocoa powder:

- Decrease UV-induced inflammation^(19, 20), TEWL⁽¹⁹⁾, skin roughness^(19, 14), scaling⁽¹⁹⁾, and wrinkles⁽¹⁴⁾
- Increase skin microcirculation^(19, 21), density, thickness, hydration⁽¹⁹⁾ and elasticity⁽¹⁴⁾.

Many studies associate cocoa and chocolate consumption with reduced risk of chronic diseases⁽¹⁵⁾, and meta/combined-analyses of supplementation trials report that both, acute and chronic chocolate, and cocoa intake, can improve blood pressure and insulin action⁽¹⁸⁾. A meta-analysis of nineteen R, PC trials showed that cocoa flavanols improved insulin sensitivity, blood lipid profiles and inflammatory markers⁽²²⁾. The Cocoa, Cognition, and Aging R, DB, PC trial including elderly people with mild cognitive impairment, showed that regular cocoa flavanols

intake can improve visual attention, task switching ability, verbal fluency, insulin resistance, blood pressure, and lipid peroxidation⁽²³⁾. A follow-up study in cognitively intact elderly subjects, showed that regular cocoa flavanols intake can reduce blood pressure and lipid peroxidation, and reduce some measures of age-related cognitive dysfunction, possibly through improving insulin sensitivity⁽²⁴⁾. Combined, these results support a protective role against metabolic syndrome and CVD that would have life extending benefits.

5.3 Cruciferous vegetables

Cruciferous vegetables include broccoli, cauliflower, cabbage, kohlrabi, kale, bok choy, arugula, Brussels sprouts, mustard and collard greens, watercress, turnip, and radishes. They contain a natural antioxidant stimulator called sulforaphane that aids liver detoxification.

Sulforaphane is made from glucoraphanin, which is naturally present in these vegetables⁽²⁵⁾, through action of an enzyme called myrosinase, which resides within a separate part of the vegetable cells away from glucoraphanin. When the plant is injured or when you chew it, the myrosinase contacts the glucoraphanin and converts it to sulforaphane. Some human gut microbes can also convert glucoraphanin to sulforaphane.

Sulforaphane produces cancer preventive, antidiabetic and antimicrobial effects mostly by increasing production of antioxidant and phase II detoxifying enzymes through Nrf2 activation. Nrf2 is the master regulator of every cell's survival response to internal and external stressors⁽²⁶⁾ and sulforaphane is one of the most potent naturally occurring Nrf2 activators⁽²⁵⁾.

As we age, the activity of our Nrf2 declines, which reduces the formation of the

antioxidant enzymes. Sulforaphane restores this ability as shown in UVB injured human epithelial cells where it increased phase II and antioxidant enzyme levels. Sulforaphane's capacity to correct this age-related deterioration in Nrf2's critical cell protective function⁽²⁾, highlights its potential role in preventing skin aging and age-related disease.



Ongoing Research

Human Clinical Studies – Liver

Sulforaphane derived from broccoli sprouts reduces the body's build-up of environmental carcinogens and other toxins⁽²⁵⁾ by inducing Phase I and II enzymes to convert them into substances that are excreted in our urine⁽²⁷⁻³¹⁾. It enhances elimination of food born aflatoxins⁽²⁸⁾, and air born PAHs^(28, 31), benzene^(27, 31), acrolein^(27, 31) and crotoaldehyde⁽³¹⁾. Removal of these toxins from the body may help reduce disease risks in people unavoidably exposed to them. In addition, a R, DB, PC trial showed sulforaphane normalizes liver enzyme function in people with fatty liver⁽³²⁾ and reduces fasting blood sugar and AGEs in diabetics⁽³³⁾.

Human Clinical Studies – Skin

Most studies to date have only tested sulforaphane applied to the skin, but they confirm it induces phase II enzymes⁽²⁶⁾ and protects against UV radiation. That protection increases with an increasing dose, although the response varied within and among different people. However, it took 2-3 days for those benefits to appear because it takes a few days for the body to produce the phase II enzymes after sulforaphane treatment⁽³⁴⁾.

To date, only one oral supplementation trial has tested the effectiveness of a glucoraphanin/sulforaphane mixture.



PRO TIP

FACTOID:

Sulforaphane is a natural insect deterrent made by plants to protect themselves from predators!

5.4 Seafood

Seafood, including fish, shellfish and crustaceans are delicious, and healthy options for those who eat animal derived foods. They are rich in many nutrients including high quality protein, omega-3 fatty acids, and many vitamins and minerals. The omega-3 LC-PUFAs, known for their anti-inflammatory and cardio- and brain-protective effects, are particularly plentiful in fatty, fleshy, saltwater fish including herring, mackerel, sardines, tuna, and salmon. In fact, much of the evidence establishing the health benefits of omega-3 LC-PUFAs relates to fish intake itself⁽³⁶⁻³⁸⁾ that provides many important nutrients in addition to omega-3s⁽³⁹⁾. These may include:

- The antioxidants vitamins A, E, C & selenium that help maintain body tissues and protect against diseases of aging
- All the B vitamins & zinc that help convert food to energy and/or breakdown & create new proteins
- Vitamin D to maintain blood levels of calcium & phosphorus, and for proper immune function
- Iron that, with the help of copper, carries & stores oxygen
- Zinc, selenium & copper for proper immune function
- Iodine for normal thyroid and metabolic function

Reports showing the impact of seafood on skin are rare, but the importance of fish derived omega-3 LC-PUFAs for skin healthy is well established.

5.5 Mushrooms

Mushrooms are rich in dietary fiber, essential amino acids⁽⁴²⁾, selenium, potassium, vitamins B2, 3, and D⁽⁴³⁾, and many bioactive compounds, especially those benefiting immune health, although the quantity of these compounds differs among different mushroom types⁽⁴²⁾. Polysaccharides and specific proteins account for most of their immunomodulating and anti-tumor effects, while lipids and phenols provide health enhancing cholesterol lowering and antioxidant effects, respectively⁽⁴⁴⁾.

Some extensively studied medicinal mushrooms include Cordyceps, Reishi and Tremella.



Ongoing Research

Human Clinical Studies - Longevity

Many studies focus on longevity benefits of eating fish. For example, the PREDIMED study followed 7202 people in Spain without prior CVD, who ate fish regularly for 5.9 years. Those with the highest omega-3 PUFAs intake from fish they ate, were the least likely to die for any reason, including CVD, coronary heart disease, and sudden cardiac death⁽⁴⁰⁾.

A similar study looked at the association between meat/fish consumption, DHA/EPA intakes, and blood DHA/EPA levels, and mortality in 1054 people in Japan that were followed for 10 years as part of the National Institute for Longevity Sciences-Longitudinal Study of Aging. Those whose blood DHA levels and EPA/AA ratio increased, because of the fish they were eating, had a lower risk of dying⁽⁴¹⁾.

- Cordyceps, found at high altitudes on the Himalayan plateau, are well-known in traditional Chinese medicine. Their therapeutic effects include anti-diabetic, anti-hyperlipidemia, anti-fungal, anti-inflammatory, immunomodulatory, antioxidant, anti-aging, anticancer, antiviral, liver-protective, hypo-sexuality, cardio-protective, antimalarial, anti-osteoporotic, and anti-arthritis effects⁽⁴⁵⁾.
- Reishi (*Ganoderma lucidum*), used as an elixir for thousands of years, is thought to have life extending benefits by preventing ROS, AGEs, and ALEs production, and protecting mitochondria⁽⁴⁶⁾.

- Tremella (*Tremella fuciformis*), is a Chinese herb containing potent polysaccharides⁽⁴⁷⁾ that help one adapt to various environmental and biological stresses through various means including antioxidant, anti-inflammatory, anti-diabetic/hypoglycemic, anti-obesity, cholesterol lowering, antitumor, memory enhancing, anti-aging^(48, 49) and immunomodulatory effects⁽⁵⁰⁾. In skin, Tremella has wound healing effects⁽⁵¹⁾, that are partly attributed to its immune enhancing capacity that may also impact longevity.

Although the potent bioactive effects of medicinal mushrooms are well-documented, to date human supplementation trials specifically aimed at measuring their benefits for skin health and longevity are lacking⁽⁴³⁾.

5.6 High polyphenol olive oil

The Mediterranean diet, with its relatively high olive oil content is connected to enhanced longevity and reduced risk of sickness and death. Health benefits of consuming olive oil, including antioxidant, anti-inflammatory, and anti-microbial effects, have traditionally been attributed to its high content of the monounsaturated fatty acid (MUFA), oleic acid. However, we now know these effects are also partly derived from its polyphenol content⁽⁵²⁾. For example, in a study comparing different types of olive oil on cardiovascular risk factors, the high polyphenol olive oil worked best to reduce harmful cholesterol and systolic blood pressure⁽⁵³⁾.

To date, clinical studies reporting the impact of high polyphenol olive oil on skin are scarce. However, its strong antioxidant, and anti-inflammatory effects would be expected to positively impact skin health.

Ongoing Research

Human Studies - Longevity

Research suggests that a delicate balance of saturated (SFA)/MUFA/PUFA is needed within cells to optimize performance related to lifespan⁽⁵⁴⁾.

The polyphenols within high polyphenol olive oil may enhance longevity in a similar way to calorie restriction⁽⁵²⁾. Although to date, no human studies have directly measured the impact that high polyphenol olive oil can have on human longevity, many studies have investigated its impact on age-related diseases and risk factors. Systematic reviews and/or meta-analyses of these studies confirm that:

- High polyphenol olive oil significantly reduced oxidative stress by improving the ratio of bad to good cholesterol, inflammatory markers, and blood pressure, compared to low-polyphenol olive oil⁽⁵⁵⁾.
- Olive oil polyphenols:
 - Increase good cholesterol, prevent oxidative stress, reduce blood vessel dysfunction which reduces blood clots, blood pressure, and inflammation, and beneficially alters gene expression that reduces atherosclerosis⁽⁵⁶⁾.
 - May provide some benefits for neurodegenerative disorders, including dementia, AD, and Parkinson's diseases⁽⁵⁷⁾.
 - Reduce metabolic syndrome risk by improving blood sugar and blood pressure control and reducing bad cholesterol⁽⁵⁸⁾.

Combined, these results provide strong evidence that high polyphenol olive oil could beneficially impact longevity.



5.7 Purple berries

Did you know that plants produce color partly to protect themselves from the sun? Well, those same intense and beautiful red, purple, and blue hues, can also protect you! The roughly 600 naturally occurring, water soluble, intensely colored anthocyanins, particularly rich in berries, absorb blue-green light and UV rays⁽⁵⁹⁾. They are found in many foods including blueberries, blackberries, raspberries, haskap, strawberries, cherries, chokecherries, currents, purple grapes, beets, red cabbage, and red beans⁽⁶⁰⁾.



Ongoing Research

Human Clinical Studies – Skin

Hundreds of scientific studies show that anthocyanins have antioxidant, anti-inflammatory, and anti-cancer properties⁽⁶⁰⁾ making them useful to protect health in general, but particularly suited to protecting skin from sun damage that contributes to skin aging and cancer⁽⁵⁹⁾. In fact, the importance of anthocyanins to health is so well recognized that two studies spanning 10 years were funded by the European Union⁽⁶¹⁾. These trials called the FLORA and ATHENA studies, and others, confirm that anthocyanins provide natural sun protection by⁽⁶⁰⁾:

- Improving antioxidant capacity
- Reducing production of enzymes that break down collagen and elastin
- Increasing Phase II internal antioxidant/detoxifying enzymes that help eliminate toxins, and reduce ROS and DNA damage that can trigger cancer formation
- Reducing inflammation⁽⁶²⁾
- Enhancing metabolism⁽⁶⁰⁾

Human Studies - Longevity

The metabolism enhancing effects of anthocyanins are especially important in cancer prevention. Cancer is a metabolic disease that thrives when blood sugar metabolism is compromised, and so people with diabetes are more likely to develop many types of cancer⁽⁶³⁾. Anthocyanins may reduce this risk partly by enhancing blood sugar metabolism. In fact, people who eat the most anthocyanins are 15% less likely to develop Type II diabetes according to a study of over 200,000 adults followed from 1980-2003⁽⁶⁴⁾. Other studies show anthocyanin-rich food intake is associated with lower insulin and inflammation levels⁽⁶⁵⁾ and may help reduce obesity⁽⁶⁶⁾, while anthocyanin supplementation improves blood lipid/fat levels, enhances antioxidant capacity, and prevents insulin resistance in Type II diabetics⁽⁶⁷⁾.

Even more impressive; men who eat vegetables, fruit, and berries (rich in anthocyanins) more than 27 times per month, are 8-10 % less likely to die from any cause compared with men who don't eat that much. In addition, eating these foods is associated with living longer and reduces the risk of dying from cancer or stroke⁽⁶⁸⁾.

To date, no human studies have directly measured the life preserving effects of purple berries in survival years. However, longevity research models report increased lifespan with reduced oxidative stress⁽⁶⁹⁾, and increased production of antioxidant enzymes and those that break down damaged proteins⁽⁷⁰⁾.



5.8 Leafy Green Vegetables

Leaf green vegetables or greens are plant leaves eaten as vegetables, and include all lettuces, spinach, collard greens, arugula, swiss chard, kale, garden cress, dandelion, and mustard greens. They are typically low in calories and fat, and high in protein per calorie, dietary fiber, vitamins C and E, carotenoids, folate, manganese, and are high in vitamin K1⁽⁷¹⁻⁷³⁾. The health promoting effects of leafy green vegetables including antioxidant, DNA protective, and detoxifying activities⁽⁷⁴⁾, are primarily attributed to their fiber, carotenoid and vitamin K content⁽⁷²⁾. Bioactive components reported to protect against cancers, include the antioxidants lutein, vitamins C, E, various flavonoids, fiber, folic acid, and chlorophyll^(73, 75).



Ongoing Research

Human Clinical Studies – Skin

Populations studies show that among adults with a history of skin cancer, those who had a high intake of green leafy vegetables, had a decreased risk of squamous cell carcinoma tumors⁽⁷³⁾. In addition, a higher intake of green/yellow vegetables (which would include leafy green vegetables) was significantly associated with less crow's-feet wrinkles regardless of smoking status, body mass index or lifetime sun exposure⁽⁷⁶⁾.

Human Clinical Studies – Longevity

In an observational study of 40,349 Japanese men and women followed for roughly 18 years, daily intake of green/yellow vegetables reduced risk of dying from stroke by 26% compared to eating them once or less weekly⁽⁷⁷⁾.

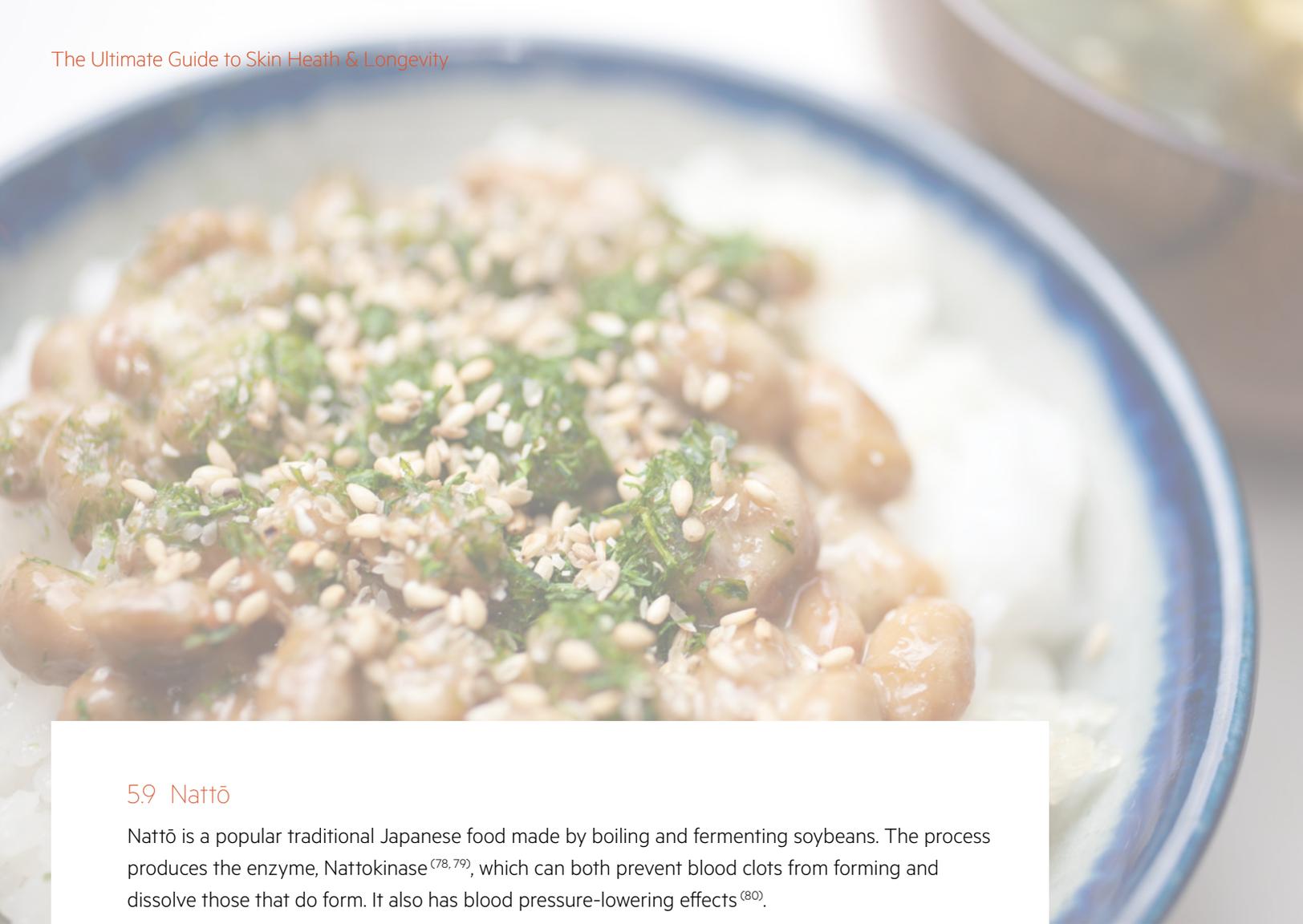
Both the skin specific anti-cancer and stroke protective effects of leafy green vegetables mentioned above would be expected to contribute to longevity. In addition, at least one longevity research model has reported significantly improved resistance to oxidative stress and extended lifespan attributed to chlorophyll⁽⁷⁴⁾.



PRO TIP

FOOD PAIRING

Vitamins K and carotenoids are fat-soluble vitamins and therefore we need to eat a little dietary fat along with leafy greens to increase the benefits associated with them⁽⁷²⁾.



5.9 Nattō

Nattō is a popular traditional Japanese food made by boiling and fermenting soybeans. The process produces the enzyme, Nattokinase^(78,79), which can both prevent blood clots from forming and dissolve those that do form. It also has blood pressure-lowering effects⁽⁸⁰⁾.

Nattō is also a rich source of the essential, fat soluble, vitamin K2, that is needed for bone health. Eating Nattō can both increase blood levels of vitamin K and activate the enzyme, osteocalcin, to concentrate and bind calcium within bone^(79,81). Maintaining bone health is important to prevent visual facial aging.

Eating Nattō is thought to contribute to lower prevalence of CVDs and longer life expectancy in Japanese populations compared to those in Western countries. At least one R, DB, PC trial showed it significantly improves blood flow in subjects with high blood pressure, diabetes, or abnormal blood cholesterol and/or triglyceride levels⁽⁸⁰⁾. These effects would be expected to contribute to longevity.

The circulation enhancing effects of Nattō would be expected to improve microcirculation and therefore skin. However, to date, clinical trials directly testing the impact of Nattō on skin health are lacking.



5.10 Walnuts

Walnuts have a unique nutrient profile compared to all other nuts⁽⁸²⁾. They contain much more ALA (omega-3), more polyphenols, and are a rich source of phytemelatonin, a plant pigment that functions similar to melatonin. This combination is associated with some health benefits not attributed to other nuts⁽⁸²⁻⁸⁷⁾ including reduced risk of age-related conditions such as CVD, coronary heart disease, type II diabetes, some cancers, and various neurological disorders⁽⁸⁵⁾.

The main polyphenol in walnuts is an ellagitannin. It has antioxidant and anti-inflammatory effects that may prevent initiation and progression of cancer, and cardiovascular and neurodegenerative diseases. Once eaten, it forms ellagic acid, which is further converted by gut microflora to urolithins⁽⁸⁸⁾ in a process influenced by individual differences in gut microbiota⁽⁸²⁾. Urolithins are better absorbed than ellagitannins, and target many organs and tissues to achieve antioxidant, anti-inflammatory, anticancer and prebiotic effects⁽⁸²⁾. A meta-analysis showed that eating ellagitannin-rich foods, particularly walnuts, reduces body fat, bad-cholesterol and blood sugar levels⁽⁸⁹⁾.



PRO TIP

WALNUTS & THE MICROBIOME

Eating walnuts promotes biodiversity and enriches the microbiome by increasing good and decreasing bad bacteria. It also reduces production of toxic and inflammatory secondary bile acids as measured in a R, PC trial including healthy men and women. These benefits were ascribed to nondigestible material from walnuts, mainly ellagitannins and fiber polysaccharides⁽⁸⁷⁾.

WALNUTS & SLEEP

At night, our pineal gland makes melatonin, a hormone with antioxidant, anti-inflammatory, anti-obesity, anticancer, and neuroprotective effects, that is best known for sleep-regulation. Walnuts are one of the richest food sources of phytemelatonin. Although to date, no study has confirmed that eating walnuts will make you sleep better, in a study in nondepressed healthy youth, it improved their mood⁽⁸⁶⁾.



Ongoing Research

Human Studies - Skin

To date, no supplementation trials have measured skin specific effects associated with increased walnut intake. However, at least one R, PC trial found significantly increased blood levels of ALA, EPA and total omega-3s after eating a walnut-enriched diet⁽⁹⁰⁾. In addition, postmenopausal women with abnormal cholesterol levels had improved microcirculation after eating a walnut-enriched diet⁽⁹¹⁾. Other reported benefits

including enhanced microcirculation⁽⁹¹⁾, omega-3 fatty acid status⁽⁹⁰⁾, mood⁽⁸⁶⁾ and microbiome composition⁽⁸⁷⁾, would be expected to improve skin health directly through enhanced nutrient supply, and toxin elimination and anti-inflammatory effects, and indirectly through the brain-skin axis and gut-skin axis, respectively.

Human Studies - Longevity

Populations studies show that eating walnuts helps to preserve life. For example, the Nurses' Health Study and The Health Professionals Follow-Up Study, found that eating walnuts one or more times weekly for up to 32 years, was associated with a 21% lower risk of CVD and 17% lower risk of stroke⁽⁸³⁾. In addition, the PREDIMED trial found people eating more than 3 servings of walnuts weekly had a 47% lower risk of cardiovascular related death compared to those who did not⁽⁹²⁾.

Meta-analyses of R, PC trials report that eating walnuts:

- Significantly dose-dependently reduced blood cholesterol in 24 studies (i.e., the more walnuts a person ate, the lower their cholesterol levels)⁽⁹³⁾.
- Significantly improved artery blood flow and blood vessel dilation in 10 studies^(82, 84).

Individual R, PC trials report that eating walnuts:

- Enhanced cholesterol transport and disposal, in healthy overweight and obese adults with abnormal cholesterol levels⁽⁹⁴⁾.
- In the Walnuts and Healthy Aging study
 - Delayed cognitive decline in high-risk subgroups^(95, 96).

- Lowered blood pressure and need to medicate⁽⁹⁷⁾.
- Significantly decreased body weight, while body fat significantly increased. However, lean body mass, waist circumference, and waist-to-hip ratio remained essentially unchanged⁽⁹⁸⁾.
- Reduced levels of several inflammatory substances⁽⁹⁹⁾.
- In mentally healthy elders, tended to preserve telomere length⁽¹⁰⁰⁾.

Although to date, no supplementation trials have directly measured increased lifespan after eating walnuts, the combined results of the above studies would be expected to provide multiple health benefits with potential to enhance longevity.



5.11 Seaweeds

Seaweeds, or sea vegetables contain bioactive components include peptides⁽¹⁰¹⁾, polysaccharides/fiber, carotenoids, and polyphenols that produce anti-cancer, anti-inflammation, antioxidant, anti-allergic, anti-wrinkling, anti-pigment, and hair growth promoting properties⁽¹⁰²⁾.

The powerful antioxidant effects of seaweeds are attributed to their large variety of plant pigments which absorb light for photosynthesis. These include chlorophylls, fucoxanthin, and carotenoids, mostly β -carotene, lutein, and zeaxanthin, that shield the plant from UV irradiation, and so may help to do the same thing for us! Seaweeds are also an important source of antioxidant vitamins including A, C, D, E⁽¹⁰³⁾ and so contribute to our total antioxidant defense system through them as well as the described plant pigments.

Seaweeds contain a lot of soluble dietary fiber⁽³⁹⁾ including polysaccharides that can be metabolized by the gut microbiome for added benefit⁽¹⁰⁴⁾. The most thoroughly studied seaweed polysaccharide is fucoidan from brown seaweed. It has antioxidant, anticancer, antimicrobial, hyperlipidemic,

anti-inflammatory⁽¹⁰³⁾, anticoagulant, and immuno-modulatory effects⁽¹⁰⁵⁾.

Seaweeds can potentially prevent sun exposure, hyperpigmentation/development of age spots, premature skin aging, and acne through various mechanisms⁽¹⁰³⁾. Fucoidans in cosmetic products reportedly reduce visible signs of skin aging such as blemishes, wrinkles, and freckles⁽¹⁰⁵⁾. However, human studies testing those effects are still pending.

Seaweeds bioactives also have potential to protect against cardiometabolic and inflammatory risk factors associated with age-related diseases, such as obesity, type 2 diabetes, metabolic syndrome, some cancers, and CVD⁽¹⁰⁴⁾. They may help correct abnormal triglyceride and cholesterol levels, oxidative stress, blood vessel inflammation, blood pressure, blood clotting, and fluid and electrolyte balance⁽¹⁰¹⁾. In addition, some may produce calorie restriction mimicking effects that impact various aging-regulation pathways and mechanisms⁽¹⁰⁶⁾. However, to date, no human clinical trials have directly measured the impact of seaweed intake on either skin health or human longevity.



5.12 Spices

5.12.1 Turmeric

Turmeric contains polyphenols called curcumins that reliably protect against oxidative stress⁽¹⁰⁷⁾ and reduce inflammation⁽¹⁰⁸⁾. In experimental models, they prevent UVB-induced inflammation and production of enzymes that break down collagen and/or elastin in keratinocytes and fibroblasts. They also reduce skin damage caused by tobacco smoke, an important risk factor for skin cancer⁽²⁾. In human fibroblasts, curcumins activate the cellular stress response, which implies they can stimulate internal antioxidant defenses and so have potential to maintain healthy skin and longevity⁽³⁾.

In clinical studies, curcumins can increase internal antioxidant levels^(107, 109, 110), reduce inflammation related pain, improve function in osteoarthritis⁽¹¹¹⁻¹¹³⁾, and may improve depression⁽¹¹⁴⁻¹¹⁶⁾, and anxiety^(116, 117). However, clinical trials testing their direct impact on skin health or longevity are uncommon, although longevity research models have reported increased lifespan⁽¹¹⁸⁾.

5.12.2 Paprika

Paprika is derived from the pepper family, and is rich in the antioxidant carotenoids, zeaxanthin, and capsicum. Benefits of capsaicin supplementation have been reported in obesity, cardiovascular and gastrointestinal conditions, various cancers, nervous bladder, and skin conditions. Many of these effects are thought to involve a cell receptor, associated with pain perception, nerve inflammation, and central nervous system-related disorders⁽¹¹⁹⁾. Activating this cell receptor in human keratinocytes, prevents production of enzymes that break down collagen and/or elastin^(119, 120), which would be expected to reduce skin collagen loss. In addition, it modifies cell division and induces apoptosis in human cancer cells, and so would be expected to have anti-cancer effects⁽¹²¹⁾. However, to date, clinical trials directly testing the impact of paprika on skin health and longevity are lacking.

5.12.3 Cinnamon

Cinnamon may help to control blood sugar, by reducing the rate at which it enters the body's metabolic pathways⁽¹²²⁾. It has also been used as a traditional medicine having blood sugar lowering, antioxidant, and antimicrobial effects⁽¹²³⁾. A water-soluble cinnamon polyphenol appears to account for most of its anti-diabetic effects⁽¹²⁴⁾. Human trials report it beneficially reduces blood glucose^(122, 125, 126), and blood lipid levels including bad cholesterol and triglycerides⁽¹²⁷⁾, and improves insulin sensitivity^(124, 128).

These results should beneficially impact metabolic syndrome and longevity. In fact, longevity research models show that cinnamon increases lifespan and healthspan⁽¹²³⁾ partly through insulin action⁽¹²⁹⁾. However, to date, no evidence exists to support a similar effect in humans.

Clinical trials investigating the impact of cinnamon on skin are scarce. However, cinnamaldehyde, a major antioxidant in cinnamon significantly reduced ROS production and increases DNA repair in UVB exposed human keratinocytes in vitro⁽¹³⁰⁾.

6.0

Our Favorite 12 Supplements to Maintain Skin Health



Supplements add to the benefits of a nutrient-dense, well-rounded, healthy diet aimed at supporting your skin health and longevity.

While many of us can get what is recommended by eating healthy, it is sometimes hard to do that all the time. In addition, some individuals may have special needs, such as the elderly, those on certain medications, or those on restrictive diets due to personal choice (e.g., vegan diets), metabolic disorders (e.g., diabetes), or allergies (e.g., those that must avoid specific foods), or people with certain genetic or health conditions (e.g., inflammatory bowel disease).

Other factors that may influence supplement use include excessive reliance on processed or junk food, and concerns about altered food nutrient profiles attributed to genetic hybrids within our food chain, mineral depletion from our waters, and rising atmospheric carbon dioxide levels that profoundly impact plant and animal composition.

That's why supplements can help make your healthy life choices shine!

6.1 Polyunsaturated fatty acids

Fatty acids, including the omega-6 and omega-3 LC-PUFAs, are found in dietary fat, and their intake influences your body composition, function, and health because they are part of every cell membrane and can influence how those cells function⁽¹³¹⁾.

LA is the most abundant PUFA within the epidermis, where it resides in the stratum corneum ceramides. The higher the amount of LA within these ceramides, the better the skin's barrier function. AA is the second most abundant PUFA in the epidermis. It is found primarily in the keratinocyte cell membrane and can be used to make both pro- and anti-inflammatory substances, depending on the circumstance. Omega-3 fatty acids make up less than 2% of total epidermal fatty acids but are still important immune-modulators there⁽¹³²⁾.

substances which account for its benefits on inflammatory skin conditions⁽¹³²⁾. AA within skin can either increase or decrease inflammation, while EPA and DHA can be made into metabolites that are primarily anti-inflammatory⁽¹³⁵⁾.

EFA (i.e., LA) deficiency significantly affects skin function and appearance. It causes skin thickening, increased inflammation⁽¹³⁶⁾, dermatitis⁽¹³²⁾, and increased TEWL reflecting barrier function loss^(132, 135, 137). These changes directly relate to the skin's fatty acid composition⁽¹³²⁾. However, EFA deficiency is virtually non-existent in industrialized societies because we eat lots of vegetable oils that typically contain plenty of LA. Instead, the appearance of these EFA deficiency signs may be partly attributed to lack of GLA⁽¹³⁸⁾.

Skin cannot make GLA, AA, EPA, or DHA. It must get these nutrients from your diet.

Unlike most other body tissues, skin does not have all the enzymes needed to convert EFAs to their corresponding LC-PUFAs. Because of this, **GLA, AA, EPA, and DHA are considered essential nutrients for the skin**⁽¹³²⁾.

Since normal skin cannot make GLA from LA, LA is instead made into a substance that reduces cell multiplication. Dietary GLA can be altered by other enzymes within skin to make anti-inflammatory

Fortunately, the fatty acid composition of the skin can be modified by dietary changes, and supplementation with omega-3 and omega-6 LC-PUFAs can significantly alter its fatty acid composition⁽¹³²⁾. Through these means, GLA can be supplied to the skin to make powerful anti-inflammatory substances, and fish oil supplementation can enrich EPA within skin cell membranes where it can compete with AA, and thereby decrease the production



PRO TIP

SKIN FUNCTION

Ceramides within the dermis and epidermis maintain barrier function, prevent TEWL, and impact cell functions ranging from division to apoptosis⁽¹³³⁾. 40-50% of the stratum corneum is made of these special lipids⁽¹³²⁾, but the amount declines with age⁽¹³⁴⁾.

of pro-inflammatory AA-derived substances while simultaneously increasing the production of its own anti-inflammatory metabolites. In fact, combining omega-3 and omega-6 LC-PUFA supplementation may be more beneficial for inflammatory skin conditions than omega-3 or omega-6 LC-PUFAs alone⁽¹³⁹⁾.

Omega-3 LC-PUFAs can also reduce UV damage in keratinocytes by mimicking calorie restriction to reduce inflammation and improve cell survival⁽¹⁴⁰⁾. The overall effect may enhance skin longevity.

6.11 Omega-3s - Eicosapentaenoic acid and Docosahexaenoic acid

Our bodies naturally produce some EPA and DHA, but the amount is too small and irregular to ensure optimal function, with DHA synthesis being the most affected and males being particularly disadvantaged^(141, 142). In addition, limited storage of the omega-3 fatty acids in body fat suggests that a continuous dietary supply is needed⁽¹⁴³⁾.



PRO TIP

GOOD TO KNOW

EPA may work better than DHA to improve skin barrier function and inflammation^(133, 145)

Fish oil supplementation improves or reduces the severity of many skin problems including wrinkles and age spots caused by photo-aging, skin cancer development, dermatitis, and poor wound healing. Such skin stabilizing and protective effects are attributed to its EPA and DHA content⁽¹⁴⁰⁾. They reduce skin inflammation⁽⁷⁵⁾ by

decreasing production of pro-inflammatory substances⁽¹⁴⁴⁾ and regulating the production of enzymes involved in inflammation, cell survival and aging. In addition, they can affect the synthesis and activity of substances that promote wound healing⁽¹⁴⁰⁾.

Studies suggest that EPA may work better than DHA to increase skin ceramide levels which improves barrier function and inflammatory status^(133, 144). One study found that EPA increased the type and amount of ceramides within human skin grown in cell culture, while DHA did not⁽¹³³⁾. A follow-on study where healthy volunteers ages 18–60 years had their skin exposed to UV-radiation, found EPA worked better than DHA to reduce proinflammatory substances⁽¹⁴⁵⁾.





Ongoing Research

Human Population Studies

High dietary EPA and DHA intake protects from both UVB-induced damage which causes sunburn and photo-aging^(75, 146, 147) and early warnings of skin cancer⁽⁷⁵⁾. In addition, higher intake decreases risk of developing certain types of skin cancers. For example:

- A 20-year study of Inuit who typically eat a fish-rich diet, found low rates of melanoma and nonmelanoma skin cancer⁽¹⁴⁸⁾.
- In 20,785 women followed for 4.5 years, higher EPA/DHA intake lowered risk of malignant melanoma by 80%⁽¹⁴⁹⁾.

Other studies link higher blood EPA and DHA levels to higher levels of substances that suppress tumors within the epidermis and basal skin layers⁽¹⁵⁰⁾, and higher blood EPA and omega-3/6 ratio is associated with lower squamous cell carcinoma incidence⁽¹⁵¹⁾.

Human Clinical Studies

Prevention of skin photo-aging: Roughly 4 g daily of EPA alone for 3 months⁽¹⁴⁸⁾, or as little as 900 mg of EPA combined with 500-1200 mg of DHA daily⁽¹⁵²⁻¹⁵⁵⁾ for 4 weeks⁽¹⁵⁵⁾ to 6 months⁽¹⁵³⁾, significantly increased UV-induced sunburn threshold. That is, the person was able to withstand “sun-like” exposure for a longer period before developing a “sunburn”. Within many of these studies, resistance to sunburn increased progressively throughout treatment, but fell 10 weeks after treatment stopped, indicating that constant supplementation is needed for continuous protection. This enhanced efficacy with prolonged use is consistent with the results obtained using 4 capsules of Bend Beauty’s Renew + Protect providing 1050 mg EPA + 350 mg DHA, plus vitamin D, lutein, and zeaxanthin for 8 weeks⁽¹⁴⁶⁾. Most of these studies were R, DB, PC trials⁽¹⁵⁶⁾.

Considering how well omega-3s protect against UV skin damage, and our population wide deficiency of these nutrients, leads me to think that nearly the entire North American population could benefit from photo-protection with omega-3 supplements⁽¹⁴⁶⁾.

Atopic eczema/dermatitis:

Treatment with 1800 mg of EPA per day for 12 weeks significantly improved scale, itch, and overall subjective severity⁽¹⁵⁷⁾, while 5400 mg of DHA daily for 8 weeks⁽¹⁵⁸⁾ or 12 weeks⁽¹⁵⁹⁾ reduced symptoms severity in R, DB, PC trials.

Psoriasis: 8 weeks supplementation with 1122 mg EPA + 756 mg DHA reduced the overall symptoms, with itch responding most rapidly⁽¹⁶⁰⁾.

Of the 80 patients treated, 7 were completely healed, 13 were more than 75% healed and only 14 had no improvement. Omega-3s also reduce elevated blood lipids and kidney side effects associated with retinoid and

cyclosporine therapy respectively⁽¹⁶¹⁾, and so are an attractive add-on treatment for psoriasis.

Acne: In R, DB, PC trials, treatment with 2000 mg per day of EPA + DHA significantly improved inflammatory and non-inflammatory acne lesions in people with mild to moderate acne⁽¹⁶²⁾. In addition, omega-3s reduced side effects of isotretinoin acne treatment⁽¹⁶³⁾.

A recent systematic review assessing the quality of scientific evidence supporting the impact of omega-3 LC-PUFAs on various skin conditions from 38 studies, concluded they are safe, low cost, simple to take supplements, that may benefit patients wishing to improve inflammatory skin conditions. They are particularly valuable for systemic UV photoprotection, and to reduce both the number of inflammatory lesions and the severity of side effects associated with isotretinoin use in acne⁽¹⁶⁴⁾.

6.1.2 Omega-6s – Linoleic acid and Gamma-linolenic acid

Higher LA intake is associated with fewer age associated wrinkles, and less dryness and skin atrophy according to the National Health and Nutrition Examination Survey that included 4025 women aged 40–74 years⁽³⁾. However, LA supplementation is largely ineffective to treat various skin ailments other than overt EFA deficiency, because skin does not have the enzyme needed to convert LA to GLA, which is its bioactive metabolite. In addition, certain people such as those with atopic eczema, have unique genetic polymorphisms that slow their conversion of one fatty acid to another. Thus, internal production of GLA may be hampered even in the presence of adequate dietary LA⁽¹³⁸⁾, which creates a scenario where GLA supplementation may be advantageous.



Ongoing Research

Human Clinical Studies

Supplementation with GLA-rich borage oil and evening primrose can restore a defective epidermal barrier, to normalize excessive TEWL and improve skin smoothness in healthy people and those with atopic eczema⁽¹³⁸⁾.

Atopic eczema: To date, at least 5 meta-analyses and/or systematic reviews have evaluated the impact of GLA on atopic eczema⁽¹⁶⁵⁻¹⁶⁹⁾. Overall, these studies show that progressive tissue fatty acid changes accompany symptom improvements that can exceed those of conventional medications. Studies published subsequently showed that GLA supplementation:

- Improves symptoms within 8 weeks while increasing blood levels of GLA and AA in a dose dependent manner⁽¹⁷⁰⁾
- Increases GLA levels while simultaneously improving symptoms⁽¹⁷¹⁾.
- Improves barrier function, especially in those with high levels of pro-inflammatory substances and/or low levels of anti-inflammatory ones⁽¹⁷²⁾.

Healthy skin: Many PC studies show that GLA can improve the structure and function of healthy skin. Twelve weeks treatment with 345 mg per day significantly improved skin moisture, water loss, elasticity, firmness, fatigue resistance and smoothness by 13, 8, 5, 17, 14 and 22% respectively⁽¹³⁸⁾, while 475 mg per day significantly decreased water loss and improved skin moisture, smoothness, and scaling⁽¹⁷³⁾. These benefits reduce the appearance of wrinkles and provide a more youthful looking skin. Similar benefits were achieved when skin was irritated with a strong detergent prior to GLA treatment, indicating that GLA can both repair damaged skin as well as improve healthy skin⁽¹⁷⁴⁾.

Acne: GLA can reduce inflammatory lesions and sebum secretions associated with acne⁽¹⁷⁵⁾. In a 10-week R, DB, PC trial where subjects with mild to moderate acne, took either an omega-3 fatty acid supplement providing 2,000 mg of EPA+DHA, borage oil providing 400 mg of GLA daily or a placebo, both omega-3 and GLA supplementation decreased inflammatory and non-inflammatory acne lesions⁽¹⁶²⁾.

6.1.3 Polyunsaturated Fatty Acids and Longevity

The impact of LC-PUFAs on longevity is a bit of a balancing act. On the one hand they could provide life preserving benefits by reducing inflammation and providing brain specific benefits⁽¹⁷⁶⁾. On the other hand, they are prone to oxidative damage that contributes to mitochondria damage⁽¹⁷⁷⁾ and subsequently to cell senescence or death, which has the potential to reduce longevity. Despite this, biological systems that have efficient detoxifying systems benefit from increased PUFA levels, especially if they are omega-3 LC-PUFAs, which increase their ratio of omega-3: omega-6. Since lower omega-6 PUFA levels activate autophagy and increase life span, a higher ratio of omega-3 to omega-6 would likely do the same thing⁽⁵⁴⁾. The right balance is everything!



Ongoing Research

Human Studies

A study in elderly nursing home residents found those with higher blood DHA levels lived longer than those with less. Since blood LC-PUFA levels mainly depend on one's eating habits, this essentially means that eating more DHA could make you live longer⁽¹⁷⁸⁾.

An expert opinion on the merits of DHA and EPA in aging says they can help regulate inflammation in various age-associated conditions to improve function and outcomes. However, variables in dose, treatment durations, initial omega-3 LCPUFA status, intake of other nutrients, etc. within existing clinical trials, make definitive conclusions difficult⁽¹⁷⁹⁾. Fortunately, further trials are ongoing.

Currently, the DO-HEALTH multinational clinical trial is testing the impact of omega-3s on longevity. It includes four groups of healthy aging European seniors treated with one of the following:

- Omega-3 fatty acids (EPA + DHA) 1000 mg per day
- Vitamin D 2000 IU per day
- 30-minute of home exercise (strength versus flexibility), three times per week
- All three combined

Measures of healthy aging including blood pressure, bone health, physical and mental performance, immune function, etc. are being tested before and after 3 years of treatment⁽¹⁸¹⁾. I cannot wait to see the results.



PRO TIP

FOOD PAIRING

Increasing EPA intake and ultimately EPA blood levels may enhance mood.

Evidence is so compelling that the 2019 International Society for Nutritional Psychiatry Research Practice Guidelines for Omega-3s in the Treatment of Major Depressive Disorder, recommends specific doses for certain individuals⁽¹⁸⁰⁾. Improving mood could benefit both skin and longevity through the Brain-Skin Axis.

6.2 Vitamin C

Vitamin C, also called L-ascorbic acid, is a powerful, water soluble antioxidant that helps protect cells from free radical damage and is necessary for collagen synthesis⁽¹⁸²⁾.

Daily vitamin C intake is essential for us because we cannot make it internally⁽¹⁸³⁾. The best food sources are fruits and vegetables including citrus fruits, tomatoes, potatoes, red and green peppers, kiwifruit, broccoli, strawberries, Brussels sprouts, and cantaloupe⁽¹⁸⁴⁾.

However, the vitamin C content of food falls upon storage and cooking^(184, 185).

Although today vitamin C deficiency is rare in developed countries, inadequacy can occur in risk groups including:

- Smokers and those exposed to secondhand smoke, where more vitamin C is needed to combat increased oxidative stress. In fact, smokers need 35 mg more vitamin C daily than non-smokers⁽¹⁸⁴⁾.
- People who have limited food variety, including some elderly, alcohol or drug abusers, food faddists, people with mental illness and, occasionally, children⁽¹⁸⁴⁻¹⁸⁸⁾.

Vitamin C is rich in Acerola (*Malpighia sp.*) fruit that is found throughout Central America and northern parts of South America. Acerola and extracts made from it, also contain many bioactive phytochemicals, including carotenoids and polyphenols. A human study shows that when acerola juice is taken, vitamin C absorption into blood increases, and urinary excretion decreases, which suggests improved vitamin C bioavailability from this source⁽¹⁸⁹⁾.

Vitamin C is the most important water-soluble antioxidant. It can neutralize free radicals from a variety of sources and is therefore involved in photo-protection and prevents photo-damage. It also recycles vitamin E which is the main fat-soluble antioxidant and protects membranes from oxidative damage by preventing lipid peroxidation and abnormal bonding between collagen fibers that accelerates skin aging⁽⁷⁵⁾.

Normal skin contains high amounts of vitamin C^(182, 190), but those levels decrease with age⁽¹⁹¹⁾ and exposure to sunlight or pollutants such as cigarette smoke and



Ongoing Research

Human Studies for Skin

People with higher dietary vitamin C have better looking skin, in particular less wrinkles and dryness⁽¹⁹⁶⁾. On the other hand, people with skin inflammation such as those with atopic eczema, have lower vitamin C status than unaffected individuals, which may reflect a higher requirement for vitamin C's antioxidant effects due to inflammation⁽¹⁸²⁾.

To date, only a few studies have tested the effects of vitamin C supplementation alone on skin health. They reported increased blood and/or skin vitamin C levels^(192, 199) accompanied by enhanced antioxidant capacity⁽¹⁹⁹⁾. When combined with vitamin E, it reduces sunburn sensitivity⁽²⁰⁰⁾ and combined with marine protein, grape seed extract, zinc, and tomato extract, it improves redness and overall appearance⁽²⁰¹⁾, while mixed with vitamin E and zinc, it enhances wound healing⁽²⁰²⁾.

Human Studies for Longevity

To date, no clinical studies have investigated the impact of vitamin C supplementation on longevity. One comparing antioxidant status in healthy centenarians, elderly subjects aged 80-99 years, elderly subjects aged 60-79 years, and adults less than 60 years, found no difference in their vitamin C levels. However, centenarians had the highest levels of vitamins A and E, and that was associated with their extreme longevity. Since vitamin C is needed to recycle vitamin E, it is likely to have had a part to play in their survival⁽²⁰³⁾.

ozone⁽¹⁸²⁾. Fortunately for us, vitamin C supplementation effectively increases vitamin C levels in skin^(192, 193).

Skin needs vitamin C for collagen synthesis⁽³⁾ where it contributes to its strength, integrity, and wound healing capacity. It stimulates collagen production, is part of the

enzyme that forms bonds between and stabilizes collagen fibers, promotes fibroblast migration, and replication⁽⁷⁵⁾ and protects against infection⁽¹⁹⁴⁾. Recently, its anti-angiogenic properties⁽¹⁹⁵⁾ have highlighted its potential to reverse or prevent skin cancers⁽⁷⁵⁾.

6.3 Vitamin D

Vitamin D is a fat-soluble vitamin that is mostly produced within our skin on exposure to UVB radiation from the sun but can also be obtained from some animal derived foods including fish, eggs, liver, and supplements⁽²⁰⁴⁾. Vitamin D status depends largely on the amount of



PRO TIP

GOOD TO KNOW

Severe vitamin D deficiency affects 5.9% of US, 7.4% of Canadian and 13% of European populations, while deficiency impacts 24%, 37% and 40% of these populations, respectively⁽²⁰⁶⁾.

time spent outdoors during the day, which itself depends on mobility, institutionalization, work hours and environment, weather, and cultural influences upon skin exposure⁽²⁰⁵⁾. In addition, in some countries during

Ongoing Research

Human Studies for Skin

People with higher vitamin D status have less systemic inflammation⁽²¹⁰⁾. In those with atopic eczema, lower vitamin D status is associated with worse symptoms⁽²¹¹⁾, while vitamin D supplementation significantly improves the extent and severity of symptoms⁽²¹²⁾.

A systematic review of studies including children with atopic dermatitis, reported significant improvement in symptom severity following vitamin D supplementation in 67% of those studies⁽²¹³⁾. Other supplementation trials found that 88% of people with psoriasis had some improvement while 26, 36, and 25%, experienced complete, moderate, and slight improvements, respectively⁽²¹⁴⁾, and 55% of people with chronic hives had quality of life improvements⁽²¹⁵⁾.

Human Studies for Longevity

As we age, our skin's capacity to make vitamin D declines along with its protective effects due to poor nutrition, excess sun exposure, and genetic variability. Therefore, ensuring we get enough vitamin D becomes more important as we age⁽³⁾.

Vitamin D may partly control our rate of aging because it regulates many body processes that impact aging including calcium and ROS signaling, mitochondrial dysfunction, inflammation, oxidative stress, epigenetic changes, DNA damage, and autophagy. Therefore, vitamin D deficiency could negatively impact or contribute to these processes, which could accelerate aging, as well as increase development of age-related diseases such as AD, Parkinson's disease, multiple sclerosis, and CVD. On the other hand, people with adequate vitamin D may be protected against these age-related diseases while their aging is slowed⁽²¹⁶⁾. The impact of vitamin D on aging is now being tested in a multinational clinical trial called DO-HEALTH⁽¹⁸⁰⁾. The details are described in Part 6.1.3 Polyunsaturated Fatty Acids and Longevity.



the winter, there is not enough UVB radiation of the appropriate wavelength needed to make vitamin D. Consequently, many of us are vitamin D deficient. However, you can maximize your vitamin D absorption from foods like fatty fish or egg yolk⁽³⁾, or supplements, by eating healthy fats and maintaining a healthy gut microbiome.

Vitamin D is critical for proper immune function and it regulates

hundreds of genes in nearly every tissue within your body, including skin where it⁽²⁰⁷⁾:

- Inhibits cell division which prevents actinic keratosis (precancerous lesions) and skin cancer
- Stimulates cell specialization which helps form the stratum corneum
- Promotes immune defenses that protect the body from foreign invaders including bacteria, etc.

- Regulates the hair follicle cycle that controls hair growth
- Suppresses tumor formation

Vitamin D reduces UV-induced damage⁽²⁰⁸⁾ and inflammation⁽²⁰⁸⁻²¹⁰⁾ that contributes to skin aging including wrinkles, sunburn, and light-associated suppression of the immune response⁽²⁰⁸⁾.

6.4 Vitamin K2

Vitamin K is a fat-soluble vitamin that is essential for blood clotting and helps to bind calcium in bone. It comes in a variety of different forms. Vitamins K1 and K2 are natural compounds, whereas vitamin K3 is artificial⁽²¹⁷⁾. Vitamin K1 is abundant in green leafy vegetables such as spinach, cauliflower, and cabbage⁽²¹⁸⁾. Vitamin K2 is found in beef liver, egg yolk, dairy products, and fermented foods like Nattō and is also produced by good intestinal bacteria⁽²¹⁸⁾.

Vitamin K2 deficiency can cause loss of bone mass⁽²¹⁸⁾ and this can impact facial aging. However, vitamin K2 supplementation can restore mitochondria's ATP production, and increase the function of skeletal and cardiac muscle in trained athletes⁽²¹⁹⁾. This would be expected to help maintain lean body mass and may contribute to facial structure preservation.

Ongoing Research

Human Studies

Vitamin K insufficiency is associated with several age-related musculoskeletal diseases, including osteoporosis, blood vessel calcification⁽²¹⁸⁾, osteoarthritis, and sarcopenia⁽²¹⁷⁾. On the other hand, high vitamin K status is associated with muscle strength, large muscle mass, and high physical performance in people with sarcopenia. A systematic review of five R, PC trials in postmenopausal women, found that vitamin K1 supplementation significantly reduced the risk of fractures while vitamin K2 reduced fracture risk in some but not all studies⁽²²⁰⁾. Further research will clarify the extent of vitamin K's role in human longevity that is currently attributed to prevention and treatment of age-related musculoskeletal disorders⁽²¹⁷⁾.

Most clinical trials testing the effects of vitamin K on skin have used topical applications and those measuring the impact of oral vitamin K on skin health are lacking.



6.5 Silicon

Silicon (not to be confused with silicone), is the third most abundant trace element in our bodies⁽²²¹⁾. We eat 24-30 mg of silicon daily as silica, but our intake decreases with age. Therefore, it is important to make a conscious effort to ensure we get enough of this nutrient.

Our bodies must convert silica to individual silicon units called ortho-silicic acid to enable absorption and use⁽²²²⁾. Foods and supplements like

bamboo, horsetail, green beans, and beer are a rich source of this organic silica.

Silicon is found in our connective tissues, especially the aorta, trachea, bones, hair, nails, and skin, where it resides in the epidermis⁽²²²⁾. Higher silicon content in hair prevents hair loss and improves brightness, while soft and brittle nails can indicate a silicon deficiency⁽²²¹⁾.

Silicon increases collagen formation in bone forming cells and skin fibroblasts by stimulating enzymes needed to make bonds between collagen fibers⁽²²³⁾. It also helps to make hyaluronic acid, that combined with collagen and elastin, ensures skin flexibility, strength, and hydration⁽²²¹⁾. Silicon deficiency impairs synthesis of collagen and hyaluronic acid⁽²²²⁾.



Ongoing Research

Human Clinical Studies

R, DB, PC trials report improvements in skin, hair, and nails. One including women aged 40–65 years with photo-damaged facial skin who took 10 mg of silicon daily for 20 weeks, had significantly decreased depth and incidence of fine wrinkles, decreased skin roughness, and less brittle hair and nails⁽²²⁴⁾. Another including women with fine hair, given the same dose for 9 months, had better hair elasticity and less breakage resulting in thicker hair⁽²²⁵⁾. In addition, males and females aged 40 to 60 years, taking ortho-silicic acid and hydrolyzed marine collagen, had significantly improved skin texture, firmness, and hydration, and 80% of them were happy with their results⁽²²⁶⁾.

Silicon is also necessary for strong bones and the strength and flexibility of our arteries, which would impact overall body and cardiovascular health, and ultimately longevity. However, clinical studies measuring these effects are rare.

6.6 Collagen

You have already learned that if you don't have enough collagen or the right kind of collagen in your skin, it can affect its structure and appearance, and that collagen is produced within our bodies by fibroblasts and epithelial cells⁽²²⁷⁾. However, if you eat animal derived foods, you are also eating collagen⁽²²⁸⁾. That collagen can be absorbed into your blood stream and carried to your skin. Here, ingested collagen can stimulate the multiplication, movement, and activation of fibroblasts⁽²²⁹⁾, which increases skin collagen production including fiber density and diameter, activates UVA radiation protection, and increases hyaluronic acid production⁽²²⁷⁾.

Hydrolyzed collagen included within supplements, consists of small peptides/pieces of protein, and may be derived from pig and cow hides⁽²³⁰⁾ or fish skin⁽²²⁷⁾.



Ongoing Research

Human Studies – Skin

Many human clinical studies report the following skin benefits of supplementing with hydrolyzed collagen⁽²²⁸⁾:

- Enhanced hydration/moisture⁽²³¹⁻²³³⁾
- Improved elasticity⁽²³²⁻²³⁴⁾, in both sun exposed and protected areas⁽²³⁵⁾
- Decreased visible fine lines⁽²²⁷⁾ and wrinkles^(227, 231-233)
- Improved smoothness⁽²³³⁾
- Increased radiance⁽²³²⁾
- Increased Type I procollagen production⁽²³⁶⁾
- Increased skin firmness⁽²³²⁾ and density⁽²³⁷⁾
- Enhanced skin microbiome⁽²³⁸⁾, which speeds wound healing^(239, 240)

When combined with antioxidants such as vitamin C, which is needed for collagen production, it:

- Improved elasticity^(241, 242)
- Improved skin texture⁽²⁴³⁾
- Reduced skin dryness^(242, 244)
- Improved skin architecture, including collagen fiber organization⁽²⁴²⁾
- A bonus: It reduced joint pain by 43% and improved joint mobility by 39%⁽²⁴²⁾

Taking hydrolyzed collagen can also thicken hair⁽²⁴¹⁾, improve nail disorders such as brittle nails⁽²⁴⁴⁾, may smooth cellulite appearance⁽²³⁶⁾, and may prevent *Staphylococcus aureus* infections in skin⁽²⁴⁵⁾.

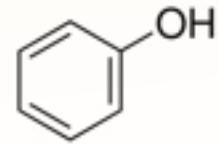
Human Studies - Longevity

Hydrolyzed collagen supplementation can help with weight loss⁽²²⁷⁾ partly because it is more filling than other collagen types⁽²⁴⁰⁾, reduce muscle loss, help balance blood sugar levels⁽²⁴⁶⁾, lower bad and increase good cholesterol⁽²⁴⁷⁾, increase bone mineral density⁽²⁴⁸⁾, thereby reducing the risk of osteoporosis, and provide anti-inflammatory effects⁽²⁴⁹⁾. So, although we may eat this 'beauty protein' to slow skin aging, its benefits are much more than skin deep!

To date, no human studies have directly measured the effects of hydrolyzed collagen on longevity.

6.7 Polyphenols

Polyphenols are a diverse array of several thousand molecules having at least one phenol ring as their common feature. They include phenolic acids and flavonoids, such as flavanols and isoflavones, to name a few⁽³⁾. They are extremely abundant in plants, where they provide protection against UV radiation and pathogens. Polyphenol rich foods include fruits and vegetables, tea, coffee, red wine, cereals, chocolate, and dry legumes⁽³⁾.



Polyphenols are known as powerful antioxidants, but they can also alter the cell's balance between pro-oxidants and antioxidants. As antioxidants, they may improve cell survival, or conversely as prooxidants, they may induce apoptosis and prevent tumor growth^(3, 75).

Many polyphenols including green tea polyphenols, grape seed proanthocyanidins, resveratrol, and silymarin have antioxidant effects. This suggests their value for protection against sunburn and potentially UV radiation damage that contributes to increased skin cancer risk⁽⁷⁵⁾.



Ongoing Research

Human Studies – Skin

Many R, DB PC trials report skin benefits following supplementation with various polyphenols such as:

French maritime pine (*Pinus pinaster*): Bark, rich in flavonoids⁽²⁵⁰⁾, prevents UV-induced skin damage⁽²⁵¹⁾ through antioxidant effects⁽²⁵²⁾ several times more powerful than vitamin E and vitamin C⁽²⁵³⁾. It:

- Improves skin barrier function and maintains the extracellular matrix⁽²⁵¹⁾ by:
 - Reducing inflammation⁽²⁵⁴⁾
 - Increasing production of enzymes that break down elastin⁽²⁵⁴⁾
 - Stimulating hyaluronic acid and collagen production⁽²⁵⁵⁾
- Improves skin dryness, elasticity, smoothness, fatigue, and density⁽²⁵⁵⁾
- Reduces skin photo-aging including wrinkles and age spots^(251, 253, 256)

Quercetin: a flavonoid shown to reduce inflammatory substances in blood and increase internal antioxidants⁽²⁾. It also prevented fibroblast senescence in healthy people with accumulated skin photo-damage, inflammaging, and fibroblast and keratinocyte damage⁽²⁵⁷⁾.

Apple polyphenols: as little as two apples daily can increase arm microcirculation⁽²⁵⁸⁾. Apple polyphenols have also been shown to:

- Prevent UV-induced skin pigmentation including redness and melanin accumulation⁽²⁵⁹⁾
- Increase hair growth, weight, and keratin content by 118.3%, 37.3%, and 35.7%, respectively within 2 months in both males and females ranging in age from 30–83 years⁽²⁶⁰⁾.

Resveratrol:

- Neutralizes free radicals and increases the production of internal antioxidant enzymes⁽³⁾
- Reduces inflammation and protects against UVB and ROS-induced cell death by mimicking calories restriction⁽²⁾
- Dose-dependently increases cell proliferation and inhibits collagen breakdown⁽³⁾

Oral resveratrol has poor bioavailability and therefore most human studies report its topical effects⁽²⁶¹⁾. However, oral treatment with its metabolite, piceatannol, significantly increased moisture content and reduced TEWL, perspiration and physical fatigue in healthy Japanese women⁽²⁶²⁾.

Pomegranate extract contains anthocyanins that are further metabolized by the microbiota. Therefore, its benefits could be derived from its components, plus others made from them by gut bacteria. Pomegranate extract:

- Significantly reduces UVB-induced skin damage ⁽²⁶³⁾
- Reduces sunburn susceptibility, pigmentation, and redness. The 20-40-year-old women in this study also reported facial “brightness” and fewer “stains and freckles” ⁽²⁶⁴⁾.

Aloe vera leaf gel (powder) can:

- Improve wrinkles in normal aging ⁽²⁶⁵⁾, photoaged ⁽²⁶⁶⁾ and dry skin ⁽²⁶⁷⁾

Human Studies – Longevity

Longevity researchers have interest in polyphenols because their antioxidant properties might help prevent diseases associated with oxidative stress, such as cancer, CVD, and neurodegenerative diseases. In addition, their calorie restriction mimicking effects may reduce aging by slowing cell metabolism, energy expenditure, mitochondrial activity and thus total ROS generation and oxidative stress load within cells ⁽³⁾.

French maritime pine (*Pinus pinaster*) bark's effects on aging are being tested in the Australian Research Council Longevity Intervention study including 465 people being treated for a year to determine its impact on cognitive/mental performance and cardiovascular health ⁽²⁶⁹⁾. In addition, brain imaging to detect brain structure and function changes, assessment of brain chemicals indicating oxidative stress associated with aging, and faecal biomarkers indicating changes to gut microflora will help determine if and what gut microbiota changes are associated with mental (e.g., attention, processing speed, memory) and mood improvements ⁽²⁷⁰⁾. I can hardly wait to see those results!

Quercetin: Countless longevity research models show quercetin can decrease senescent cell numbers, which typically drive the aging process and lead to the development of many neurodegenerative diseases,

- Improve elasticity in photoaged/damaged skin ^(265, 266)
- Improve moisture in normal aging ⁽²⁶⁵⁾ and dry skin ^(267, 268)
- Reduce TEWL in normal skin ⁽²⁶⁸⁾
- Increase barrier function, and collagen content in normal aging skin ⁽²⁶⁵⁾
- Increase collagen production in normal skin ⁽²⁶⁷⁾ and photo-protected skin ⁽²⁶⁶⁾.
- Decrease collagen degrading enzymes in photo-protected skin ⁽²⁶⁶⁾.
- Reduce face redness and itching on inner and outer arms in people with healthy skin ⁽²⁶⁸⁾

including AD, other dementias, and Parkinson's disease. To date, no human studies have determined the impact of quercetin on neurodegenerative disease development. However, an upcoming study in men and women over age 65 with mild to moderate AD being treated with quercetin for 2 years, will monitor brain plaque formation associated with the disease, senescent cell accumulation, brain cognition, physical performance, and blood markers for oxidative stress, inflammation, glucose and insulin control, and bone turnover ⁽²⁷²⁾. It is another one to watch for!

Apple polyphenols: There is a lot of truth in the saying “An apple a day keeps doctors away.” Their intake has been associated lower risks of CVD, elevated cholesterol levels, and various cancers. For example:

- The Women's Health Study, involving roughly 40,000 women followed for about 7 years, found less CVD was associated with eating more apples ⁽²⁷³⁾
- The Iowa Women Study of nearly 35,000 women showed that eating apples was associated with fewer deaths from coronary heart disease in postmenopausal women ⁽²⁷⁴⁾
- Several studies have linked apple intake with lower risk of cancers, especially lung cancer, but that effect was better in women than in men ^(275, 276)

These longevity enhancing effects of apples have been attributed to their high polyphenol content. Subsequent

studies show that apple polyphenols normalize blood sugar control in high-normal and borderline diabetic subjects⁽²⁷⁷⁾ and improve the function of blood vessel linings in individuals at risk for CVD⁽²⁷⁸⁾.



PRO TIP

HELP FOR OUR HONEYBEES

Bees suffer toxin overload and the resulting oxidative stress just like us. Consequently, colony losses often occur due to insecticide and fungicide exposure that contributes to their toxin load. Quercetin reduces the associated xenobiotic stress, and in doing so increases their longevity⁽²⁷¹⁾.

Some preclinical longevity research models report up to 10% increases in lifespan that accompany higher production of internal antioxidant enzymes⁽²⁷⁹⁾, while others report genome and mitochondria protective effects that sustain cell survival⁽²⁸⁰⁾. However, to date, no similar studies have been completed in humans.

Resveratrol is one of the most well-known, and highly researched caloric restriction mimetic (i.e., a substance that mimics the benefits of calorie restriction without having to reduce calories)⁽²⁸¹⁾. In this capacity it has anti-cancer effects, aids cardiovascular health by improving circulation and lowering levels of bad cholesterol and inflammatory substances, and benefits AD by breaking down damaged proteins within the brain⁽³⁾. Although it has improved

brain blood flow and cognition in postmenopausal women⁽²⁸²⁾, recent systematic reviews and meta-analysis report no significant improvements in memory, cognitive performance, or mood⁽²⁸³⁾.

To date, the “jury is still out” pertaining to the magnitude of impact that resveratrol may have on human longevity. However, it has been suggested that the combined impact of resveratrol’s caloric restriction mimetics with other antioxidants within the Mediterranean diet, may account for that diet’s overall healthy aging effects⁽²⁸⁴⁾.

Pomegranate extract can help repair damaged mitochondria under both normal and stressed condition, and in doing so, can help to preserve life⁽²⁸⁵⁾. Various human studies report potential longevity enhancing effects including:

- Brain function preserving effects, where it sustained visual learning ability in middle-aged and older adults⁽²⁸⁶⁾
- Cardiovascular health benefits including blood pressure lowering effects⁽²⁸⁷⁾
- Cancer preventive effects, where prostate cancer patients with defective antioxidant enzyme function had slower rises in prostate antigen; a measure of disease progression⁽²⁸⁸⁾

To date, no studies have directly measured the impact of pomegranate on human longevity. However, many longevity research models attribute observed extended lifespan to improved antioxidant defense mechanisms⁽²⁸⁹⁾.

Aloe vera leaf gel (powder) can increase urinary secretion of tobacco carcinogens while improving liver function in smokers⁽²⁹⁰⁾. These detoxifying effects would be expected to enhance longevity. However, to date no studies have quantified its impact on human lifespan/healthspan, although longevity research models have reported extended lifespan through increased antioxidant enzyme activity⁽²⁹¹⁾.

6.8 Carotenoids

People with high carotenoid levels in their skin look young for their age, while those with lower amounts appear older⁽²⁹²⁾.

Carotenoids, including xanthophylls and carotenes, are fat-soluble natural colorants within our diet; hence they are best absorbed when eaten with fat. They are highly effective antioxidants producing photoprotective effects⁽³⁾.

- Xanthophylls, including lutein, zeaxanthin and astaxanthin are known to protect our eyes from sunlight. They are sometimes yellow and are found in kale, spinach, corn, summer squash, and egg yolks⁽³⁾.
- Carotenes, including β -carotene and lycopene are deeper orange in color and are found in carrots, cantaloupe, sweet potatoes, winter squash, papaya, and tangerines⁽³⁾.

Some carotenoids including β -carotene can be made into vitamin A and so are “functionally essential”, because vitamin A is essential for human growth and especially for eye health. The active form of vitamin A, retinoic acid, is involved in fat and energy metabolism and is needed to enable glucose uptake into muscle. The only dietary sources of vitamin A are milk, liver, and eggs – if you eat those foods⁽²⁹³⁾. However, vitamin A is typically not used as an oral supplement because it can accumulate in the body and is toxic at relatively low levels^(294, 295).



Ongoing Research

Human Studies – Skin

Your skin contains carotenoids, such as α -, γ -, β -carotene, lutein, zeaxanthin and lycopene, which protect the living cells from oxidation. In fact, their levels within your skin reliably indicate your overall antioxidant status. But even more intriguing, people with high skin levels of carotenoids look young for their age, whilst individuals with lower carotenoid levels appear older⁽²⁹²⁾.

Many R, DB PC trials report skin benefits following supplementation with various carotenoids, for example:

β -Carotene was well established through a 2008 meta-analysis of many R, DB PC to protect against sunburn, and those benefits increase with continued use⁽²⁹⁶⁾. Since then, a study where healthy women over age 50 years took either 30 or 90 mg/day of β -carotene for 90 days, surprisingly showed the lower dose to be more effective to increase collagen synthesis and reduce DNA damage, but only the high dose decreased sunburn reaction⁽²⁹⁷⁾. This highlights the need to follow dosage recommendations on product labels for their specific purposes when you are using supplements.

Lutein and Zeaxanthin are essential nutrients because they cannot be made internally⁽²⁹⁸⁾. Many studies show they prevent skin wrinkles and improve skin hydration⁽⁷⁵⁾ by improving:

- Skin lipid content, hydration, elasticity, and sunburn threshold⁽²⁹⁹⁾ in people with normal skin
- Skin tone and luminance/brightness in people with mild to moderately dry skin⁽³⁰⁰⁾.

All these benefits enhance the structure and function of skin resulting in less wrinkles and more youthful appearance. In addition, lutein prevented not only UVA and UVB skin damage, but it also protected against subsequent



UVA-induced gene expression that contributes to photo-aging, cancer formation and dermatosis in healthy volunteers⁽³⁰¹⁾.

Lycopene: Human skin is relatively enriched in lycopene that is well known to protect against sunburn by increasing skin's defense against UV damage⁽³⁾. Studies show it:

- Reduces UV-induced sunburn in volunteers⁽³⁰²⁾
- Protects against UVA and UVB skin damage, and subsequent UVA-induced gene expression that would contribute to photo-aging, photo-carcinogenesis, and photo-dermatoses in healthy volunteers⁽³⁰¹⁾.

Astaxanthin is a marine algae⁽³⁰³⁾ and crustacean⁽³⁰⁴⁾ derived antioxidant that benefits skin homeostasis through photoprotection, antioxidant, anti-inflammatory⁽³⁰³⁾, immunomodulating, and DNA repair effects⁽³⁰⁵⁾. It is considered by some, to be one of the most powerful carotenoids because it can scavenge and quench ROS and free radicals in both the inner and outer layers of cell membranes, unlike most antioxidants,

which reside either in the inner (vitamin E and β -carotene) or the outer side of the membrane (vitamin C)⁽²⁹³⁾.

Studies show it:

- Improved crow's feet wrinkles, elasticity, TEWL, as well as moisture content and sebum oil level in the cheek zone in healthy men⁽³⁰⁶⁾
- Protected from sunburn and reduced moisture loss in skin areas exposed to UV radiation, and improved roughness and texture in unexposed areas in healthy people; indicating it both protects against UV-induced skin deterioration and helps maintain healthy skin⁽³⁰⁷⁾
- Combined with collagen hydrolysate, it improved elasticity and TEWL, and increased production of collagen making enzymes while decreasing those that break down collagen. In essence, the combination of ingredients improved skin elasticity and barrier integrity in healthy people with moderately photoaged skin⁽³⁰⁸⁾



PRO TIP

GOOD TO KNOW

Some scientists believe that nutrient deficiencies sway the body towards making survival associated proteins rather than those needed to protect against future damage (i.e., longevity proteins). Nutrients required for proper function of longevity proteins are called longevity vitamins, and include lutein, zeaxanthin, lycopene, α - and β -carotene, astaxanthin and others⁽³¹²⁾.

Human Studies - Longevity

Higher dietary intake of green and yellow vegetables that are rich in carotenoids^(309, 310) and carotenoids in general, are associated with lower risk for many cancers in different tissues⁽³¹¹⁾. This observation alone should be enough to substantiate their beneficial impact on longevity. However, that is not the whole story.

β -Carotene: Two meta-analyses of R, DB, PC trials report that β -carotene does not reduce cancer risk, and in some limited circumstances increased it as follows:

- Combined results of 9 studies found no cancer preventive effects, but instead increased risk of lung and gastric cancer at doses of 20-30 mg/day in smokers and asbestos workers⁽³¹³⁾
- Combined results of 6 studies found it did not prevent either cancer incidence or deaths, and increased risk of urothelial, especially bladder cancer, and marginally increased cancer risk in current smokers⁽³¹⁴⁾

This highlights the importance of knowing the right circumstance and purpose for supplement use.

Lutein and Zeaxanthin: Few human trials have studied the direct link between lutein/zeaxanthin intake and age-related conditions, although one open trial in healthy Japanese people ages 26–57 years, found that supplementation increased skin carotenoid levels while decreasing macular pigment that contributes to age-related macular degeneration⁽³¹⁵⁾. To date, no human studies have quantified their impact on human longevity, but some longevity research models report that lutein can extend lifespan⁽³¹⁶⁾.

Lycopene: Low blood levels of lycopene are associated with death from any cause. However, its direct protective impact on age-related conditions such as AD is still unclear⁽³¹⁷⁾. To date, no human studies have measured the impact of lycopene on human longevity. Longevity research models show it has no negative impact on lifespan, but there is no clear proof that it increases survival beyond expected⁽³¹⁸⁾.

Astaxanthin may protect against age-associated loss of blood sugar control, muscle maintenance and mitochondrial function, and therefore could help maintain longevity⁽²⁹³⁾. It is most revered for its brain protective effects because it activates a gene that critically controls brain cell fate and function, and it can robustly mimic calorie restriction. Experimental evidence shows it slows brain aging by reducing oxidative damage to lipids, protein, and DNA, and protecting mitochondrial functions^(293, 319). To date, no human studies have confirmed that astaxanthin increases longevity. However, many longevity research models support its role in that regard⁽³¹⁹⁾.



6.9 Probiotics and Prebiotics

You learned in Part 4.1 The Gut-Skin Axis, that our gut microbiome impacts how foods and supplements influence our body functions. Our gut microbiota communicates with us through various biomolecules, nutrient signaling and sensing pathways, and epigenetic mechanisms⁽³²⁰⁾. This means we can harness and control our microbiome⁽³²¹⁾ through dietary manipulation, to achieve, maintain or restore favourable balance in our gastrointestinal tract, that will also maintain and improve our overall health⁽³²²⁾, and could impact our longevity. The easiest ways to do that is by consuming probiotics and/or prebiotics.

Prebiotics are fibers such as carbohydrates and resistant starches that are not digested in your stomach and small

intestine⁽³²³⁾. They can be either soluble, which means they are fermented in the colon, or insoluble which means they provide bulk to your stool but are not otherwise digested⁽³²⁴⁾. The fermentation is carried out by your microbiome. This bacterial-dependent process, although not considered to be “human digestion”, can produce products that provide us with nutritional or functional benefits which⁽³²⁵⁾:

- Improve the environmental conditions within the colon
- Enable growth of more healthful gut microbes
- Are absorbed and transported through the bloodstream to modify processes in other body locations



Ongoing Research

Human Studies – Probiotics for Skin

Probiotic supplementation, that is, taking live beneficial gut bacteria, can⁽³²⁶⁾:

- Decrease TEWL by improving skin barrier function
- Decrease skin sensitivity
- Improve skin elasticity and increase hydration after UV damage
- Reverse UV-induced skin aging through its immune modulating effect
- Prevent AD in high-risk infants
- Significantly reduce blood levels of inflammatory substances in psoriasis patients

However, probiotics have largely failed to significantly improve conditions such as atopic dermatitis/eczema, that are associated with abnormal gut microbiome composition⁽³²⁷⁾; perhaps because their effectiveness depends on if the right type and amount of food is available for them to survive and flourish. In fact, a meta-analysis confirmed that pre-and probiotic combinations can prevent and improve atopic eczema⁽³²⁸⁾, while a systematic review, found that prebiotics alone were effective for eczema in atopic children, but probiotics were not⁽³²⁹⁾.

Human studies - Prebiotics for Skin

Prebiotics selectively stimulate growth of existing microbes within the host's intestine, unlike probiotics that must compete with them⁽³²²⁾. All prebiotics including partially hydrolysed guar gum, Acacia gum, etc., can significantly increase beneficial bacteria levels, in particular *Bifidobacterium*, and can enhance immune function by^(322, 326):

- Modifying chromosome structures to make immune function related genes more accessible for use
- Increasing numbers of white blood cells that play a role in the gut immune response
- Stimulating specific immune cells to activate additional immune responses
- Inhibiting production of proinflammatory substances
- Promoting production of anti-inflammatory substances

They can also⁽³²⁶⁾:

- Modify microbiome composition to replace harmful microorganisms with more beneficial ones

- Prevent pathogen invasion by binding to the intestinal lining, thereby preventing enter
- Suppress pathogen growth by secreting a protein that is toxic to many harmful bacteria
- Help restore impaired barrier function

Some of these effects may help people with inflammatory skin conditions including acne, atopic dermatitis, and psoriasis^(326, 328), but studies are scarce. To date, R, DB, PC trials report that:

- Fructo-oligosaccharides and galacto-oligosaccharides improve blood sugar and fat levels in women with mild to moderate acne. Although no measures of acne status were mentioned, this would be expected to help prevent acne because high glycemic diets tend to worsen acne⁽³³⁰⁾.
- Galacto-oligosaccharides decrease skin redness and pigmentation in healthy volunteers⁽³³¹⁾ and improve skin health by reducing TEWL and this decreased wrinkles in healthy adults⁽³³²⁾.

Human studies - Probiotics and Prebiotics for Longevity

Our gut microbiome changes with age and health status. For example, there are profound differences between the microbiomes of long-lived versus frail people⁽³³³⁾, where overall richness decreases, while a certain group of bacteria associated with frailty increases⁽³²⁰⁾. However, it is not clear if these differences are attributed to physiologic, inflammaging, or immune function changes, or if diet, medications, or chronic health conditions are also to blame.

Basic research models show that age-related gut dysbiosis can trigger an initial immune response and chronic low-grade inflammation, which leads to many age-related degenerative conditions, unhealthy aging, and reduced longevity. This implies that one's microbiome might drive one's rate of aging⁽³³⁴⁾. To date, only one R, DB, PC trial has studied the impact of probiotic supplementation

on immune function in the elderly. Although immune function characteristically declines with age, the treated subjects had improved immune function, decreased levels of pro-inflammatory substances and increased level of an antimicrobial substance⁽³³⁵⁾. These results confirmed that probiotic supplementation can enhance immune function that would be expected to contribute to improved health and possibly longevity.

To date, no human studies have measured the degree to which prebiotics may contribute to enhanced immune function that could impact human longevity. However, longevity research model studies suggest that pre- and/or probiotic interventions are worth investigating in this regard⁽³³³⁾.

6.10 Silymarin (Milk thistle)

Milk thistle (*Silybum marianum*) is the most well-researched plant in the treatment of acute and chronic liver disease with confirmed mechanisms of action^(336, 337) attributed to silymarin within its lipid/oil soluble seed extract⁽³³⁶⁾.

Within the liver, silymarin:

- Provides antioxidant protection by reducing ROS production⁽³³⁸⁾
- Reduces inflammation by reducing production of inflammatory substances⁽³³⁸⁾
- Prevents liver cell proliferation and tissue fibrosis⁽³³⁸⁾
- Improves blood sugar levels by preventing glucose synthesis from fats within the liver⁽³³⁹⁾
- Prevents entry of toxic chemicals into liver cells, which reduces liver damage⁽³³⁸⁾
- Stimulates formation and activity of enzymes involved in liver xenobiotic detoxification⁽³³⁸⁾
- Enhances liver function by reducing liver enzymes levels in liver diseases⁽³³⁸⁾
- Reduces liver fat accumulation, lobular inflammation, and fibrosis⁽³³⁹⁾

On a whole-body scale, silymarin lowers blood sugar by increasing muscle, fat, and liver's sensitivity to insulin.



Ongoing Research

Human Clinical Studies – Liver

Over 10,904 studies pertaining to the effects of silymarin in patients with various liver diseases have been published! A 2017 systematic review and meta-analysis of R, PC trials confirmed it can⁽³³⁸⁾:

- Improve liver enzyme function
- Reduce liver cell death and liver fibrosis
- Enhance blood sugar metabolism
- Improve lipid/fat metabolism including blood cholesterol and triglyceride levels
- Reduce liver fat accumulation
- Improve antioxidant status

Silymarin has been used to treat acute and chronic viral hepatitis, toxin-induced liver diseases⁽³³⁶⁾, mushroom poisoning⁽³⁴⁰⁾, non-alcoholic fatty liver disease⁽³⁴¹⁾, nonalcoholic steatohepatitis⁽³⁴²⁾, drug-induced liver injuries⁽³⁴³⁾, iron overload⁽³⁴⁴⁾, cirrhosis where it significantly reduces liver-related deaths, diabetics where it improves blood and insulin levels, cholesterol levels, and oxidative stress⁽³⁴⁵⁾, alcoholic associated cirrhosis where it improves blood sugar levels⁽³⁴⁶⁾, metabolic syndrome⁽³⁴⁷⁾ and liver cancer⁽³³⁹⁾.

Human Clinical Studies – Skin

Presumably, silymarin may reduce cancers⁽³³⁷⁾ including those in skin⁽³⁴⁸⁾ because it stimulates one's natural cancer defense that regulates the balance between cell death and cell survival⁽³³⁷⁾. It can also protect against chemically induced skin injuries, and reduces oxidative stress caused by UVA and UVB⁽³⁴⁸⁾ exposure thereby preventing skin damage^(337, 348). However human studies are rare and so far, only report significantly decreased vitiligo, a condition where pale white patches develop on the skin⁽³⁴⁹⁾, enhanced effectiveness of doxycycline to treat acne⁽³⁵⁰⁾ and decreased inflammatory acne lesions and oxidative stress⁽³⁵¹⁾.

Longevity Effects

Longevity research models show that silymarin increases lifespan like other antioxidant and xenobiotic detoxification stimulators^(352, 353). To date no human trials have specifically reported increased lifespan, even though its beneficial impact on liver function in severe liver disease would be expected to enhance survival rates.

6.11 *Centella asiatica*

Centella asiatica, also called Gotu Kola ⁽³⁵⁴⁾, is a perennial plant ⁽³⁵⁵⁾, native to tropical regions that has been used for at least 3000 years as a medicinal herb and in China, it is considered a miracle elixir of life ⁽³⁵⁴⁾. Its active component, asiatic acid, promotes normal collagen production ⁽³⁵⁶⁾, and has wound healing, anti-inflammatory, antidiabetic, antioxidant, liver and brain protective ⁽³⁵⁵⁾, blood pressure lowering, antimicrobial, and antitumor effects ⁽³⁵⁷⁾.

Centella asiatica is used in traditional and folk medicine to treat depression, memory loss, stress, healing resistant wounds, heart diseases, and cancer ⁽³⁵⁷⁾. Modern skin associated uses include treating small wounds, keloids/proud flesh, burns, psoriasis, scleroderma, skin photo-aging, cellulite, stretch marks ⁽³⁵⁴⁾ and eczema ⁽³⁵⁸⁾. It also improves microcirculation that would be expected to benefit skin health and longevity ⁽³⁵⁹⁻³⁶¹⁾.



Ongoing Research

Human Clinical Studies – Skin

R, DB, PC clinical trials show that *Centella asiatica*:

- Reduces wound bleeding time and pain, while promoting earlier healing ⁽³⁶²⁾, and wound contraction ⁽³⁶³⁾. The latter makes it particularly appealing to tighten skin, a feature owed to its ability to simultaneously inhibit enzymes that break down collagen ⁽³⁶⁴⁾ while increasing the rate of collagen synthesis ⁽³⁶⁵⁾.
- Reduces fat cell size and surrounding fibrosis within the hips, thighs, and upper arms, thereby reducing cellulite ⁽³⁶⁶⁾.

Longevity Effects

Centella asiatica has a reputation to restore declining cognitive function in traditional medicine, so the following results are not surprisingly:

- In subjects with generalized anxiety disorder, it significantly improved anxiety, mental flexibility/willingness to adjust and cognition, and reduced stress and associated depression ⁽³⁶⁷⁾
- In a R, DB, PC trial including healthy elderly people, it reduced their age-related decline in cognitive function and enhanced their mood ⁽³⁶⁸⁾

These psychological changes would be expected to not only benefit longevity directly, but also the skin through the Brain-Skin Axis.

Many longevity research models have reported longevity enhancing effects of *Centella asiatica*. However, to date no evidence exists to support a similar effect in humans.



6.12 Ashwagandha

Ashwagandha (*Withania somnifera*), also known as Indian ginseng, is used in Ayurveda/Indian traditional medicine for vitality, cardio-protection and to treat neurological disorders, gout, and skin diseases⁽³⁶⁹⁾. Studies in humans are many and suggest that Ashwagandha root extract improves sexual performance in both males and females, reduces and helps to manage stress and anxiety, and improves memory and cognition in healthy adults and patients with bipolar disorder. This versatile herb also increases muscle strength, muscle size and improves muscle recovery⁽³⁷⁰⁾.



Ongoing Research

Human Clinical Studies

A systematic review of five studies including older adults with mild cognitive impairment and adults with schizophrenia, schizoaffective disorder, or bipolar disorder, showed improved performance on cognitive tasks, executive function, attention, and reaction time⁽³⁷¹⁾.

R, DB, PC clinical trials show that Ashwagandha has many beneficial effects including:

Anxiety/Stress relief:

- In people with chronic mental stress, it improved stress and reduced stress hormone levels by 27.9%⁽³⁷²⁾
- In people with anxiety disorders, it reduced anxiety by 56.5% compared to only 30.5% with placebo⁽³⁷³⁾
- In subjects on a weight loss program that were chronically stressed, it reduced stress, food cravings, and improved happiness, stress hormone levels, body weight, and body mass index, suggesting it can be used to manage stress during weight loss programs⁽³⁷⁴⁾
- In stressed healthy adults, it

reduced stress, anxiety, and stress hormone levels while improving sleep quality⁽³⁷⁵⁾

Vitality/Energy/Performance enhancing:

- In male and female healthy adults, it improved power output and sprint speed, and VO2 max (the maximum rate of oxygen consumed during incremental exercise) without affecting blood pressure⁽³⁷⁶⁾
- In elite cyclists, it increased their VO2 max by 12.5% and time to exhaustion by 7.2%⁽³⁷⁷⁾
- In healthy, young, active men, it increased their ability to do both squats and bench presses⁽³⁷⁸⁾
- In healthy males, it significantly improved reaction time, but not accuracy⁽³⁷⁹⁾
- In people with anxiety disorders, it significantly improved fatigue⁽³⁷³⁾

Sleep enhancement:

- In patients with all stages of breast cancer, it significantly improved insomnia⁽³⁸⁰⁾
- In subjects diagnosed with insomnia, it significantly improved

sleep quality including onset latency, and efficiency, and it tended to improve total sleep time and time awake after sleep onset⁽³⁷⁰⁾

Motivation related:

- In people with anxiety disorders, it significantly improved motivation, concentration, self-reported quality of life including general health, vitality, social functioning, and emotional and mental health⁽³⁷³⁾.

The psychological related benefits described would be expected to enhance skin health through the Brain-Skin Axis. Similarly, the physical performance related effects would be expected to contribute to lean body mass maintenance, and thereby benefit skin health. In addition, the psychological related benefits coupled with the sleep enhancing effects would be expected to contribute to both skin health and longevity.

To put it mildly, this herb is one of the most influential of all for healthy skin and longevity!

Summary Benefits Table

Various foods and supplements contain bioactive substances that may beneficially impact your skin health and longevity as follows:

Antioxidant Protection

- 5.2 Cocoa
- 5.7 Purple berries
- 5.11 Seaweeds
- 5.12.1 Turmeric
- 5.12.2 Paprika
- 6.2 Vitamin C
- 6.7 Polyphenols

Anti-inflammatory effects:

- 5.4 Seafood
- 5.11 Seaweeds
- 6.1 Polyunsaturated fatty acids
- 6.3 Vitamin D

Detoxifying effects:

- 5.3 Cruciferous vegetables
- 5.9 Nattō
- 6.10 Silymarin (Milk thistle)

Skin photo-protective and health preserving:

- 5.12.1 Turmeric
- 5.7 Purple berries
- 6.7 Polyphenols
- 6.8 Carotenoids
- 6.1 Polyunsaturated fatty acids

Skin structure and function improving effects that result in less roughness, wrinkles, dryness, and discoloration:

- 6.6 Collagen
- 6.7 Polyphenols
- 6.7 Carotenoids

Collagen building and/or preserving effects:

- 6.2 Vitamin C
- 6.5 Silicon
- 6.6 Collagen
- 6.11 Centella asiatica

Enhancing wound healing:

- 6.2 Vitamin C
- 6.6 Collagen
- 6.11 Centella asiatica

Enhancing immune response:

- 5.5 Mushrooms
- 6.9 Probiotics and Prebiotics

Repairing damaged cells and tissues:

- 6.6 Collagen

Preventing cell death:

- 6.7 Polyphenols
- 6.10 Silymarin (Milk thistle)

Preventing carcinogenesis:

- 5.7 Purple berries
- 5.8 Leafy green vegetables
- 6.8 Carotenoids

Improving fat metabolism:

- 6.1 Polyunsaturated fatty acids
- 6.10 Silymarin (Milk thistle)

Regulating blood sugar:

- 5.5 Mushrooms
- 5.7 Purple berries
- 5.12.3 Cinnamon
- 6.7 Polyphenols
- 6.10 Silymarin (Milk thistle)

Enhancing microcirculation:

- 5.2 Cocoa
- 5.9 Nattō
- 5.10 Walnuts
- 6.4 Vitamin K2
- 6.7 Polyphenols
- 6.11 Centella asiatica

Bone preserving effects

- 5.9 Nattō
- 6.3 Vitamin D
- 6.4 Vitamin K2

Lean body mass preserving:

- 5.10 Walnuts
- 6.4 Vitamin K2
- 6.6 Collagen
- 6.12 Ashwagandha

Cardiovascular and brain preserving effects:

- 5.4 Seafood
- 5.8 Leafy green vegetables
- 5.9 Nattō
- 6.1 Polyunsaturated fatty acids
- 6.7 Polyphenols
- 6.8 Carotenoids

Longevity promoting through calorie restriction mimetics:

- 5.6 High polyphenol olive oil
- 6.7 Polyphenols

Longevity promoting through metabolism protective effects:

- 5.8 Leafy green vegetables
- 6.8 Carotenoids

Adaptogen effects:

- 5.5 Mushrooms

Improving sleep:

- 6.12 Ashwagandha

Reducing psychological stress:

- 5.12.1 Turmeric
- 6.11 Centella asiatica

Improving mood:

- 5.4 Seafood
- 5.12.1 Turmeric
- 6.11 EPA
- 6.12 Ashwagandha
- 6.1.3 Polyunsaturated fatty acids

Conclusion

What did you learn in Section 3?

Your journey through life exposes you to many stressors that can be both good and bad. The impact of accumulative negative stress can damage your metabolic and regulatory processes, cellular tissues, and organelles, and eventually your whole cells and body.

Your skin takes the brunt of the impact because it is exposed to harmful sun effects on top of damage attributed to your other life stressors. A resilient Skin Climate® and well performing tissue repair mechanisms can go a long way towards minimizing the added assault. Without that protection, overtime and through repeated attack, your skin can become dry, wrinkled, discolored, inflamed and diseased, and its ability to perform many functions that contribute to your overall health could be compromised, including barrier maintenance and detoxification. In addition, abnormal metabolic processes and regulatory functions that are occurring in other parts of your body, could contribute to this deteriorating process. Consequently, your skin's appearance and function may become a warning that damage is taking place in another body location.

As your journey through life progresses, aging occurs. It is a complex, inevitable, and multifactorial process involving molecular and cellular decline that makes you more

susceptible to disease and dying. It adds to the stress related decline mentioned above. Maintaining cell integrity, healthy metabolism, and adequate defense mechanisms are ways to slow the age-related structural and functional deterioration. Avoiding unnecessary stresses that speed up that process, will take you one step further towards a longer life.

Features linked to a more radiant self, regardless of your age, may include molecular integrity of your genome, telomere length, epigenetic stability, and protein homeostasis. These are associated with mitochondrial fitness, appropriate metabolic regulation, efficient intercellular communication, stem cell renewal, and regenerative capacity within your tissues⁽³⁸¹⁾.

A healthy diet and lifestyle can enhance your repair mechanisms and detoxifying capacity to protect you from damaging life factors, and thereby contribute to a more youthful self, both inside and out! This reduces skin aging and promotes longevity. Certain foods and supplements can further contribute to these beauty-enhancing and life-preserving benefits, so you can look your best, while living healthier and longer, in your quest for a beautiful life!

MY TAKE HOME MESSAGE:

Take care of your skin, and it will take care of you!

brought to
you by:

bend
BEAUTY



What's Next!

1. Re-reading part or all of this book. You may learn even more during your second reading. I know I did!
2. Using the knowledge gained to improve your skin health and longevity
3. Using the knowledge gained to help others improve their skin health and longevity
4. **Creating a beautiful life!**



Author's Farewell

Thank you for persevering to this point, and for tolerating all those annoying unfamiliar terms and my repetitive explanation of countless body processes.

But alas, we have reached the end of your scientific journey to discover the connection between healthy skin and longevity. I am honored to have had this opportunity to share my knowledge on the subject. I am sure my attempt has merely scratched the surface of what could be, one of the most enlightening realizations of how important your skin is to your very survival.

I hope I have managed to endow you with the knowledge needed and inspired you to make any necessary changes in your life, to maintain your skin health to enhance your longevity. I also hope your new awareness and understanding gives you the courage to suggest the same to others.

May you have a beautiful life!

About the Author:

Nancy L. Morse, BSc. (Hons), CNPA, Scientific Research Consultant.

Educated at both Acadia and Dalhousie Universities in Nova Scotia, Nancy has had a 38-year career in natural health and pharmaceutical product development. She is the sole author of 7 peer-reviewed scientific publications and of numerous books within the alive Healthy Living Guide series, as well as co-author of over 35 additional scientific journal publications. She has been an invited speaker at universities, taught courses, and workshops in nearly two dozen countries and has been a guest on radio and television talk shows. She currently maintains contracts with various companies involving new natural and pharmaceutical product development, clinical research collaborations, product marketing and training initiatives, and quality system implementation.

Nancy is also a Certified Natural Products Advisor (CNPA), and is a retired, formerly certified, Nutrition and Wellness Specialist, Fitness Instructor Specialist, Personal Trainer and Kickboxing Instructor. Today she enjoys ballroom dancing, beachcombing, and flower and vegetable gardening as her favorite pastimes.

To her, *Creating a Beautiful Life* is all about the freedom and power to make a positive difference. It is having the mental, emotional, and physical health to do the things she wants, where and when she wants, with the people she wants; while doing what good she can, by all the means she can, for all the people she can, for as long as she can.



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Glossary of Terms

Apoptosis

A form of programmed cell death that occurs under normal physiological as well as pathological/disease conditions and involves specific changes in shape and biochemical features.

Epigenetic

Nongenetic influences on gene expression

Homeostasis

The constant state of steady internal, physical, and chemical conditions maintained within living organisms that enables optimal functioning and includes many metabolic variables being kept within limits.

Meta-analysis

A quantitative, formal, study design used to systematically assess the results of a relatively large body of previous research to derive conclusions about the totality of evidence. Typically, but not always, these include randomized, double-blind, placebo-controlled trials.

Mitochondria

Known as the powerplants within cells, are organelles/“organs” with cells, that create energy from nutrients through a process called cellular respiration.

Nrf2: Is a protein that helps regulate a group of antioxidant proteins that can help protect against oxidative damage. This oxidative damage can be triggered by injury and inflammation and involves the production of free radicals. The Nrf2A pathway is a major mechanism in the cellular defense against oxidative stress which controls the expression of genes whose protein products are involved in the detoxication and elimination of ROS.

Polymorphisms: Variants within DNA sequences of genes that potentially alter the functionality of proteins synthesized based on the resulting modified genetic code.

Proteostasis

The process that regulates creation and maintenance of proteins within the cell to maintain their health and that of the organism itself.

Randomized, double-blind placebo-controlled trials

Involve the random placement of subjects into treatment groups; an experimental group(s) that receives the investigational treatment(s) and a control group that is given a placebo. Neither the researchers nor the study subjects know who is getting the experimental treatment and who is getting a placebo. This type of clinical study ranks as the gold standard to assess efficacy of treatment interventions⁽¹⁵⁵⁾.

Senescence

When a cell ages and permanently stops dividing but does not die. During this phase, the cell is essentially in ‘suspended animation’ because it is resistant to growth-promoting stimuli, typically in response to DNA damage.

Systematic reviews

A body of work that identifies, evaluates, and summarizes the findings of all relevant individual studies relative to a health-related issue and/or treatment, thereby making the available evidence more accessible.

List of Abbreviations

AD = Alzheimer's disease

ATP = Adenosine triphosphate

AA = Arachidonic acid

AGEs = Advanced glycation end-products

ALA = Alpha-linolenic acid

ALEs = Advanced lipoxidation end products

BMI = Body Mass Index

COPD = Chronic obstructive pulmonary disorder

CVD = Cardiovascular disease

DGLA = Dihomo- γ -linolenic acid

DHA = Docosahexaenoic acid

DNA = Deoxyribonucleic acid

EFAs = Essential fatty acids

EGCG = Epigallocatechin-3-gallate

EPA = Eicosapentaenoic acid

GLA = Gamma-linolenic acid

LC-PUFAs = Long chain polyunsaturated fatty acids – contains many double bonds that are prone to oxidation

LA = Linoleic acid

MED = Minimal erythema dose

MUFA = Monounsaturated fatty acid – contains one double-bond that is prone to oxidation

Nrf2 = Nuclear factor erythroid 2

PAHs = Polycyclic aromatic hydrocarbons

R, DB, PC = Randomized, double-blind, placebo-controlled

ROS = Reactive oxygen species

SFA = Saturated fatty acid

TEWL = Trans epidermal water loss

UV = Ultraviolet radiation

UVA = Ultraviolet A

UVB = Ultraviolet B

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