Deep Science Publishing
https://doi.org/10.70593/978-93-49910-64-5_8

Chapter 8: Targeting Longevity: Supplements as Interventions to Modulate Aging Pathways and Enhance Healthspan

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Abstract

The aging process, characterized by the progressive decline of cellular and physiological functions, can be influenced by nutritional and pharmacological interventions. Recent research highlights the potential of various supplements to slow aspects of biological aging by targeting key mechanisms such as oxidative stress, inflammation, mitochondrial dysfunction, and genomic instability. Compounds like antioxidants (vitamins C and E), coenzyme Q10, omega-3 fatty acids, polyphenols (such as resveratrol), and NAD^+ precursors have shown promise in promoting cellular health and extending healthspan. Additionally, supplements that modulate nutrient-sensing pathways, such as rapamycin analogs and metformin, are being explored for their anti-aging effects. While supplements offer a promising approach to support healthy aging, their efficacy and safety require further validation through long-term clinical studies. A deeper understanding of personalized supplementation strategies may pave the way for individualized interventions to enhance longevity and quality of life.

Keywords: Anti-Aging Supplements, Antioxidants, Dietary Interventions, Enhanced Longevity, Healthspan Extension, Nutraceuticals, Polyphenols, NAD^+ Boosters.

8.1. Introduction

Ageing is a natural biological process marked by gradual deterioration in cellular function, tissue repair, and overall physiological performance. Aginf can be

influenced by lifestyle factors, including diet, exercise, and nutritional supplementation. In recent years, dietary supplements have gained attention as while it cannot be completely halted, growing scientific evidence suggests that the pace of ageing can potential tools to slow the ageing process and promote healthy longevity. Certain vitamins, minerals, antioxidants, and bioactive compounds—such as vitamin D, omega-3 fatty acids, resveratrol, NAD+ boosters, and coenzyme Q10—have been studied for their roles in reducing oxidative stress, supporting mitochondrial function, and enhancing cellular repair mechanisms.

These supplements aim not only to fill nutritional gaps but also to target specific molecular pathways associated with ageing, such as inflammation, telomere shortening, and DNA damage. Although the effectiveness and safety of many anti-ageing supplements remain under investigation, their use represents a promising frontier in the field of preventive and personalized medicine.

8.2. Can ageing be slowed?

Ageing is a state of body which can be characterize by physiological condition of body and symptoms like muscles weakness/laxity, skin damage or wrinkles, memory loss, eye sight, hair's characters (colour, roughness, thin, thick, baldness etc), bone density, wound healing time, etc. Biochemically all of these statuses are directly depends on compositions of proteins, enzymes, and genes. These physiological conditions can be considered as parameters of measuring ageing.

The physiology of the body and signs like muscle weakness or laxity, skin damage or wrinkles, memory loss, eye sight, hair characteristics (colour, texture, thickness, baldness, etc.), bone density, wound healing time, etc., can all be used to describe the ageing process. Aging is a body state that can be described by the process of ageing. From a biochemical point of view, each of these states is directly caused by the way proteins, enzymes, and genes are put together. You can think of these physiological traits as parameters that can be used to measure the ageing process. For example, psychomotor and cognitive performance (dementia) decreases with age in both animals and people, even if they don't have neurodegenerative diseases like Alzheimer's or Parkinson's. This is called "dementia caused by getting older."

For example, both animals and humans show loss in psychomotor and cognitive functioning decreases (dementia) with age, even in the absence of neurodegenerative diseases such as Alzheimer's and Parkinson's disease. This ageing effect may be a result of losses of neurotransmitter receptor sensitivity and associated second messengers, as well as alterations in calcium-sensitive signaling agents (e.g.

mitogen-activated protein kinases) associated with memory, especially the conversion of short- to long-term memory.

With age brain can loss conscious control of movement and an alterations in motor function that ultimately responsible for decreases in balance, muscle strength and coordination, while memory deficits are seen on cognitive tasks that require the use of spatial learning and memory (Shukitt-Hale et al., 1998). It has been noted that intrinsic ageing proceeds at different rates in living beings at a genetically determined pace caused primarily by the buildup of reactive oxygen species (ROS) as a by-product of cellular metabolism. ROS, in turn, cause damage to critical cellular components like membranes, enzymes, and deoxyribonucleic acid (DNA). In addition, as individual ages, skin cells are also biologically ageing. Proliferation rates consequently begin to drop in the epidermis, inducing a steady deterioration of skin structure and function. The antioxidant, anti-inflammatory compounds found in fruits and vegetables considered to be have efficacy in reversing or slowing down the ageing.

This effect of getting older may be caused by a loss of sensitivity in neurotransmitter receptors and the second messengers they send, as well as changes in calcium-sensitive signaling agents like mitogen-activated protein kinases, which are linked to memory, especially the conversion of short-term memory to long-term memory. As people get older, they have trouble remembering things that require them to learn and remember where things are. As the brain ages, it can lose the ability to control its movements consciously and change how its muscles work. In the end, these changes cause balance, muscle strength, and coordination to get worse (Shukitt-Hale et al., 1998).

The main thing that causes intrinsic ageing is the buildup of reactive oxygen species (ROS), which is a byproduct of cellular metabolism. This happens at different rates in different living things, which is mostly determined by their genes. ROS, in turn, damage important parts of the body like membranes, enzymes, and deoxyribonucleic acid (DNA). Also, a person's skin cells go through biochemical changes that make them age as well as the person does. Because of this, the rate of cell growth in the epidermis starts to slow down, which causes the structure and function of the skin to slowly get worse. Compounds in fruits and vegetables that have antioxidant and anti-inflammatory properties are thought to be able to slow down or even stop the effects of ageing.

Ageing can be defined as functional deterioration over time, accompanied by an increased vulnerability to disease. Even though the exact cause of ageing is not fully understood, there are several hypotheses for the process of ageing. One way to

describe getting older is that it means losing the ability to do things and getting sick more often as time goes on. Even though the exact reason why we age is not fully understood, there are a number of ideas about the ageing process.

8.3. Antioxidants

Since 1950s, researchers thought that ROS (unstable molecules) might hurt cells. Since then, free radicals have been linked to the ageing process. Free radicals are made by the body's natural processes, and their levels go up when a person is exposed to things in the environment, like the effects of smoking or the sun's ultraviolet (UV) radiation. The natural process of oxidation and reduction in the body is thrown off balance when free radicals, like ROS, are made by metabolic processes. Through a complicated genetic path, this imbalance then leads to inflammation in the blood vessels. Inflammation is an important part of our body's defence system. It is triggered to protect and heal infected or damaged tissues or body parts caused by things outside of our bodies. This response is triggered to protect and heal infected or damaged tissue or parts of the body.

At the same time, inflammatory processes can speed up or slow down the ageing process by adding to the breakdown of tissues and diseases that come with age. But the mechanism behind this chain of events is unknown, and it is possible that the reason why inflammatory responses change as people get older can't be explained. These changes could be the result of a "natural" breakdown of cells caused by things like stress, or they could be the result of a disease that is happening in the body.

In the 1950s, a theory called the Mitochondrial Free Radical Theory of Aging (MFRTA) gets a lot of attention as a possible way to explain how people age. One school of thought says that oxidative damage is caused by the free radicals made in the mitochondria when the body's cells break down food. This idea is supported by a number of experimental findings, such as the fact that the ability of an animal to burn energy (its metabolic rate) and the amount of antioxidant activity in a species are roughly the same. But the longest-living rodent, the *Heterocephalus glaber*, does not prove that the production of free radicals affects how long a person lives. One person who supports MFRTA says that oxidative damage to mtDNA has a negative relationship with maximum lifespan. It is thought that this is the case because oxidative damage can cause mutations that change how the mitochondria make ATP.

Experiments with mice have also shown that high levels of oxidative damage to mtDNA do not shorten the average lifespan of the animals. Also, mice with mutations in polymerase gamma, which is the mitochondrial DNA polymerase, have 500 times more point mutations in their mtDNA than mice without these mutations,

but they don't age any faster. Dietary restriction (DR), which is also called caloric restriction, is the only non-genetic therapy that has been shown to increase both the average and maximum lifespan. The MFRTA says that animals who are limited in how many calories they can eat make less mitochondrial reactive oxygen species (mtROS). But DR affects more than just the production of free radicals. For example, it can reduce insulin signaling. Because of this, the increase in lifespan cannot be attributed solely to a decrease in the production of mtROS. So, moderate activity causes similar changes in the formation of free radicals and oxidative damage without making the maximum lifespan longer (Sanz & Stefanatos, 2008).

It is common knowledge that antioxidants prevent free radicals from causing harm to cells in the body and on the skin (Paital, 2012; Sahoo et al., 2024). This protection is provided both internally and externally. The vitamins E and C, rutin, quecertin, morin, kaempferol, aloin, vanillin, salicin, linalool, and silymarin are all powerful antioxidants. Other important antioxidants include: Besides quecertin, morin, and kaempferol, there are many more antioxidants. As a result of its ability to retain cell membranes and prevent damage to the enzymes that are related to them, vitamin E can aid in the repair of skin damage brought on by exposure to ultraviolet radiation from the sun, as well as improve the skin's wrinkles and texture. The amount of vitamin E that should be taken each day is advised to be 400 mg. Foods like sunflower oil, cereals, oats, almonds, and dairy products can all be good sources of vitamin E.

Additionally, it can be found in a variety of vegetable oils. It is well-established that the consumption of tobacco, extended exposure to the sun, and inhalation of polluted air all contribute to a depletion of vitamin C levels in the body. Additionally, vitamin C helps protect organs from the damage that is induced by the pressures of the environment (Sahoo et al., 2022). Selenium is a mineral that can help prevent cancer from growing in the body, particularly the type of skin cancer that is brought on by too much time spent in the sun. In addition to this, it assists in the preservation of the pliability of the tissues and slows down the pace of oxidatively induced ageing as well as the hardness of the tissues. Foods such as shellfish, eggs, garlic, and cereals made with whole grains are examples of foods that are rich in the mineral and may be included in a healthy diet.

Good sources of the last few essential antioxidants are potatoes, grapes, the leaves of mulberry trees, green tea, aloe vera, vanilla beans, willow, bergamot, and thistle. Morin and silymarin are two of those that have been shown to have the potential to have greater levels of the ability to scavenge free radicals. Recent studies on animals have revealed that selenium, in the form of L-selenomethionine, which may either be swallowed or absorbed via the skin as L-selenomethionine, gives protection

against both typical and high levels of UV damage. This protection can be achieved by either method.

Antioxidants have a role in reducing how quickly free radicals are produced in the body. On the other hand, there is mounting evidence to show that antioxidants may not make the ageing process slower, and that free radicals can sometimes be seen as a benign warning sign of impending danger. The natural defence systems of the cell, such as detoxification enzymes and repair proteins, can be stimulated by free radicals, which in turn protect our cells from age-related damage. Free radicals can also cause DNA damage. Studies have shown that the lifetime of *Caenorhabditis elegans* (worms) that have had their genes altered to produce more free radicals has increased by 32%. This was discovered when the worms were subjected to the same conditions as humans.

If you feed worms a herbicide that kills weeds but also induces an increase in the creation of free radicals, the worms will have a lifespan that is 58% longer than they would have had they not been given the herbicide. Mutated worms did not demonstrate an increased level of resistance to the strain that was produced by free radicals. In most of the experiments, mutants actually displayed a higher level of sensitivity than non-mutants did. In spite of the fact that free radicals aren't always bad for you, using antioxidants might end up being damaging to you. According to the findings of a comprehensive meta-analysis that encompassed 230 000 individuals, those who take antioxidants have a greater chance of passing away than those who do not take antioxidants. There is no direct connection between free radicals and the ageing process, despite the fact that free radicals are most likely involved in the process of ageing in some manner.

Isoflavone may have a role in delaying the ageing process by bringing the amounts of pro-inflammatory proteins in the body down to a more manageable level. It did not appear that the isofavone known as genistein was able to exert a significant inhibiting impact on the activation of the pro-inflammatory protein known as NF-kB in the kidney tissues that were studied. The activation of the NF-kB pathway is a necessary step in the creation of pro-inflammatory proteins, which is why this phase is considered an essential part of the process. In order to get the samples ready for this assessment, a chemical process was performed on them that caused them to over express, or produce an excessive quantity of NF–kB. This was done in preparation for the examination. (As a result of the overexpression, it would be much easier to evaluate the levels of NF–kB.) After this process, the samples of kidney cells were put through

a series of treatments with morin and silymarin in which the concentrations were changed.

In conclusion, free radicals were added to the samples; this is the step that often causes an increase in the quantity of NF-kB that is present in the cells, therefore this was an important part of the experiment. If the amount of NF–kB remains unchanged or decreases when the free radicals are introduced, this would indicate that the antioxidant that is already present is effective at neutralising the free radicals and, as a result, reducing the activation of NF–kB. This would suggest that the antioxidant that is already present is effective at neutralising the free radicals. The results of this research suggested that morin was successful however the silymarin did not fare as well as the other treatments.

To summarise, there is no guarantee that ingesting antioxidants will result in positive outcomes in each and every circumstance. If your body is low in certain antioxidants, you will need to take more of those antioxidants in order to bring the levels back into balance. Unfortunately, it does not appear that increasing the amount of antioxidants you consume will be useful in slowing down the ageing process. In the meanwhile, it would appear that there is a great deal more going on with the ageing process than merely free radicals inflicting harm to the machinery inside of our cells.

One of the most significant factors that contribute to the ageing process is known as "cellular senescence," which is also commonly referred to as "ageing of the cell." When a cell reaches this point, it is no longer capable of dividing into further copies of itself through the process of cell division. When this happens, the damaged cell will start generating inflammatory signals, which will trigger the immune system to "clean up" the damaged cell. When this happens, the process is called "apoptosis." When we are younger, our bodies are better equipped to destroy senescent cells rapidly; but, as we become older, our systems become less capable of doing so. When we are younger, our bodies are more fitted to eliminate senescent cells readily. This finally results in the breakdown of tissue as a result of the accumulation of wounded cells, which in turn gives rise to low-level inflammation. It is still possible for senolytics to lighten the stress that senescent cells put on the body.

Apples, strawberries, onions, and cucumbers are just few of the many fruits and vegetables that contain the flavonoid known as fisetin. Fisetin is found in apples. It has been proven that these compounds exist naturally and exhibit both anti-inflammatory and antioxidant properties. It led to a decrease in the amount of senescent

cells that were discovered in the animals, which in turn led to an increase in the animals' lifespans as well as an improvement in their overall health.

8.4. immune-boosting and anti-inflammatory support

Bioactive chemicals are found in tiny amounts in food, and researchers are constantly discovering more about the effects these compounds have on human health. Fruits are high in bioactive substances such as vitamins (provitamin A, C, E, and K), minerals (calcium, magnesium, and potassium), phytochemicals (phenolic acids, flavonoids, carotenoids, and tannins), and dietary fibres (Chhabria et al., 2022). These substances reduce the chance of acquiring a variety of chronic illnesses, including diabetes, cancer, and others (Liu, 2004). They also have medicinal properties such as antibacterial, anticancer, anti-inflammatory, and antioxidant action (Ilango et al., 2022).

8.4.1. Ascorbic acid, or vitamin C

It scavenges ROS produced by cellular metabolism. As a result, it protects cells from oxidative damage, neurological disorders (such as Parkinson's and Alzheimer's disease), and inflammatory dysfunction (arteriosclerosis), which are all caused by ROS production (Shashirekha et al., 2015).

8.4.2. Vitamin E

It is found in high concentrations in plasma lipoproteins as well as cell membranes, notably in red blood cells. In humans, vitamin E, a key fat-soluble chain-breaking antioxidant, protects DNA, polyunsaturated fatty acids, and low-density lipoproteins against oxidative damage. This is due to the fact that vitamin E is a fat-soluble molecule (Shashirekha et al., 2015).

8.4.3. Phenolic acid molecules, anthocyanins, and carotenoid pigments

The above molecules can all operate as antioxidants. They are capable of preventing tissue damage induced by oxidative stress. Furthermore, anthocyanins have the power to excite our immune cells by imitating pathogen-associated molecular patterns and causing our immune system's gamma T cells to behave in a proactive manner (Percival, 2009;). Carotenoids (Retinol, Beta-Carotene, and Vitamin A) have the ability to combat damaging free radicals. According to Lademann et al., (2011), those who have a high quantity of carotenoids (antioxidants) in their system had younger-looking skin.

8.4.4. Polyphenols

These are a type of bioactive molecule that promotes intestinal health by controlling mucosal immunity and inflammation. Consuming polyphenols is capably protected from the harmful effects of ultraviolet light. They also have actions that protect DNA from being damaged and are powerful antioxidants and anti-inflammatory agents (Nichols & Katiyar, 2010). Fruits and vegetables contain polyphenols. Polyphenols have been found to boost intestinal mucosal immunity in ascaris-infected pigs by increasing the number of intraepithelial T cells and mucosal eosinophils. This was shown through in vivo studies (Williams et al., 2017). There is evidence that polyphenols such as epigallocatechin-3-gallate, epicatechin-3-gallate, or epigallocatechin can boost human white blood cell production of the cytokine interleukin-10 (IL-10) (Crouvezier et al., 2001). As a result, they are responsible for a decrease in proinflammatory cytokine activity generated by macrophages and an increase in anti-inflammatory cytokine activity (Crouvezier et al., 2001).

8.4.5. Epigallocatechin-3-gallate

It has also been found to reduce some of the symptoms of autoimmune illnesses in animals. Mice fed epigallocatechin-3-gallate exhibited considerably more regulatory T cells (Tregs) in their lymph nodes and spleens, but their T-cell responses were markedly reduced (Pae et al., 2012,). Dendritic cells are believed to be the most efficient antigen-presenting cells in the normal immune response. Because of their particular capacity to integrate and send a huge number of incoming signals to lymphocytes, these cells are in charge of activating and monitoring the acquired immune system (Buckwalter & Albert, 2009). Polyphenols have been demonstrated to alter dendritic cell development and maturation (Xu et al., 2013). They inhibit the immune system by preventing the polarisation of Th1 cells, which is induced by dendritic cells and mediated by these cells. It has been shown that phenolic compounds can affect humoral immunity by boosting the secretion of certain immunoglobulins (Igs). Both serum IgM and IgG levels were found to be considerably higher after ellagic acid treatment. Ellagic acid is a phenolic compound found in fruits (Allam et al., 2016).

8.4.6. Flavonoids

These are recognized to have antioxidant, anticancer, antibacterial, cytotoxic, and antimutagenic properties. **Polyphenols** such as flavone-3-ols, procyanidins, catechins, flavones, resveratrol, anthocyanidins, and flavanones may assist the body maintain a healthy balance of Th1/Th2 cells and suppress the development of antigen-specific immunoglobulin E (IgE) (Kumazawa et al., 2014). Quercetin, a flavonoid found in nature, has the capacity to decrease IL-6 and IL-8 and relieve symptoms of

encephalomyelitis, an inflammatory illness linked with immune responses mediated by Th1 cells (Yu et al., 2008). It was also proposed that quercetin might have an effect on the immune system by enhancing phagocytosis in macrophages and raising the activity of natural killer cells in mice (Yu et al., 2009;). Several studies have shown that fruit flavonoids inhibit the activity of enzymes involved in the formation of inflammatory mediators such as leukotrienes and nitric oxide (NO) or prostanoids (Gonzalez-Gallego et al., 2010;).

Flavonols such as kaempferol and quercetin, as well as flavones such as apigenin, reduce NO generation (Liang et al., 1999). Tannins are another type of bioactive molecule with physiological effects such as phagocytic cell stimulation and host-mediated tumour activity. Plants may contain tannins. They do this by establishing bonds with enzymes, which inhibits the action of lipoxygenase and peroxidase; as a result, they have antioxidant potential (Shashirekha et al., 2015). All these bioactive molecules consists various intermediary pathways of action to affect our immune system.

Experimental evidences have reported that immunological factors contribute to the pathogenesis of solar UV-induced skin cancer in mice, and as a result, analogous activity in humans is predicted. Nonimmune mechanisms, however, may also play a role in the illness. As a result, ultraviolet (UV) rays are often known as "ageing rays." UV light-induced erythema, edoema, and hyperplastic epithelial responses are thought to be markers of inflammation. Keratinocytes often respond to UVB radiation by inducing cyclooxygenase-2 (COX-2) expression, which is followed by an increase in the production of prostaglandin (PG) metabolites in the skin. This might happen either suddenly or gradually. COX-2 expression has been linked to the etiology of both inflammation and cancer.

The rate-limiting enzyme for the production of PG metabolites from arachidonic acid is COX-2. Silymarin has been shown to reduce UVB-induced COX-2 expression and, as a result, the formation of PG metabolites in the skin. These PG metabolites are considered to be skin tumour promoters. It has also been shown that silymarin can suppress the synthesis of ornithine decarboxylase. This enzyme is required for polyamine production and has a role in the formation of tumours in skin exposed to UVB radiation (Nichols & Katiyar, 2010).

8.4.8. Phosphoric acid, caffeic acid, and coumaric acid

These are examples of simple phenolic acids. The more frequent hydroxybenzoic and hydroxycinnamic acids are examples of phenolic acids. Phenolic acids may be present in a wide range of foods. Hydroxycinnamic acid compounds,

such as p-coumaric acid, caffeic acid, and ferulic acid, almost always exist as straight esters with hydroxy carboxylic acids or glucose, whereas hydroxybenzoic acid compounds, such as p-hydroxybenzoic acid, gallic acid, and ellagic acid, almost always exist as glucosides. Pomegranates have high ellagic acid content. Caffeic acid, ferulic acid, and p-coumaric acid are only a few of the bonded phenolic acids found in coffee. Gallic acid, p-hydroxybenzoic acid, caffeic acid, p-coumaric acid, and vanillic acid are among the phenolic acids found in blueberries.

8.4.9. Green tea polyphenols and catechins

These were mixed into the mice's drinking water. This resulted in significant protection against the formation of skin tumours in terms of the incidence, number, and size of tumours. Resveratrol can be found in the skin of coloured grapes, peanuts, mulberries, and grapes fermented into red wine. When administered topically, resveratrol inhibits the genesis, growth, and progression of UVB-induced skin tumours. In experimental animals, silymarin, a flavonoid derived from milk thistle, has been shown to have anti-photocarcinogenic properties. In a hydrophilic ointment treatment of human fibroblasts in culture, ()-epigallocatechin-3-gallate (EGCG) inhibited the UV-induced increase in collagen production and collagenase mRNA levels. It also blocked the UV-induced nuclear transcription factors nuclear factor- kB (NF-kB) and activated protein (AP)-1 from binding. The principles of DNA repair showed that the fast repair of UV-induced cyclo (IL-12) (Nichols & Katiyar, 2010).

8.4.10. Tea leaves and buds contain catechins

These are polyphenolic chemicals. These chemicals have been demonstrated to boost antioxidant defence enzymes and DNA repair processes while inhibiting H2O2, NO, iNOS, LPO, MPO, inflammation, COX-2, PGs, IL, NF-B, IKK, AP-1, MAPK proteins, and DNA damage pathways. Catechins are also anti-inflammatory. Proanthocyanidins, found in grape seeds, nuts, and bark; resveratrol, found in grape skin, peanuts, red wine, and mulberries; and silymarin, found in milk thistle, are thought to have comparable potential (Nichols & Katiyar, 2010).

Our bodies' immune systems protect us from infections such as bacteria and viruses, as well as allergies, toxins, and other unwanted biological invaders. Any decrease in the host's capacity to perform its regular duties raises the probability of infection with a range of diseases. The immune system activation potential of the fruits is highly promising. Consuming a proper amount of fruits on a daily basis is critical to ensuring that our immune system is at its peak performance. They are high in phytochemicals that are both nutritious and nonnutritive, including as carotenoids, flavonoids, phenolic acids, and tannins. Vitamins A, C, and E are examples of

micronutrients. These bioactive chemicals are critically important for the production of antibodies, the activation of phagocytosis, the suppression of proinflammatory cytokine activity, lymphocyte proliferation, and the enhancement of natural killer cell function.

They sustain our immune system's surveillance state and play a crucial role in boosting cells involved in both innate and acquired immunological responses. They do this mostly by scavenging free radicals, which is one of the primary processes by which they strengthen our immunity and protect our body's cells from oxidative damage. As a result, a diet deficient in fruits creates an immunosuppressive environment that makes our bodies more prone to sickness. Despite the fact that there is encouraging evidence that these bioactive molecules have a role in immune system modulation, there is a lack of study defining the specific mechanism of their activity. More in-vivo study is needed to have a better grasp of the roles that various phytochemicals perform in the body (Maheshwari et al., 2022).

8.5. Food supplements including proteins

Slowing aging with food supplements involves targeting cellular processes like oxidative stress, inflammation, and mitochondrial function. While supplements can support healthy aging, they work best alongside a balanced diet, exercise, and good lifestyle habits. Here are some well-researched supplements known for their potential anti-aging effects: on Cellular Health & DNA Repair. This includes NMN (Nicotinamide mononucleotide) and NR (Nicotinamide Riboside): Boost NAD+ levels, essential for cellular energy and DNA repair. Resveratrol found in red grapes and wine, it activates sirtuins, proteins linked to longevity. And quercetin: A flavonoid that reduces senescent (aged) cells and inflammation.

Antioxidants to Combat Oxidative Stress can slower aging processes. CoQ10 (Coenzyme Q10): Supports mitochondrial function and energy production while reducing oxidative damage. Astaxanthin: A powerful antioxidant from algae known to protect skin and cells. Vitamin C and E products: Protect cells from free radical damage.

Anti-Inflammatory Support with natural commands such as curcumin (from turmeric), Known for its potent anti-inflammatory and antioxidant effects, omega-3 Fatty Acids (EPA & DHA) can also reduce inflammation and support brain and heart health (Mishra et al., 2021).

Brain & cognitive function can be targeted with phosphatidylserine that supports cognitive function and reduces age-related memory decline. Lion’s Mane

Mushroom that promotes nerve growth and brain health. Along with neural tissues bone, muscle & skin support with collagen peptides that promote skin elasticity, joint health, and bone strength, vitamin D3 + K2 that work together to support bone health and cardiovascular function.

Slowing aging with food supplements involves using specific nutrients that support cellular health, reduce oxidative stress, and promote longevity. Some key supplements with anti-aging benefits include antioxidants which help combat oxidative stress, which is a major contributor to aging. They include vitamin C – Supports collagen production and protects against free radicals, vitamin E – Protects skin and cells from oxidative damage and coenzyme Q10 (CoQ10) – Boosts energy production in cells and reduces oxidative stress.

Collagen & sin health with collagen Peptides – Improves skin elasticity and reduces wrinkles and hyaluronic acid – helps retain moisture in skin and joints, can be used.

Mitochondrial & cellular health can also be taken care with nicotinamide Mononucleotide (NMN) & Nicotinamide Riboside (NR) – Boost NAD+ levels, which are crucial for cellular energy and repair, resveratrol – Found in red wine, supports longevity genes (sirtuins) and pterostilbene – Similar to resveratrol but with better bioavailability.

Anti-inflammatory nutrients like omega-3 Fatty Acids (Fish Oil or Algal DHA/EPA) – Reduces inflammation and supports brain and heart health, curcumin (from turmeric) – Strong anti-inflammatory and antioxidant properties and quercetin – Supports immune function and reduces inflammation can supplemented.

Similarly, gut & immune support with probiotics & prebiotics – maintain gut microbiome balance, which affects overall health and aging with polyphenols (Green Tea Extract, Olive Leaf Extract), have strong anti-aging effects on cells can be helpful.

Finally, hormonal balance & brain function with DHEA (Dehydroepiandrosterone) – Supports hormone production and energy levels, Lion's Mane Mushroom – Supports brain health and cognitive function and phosphatidylserine – Helps maintain memory and cognitive performance can be useful.

8.6. Sirtuins

Sirtuins are a family of proteins that play a crucial role in aging, cellular repair, and metabolism. They act as enzymes that regulate gene expression, DNA repair,

inflammation, and cellular stress resistance. There are seven known sirtuins (SIRT1 to SIRT7), with **SIRT1** being the most studied for its role in longevity.

8.6.1. How sirtuins affect aging

Sirtuins can affect aging by DNA Repair: Sirtuins help repair damaged DNA, which accumulates with age, Mitochondrial Function: They enhance mitochondrial health, improving energy production and reducing cellular aging, Inflammation Control: Sirtuins suppress chronic inflammation, a major factor in age-related diseases, Metabolic Regulation: They improve insulin sensitivity and glucose metabolism, promoting healthier aging and Cellular Stress Resistance: Sirtuins activate pathways that protect cells from oxidative stress and damage.

8.6.2. Nutrients & supplements that activate sirtuins

Several compounds can activate sirtuins naturally: They are Resveratrol: Found in red wine, grapes, and peanuts. Enhances SIRT1 activity and mimics calorie restriction benefits, Nicotinamide Mononucleotide (NMN) & Nicotinamide Riboside (NR): Boost NAD+ levels, which sirtuins rely on for function, Quercetin: A flavonoid found in apples, onions, and berries that supports sirtuin activity, Fisetin: Found in strawberries, known for promoting cellular senescence clearance and sirtuin activation, and Polyphenols: Found in green tea, olive oil, and dark chocolate, these compounds support sirtuin pathways.

8.6.3. Lifestyle tips to boost sirtuins

One of the main factors that fasters aging in bad life style. A changing life style that includes Caloric Restriction & Fasting: Intermittent fasting or calorie restriction naturally increases sirtuin activity, Exercise: Regular physical activity boosts NAD+ levels and sirtuin expression, and Sleep: Quality sleep supports sirtuin function and cellular repair is very useful to slow down aging processes.

8.7. Caloric Restriction

Caloric restriction (CR) is one of the well-researched strategies for slowing aging and extending lifespan. It involves reducing daily calorie intake by 20–40% without causing malnutrition. Studies in animals and humans show that CR can improve healthspan by enhancing metabolic function, reducing inflammation, and promoting cellular repair.

8.7.1. How caloric restriction slows aging

Caloric restriction has multifaceted contribution to slow down the aging processes. It includes Boosts Sirtuins: CR increases NAD+ levels, which activate sirtuins—proteins that enhance DNA repair and cellular health, Reduces Oxidative Stress: Lower calorie intake decreases free radical production, protecting cells from damage, Improves Mitochondrial Function: CR enhances mitochondrial efficiency, promoting better energy production and reduced cellular aging, Enhances Autophagy: CR triggers autophagy, a cellular "clean-up" process that removes damaged components, Reduces Inflammation: Chronic inflammation contributes to aging, and CR helps suppress inflammatory pathways, and Improves Insulin Sensitivity: CR lowers blood sugar and insulin levels, reducing the risk of age-related diseases.

8.7.2. Approaches to caloric restriction

So, one that solely interested in caloric restriction must the following approaches. Mild Daily Caloric Restriction (10–25%): Reduce daily calories by 300–500 kcal, Focus on nutrient-dense foods like vegetables, legumes, lean proteins, and healthy fats, Intermittent Fasting (IF): Popular methods include 16:8 (16 hours fasting, 8 hours eating) or 5:2 (normal intake for 5 days, reduced intake for 2 days) and IF provides CR benefits without constant restriction, Alternate-Day Fasting: Eat normally one day and reduce calories (by 50–70%) the next day and Time-Restricted Eating (TRE): Limit eating to a specific window (e.g., 10 am to 6 pm) while maintaining overall calorie intake.

8.7.3. Nutritional considerations

To practice CR safely: Prioritize Nutrient Density: Eat plenty of vegetables, fruits, legumes, nuts, seeds, and lean proteins, Ensure Adequate Protein: Prevent muscle loss with 1.2–1.6 g of protein per kg of body weight, Include Healthy Fats: Avocados, olive oil, and fatty fish provide essential fatty acids and Supplement Wisely: Consider vitamins B12, D, calcium, magnesium, and omega-3s.

8.7.4. Potential Benefits of Caloric Restriction

Caloric restriction helps in increased lifespan (seen in animals, with ongoing human trials), improved cardiovascular health (lower blood pressure and cholesterol), enhanced cognitive function and neuroprotection, and lower risk of age-related diseases like diabetes, cancer, and Alzheimer’s.

8.7.5. Risks and Who Should Avoid CR

Excessive restriction can lead to nutrient deficiencies, muscle loss, fatigue, and hormonal imbalance, So, caloric restriction is not recommended for children, pregnant women, people with eating disorders, or those with certain medical conditions.

8.8. Plant Products

The combination of a pharmaceutically active substance with a cosmetic product is what's known as a cosmeceutical (Debata et al., 2021). It has been deemed to be the commercially rising category in the skin and personal care market because to the increased awareness that individuals have towards their own physical appearance, cleanliness, and attractiveness. The majority of cosmetic products that are now on the market use extracts from plants and botanicals as their primary sources of active ingredients. Research conducted both in the past and more recently has unearthed the secret, which consists of the fact that plants include various components that are essential to maintaining healthy skin and other organs. The majority of these plants are grown and available in the people's backyard garden. A few plants here that fight ageing have been mentioned along with their main component and mode of action.

8.8.1. Plants for Skin Care

Coconut Oil

Antioxidants and vitamins C and E are abundant in coconut oil's composition which is of great assistance in mending damaged cells and getting rid of free radicals in the body. Skin softening is attainable by the use of a lotion, a bar of soap, or even as the raw oil. Additionally, the antibacterial properties of coconut oil help to maintain healthy skin. This oil may also be used as a hair conditioner in addition to assisting with weight loss.

Moringa Powder

Moringa oleifera, sometimes known as the drumstick tree or the miracle tree, is a tree that can help alleviate symptoms of a broad variety of diseases, illnesses, and afflictions. In addition to vitamins and minerals, the Moringa tree has been shown to have over 40 different types of antioxidants, 90 different nutrients, and 40 different anti-inflammatory compounds. Antioxidants aid in avoiding skin damages. The nutrients contribute to the maintenance of the body's capacity to produce new collagen and skin cells, in addition to elastin, which are the structural components of young skin. The oil, which is also known as ben oil, assists in the process of cellular regeneration and helps the skin to become more youthful.

Blueberry

The final option, although by no means the least important, are good old blueberries. They are scrumptious to eat and are really beneficial to your health. You don't have to worry about them going bad in the refrigerator since you can either consume them in their natural state or take them in supplement form. They are always a lovely complement to any smoothie, fruit salad, or yoghurt cup, as well as serving as an excellent accent to any yoghurt parfait.

Turmeric

Instead of using soap, Indian ladies typically use a natural cleanser called Turmeric Skin Polisher. This cleanser is intended to exfoliate the skin. In addition to that, it has antioxidants and anti-inflammatory qualities, both of which can help calm acne and skin outbreaks. The anti-aging properties of turmeric, lemon juice, and jojoba oil may help diminish the appearance of fine lines and wrinkles, as well as age spots, hyperpigmentation, and other telltale indications of ageing.

Cocoa Tree

On the skin, cocoa serves as an antioxidant, as well as an anti-aging and hydrating agent. The extract, which is filled with magnesium and fatty acids, helps to prevent the indications of ageing and neutralizes hazardous pollutants, in addition to being an essential component for well-nourished skin. Because of its incredibly high moisturizing characteristics, cocoa is a primary component in a variety of beauty products, including soaps, bath and body care products, and beauty brands. Cocoa butter, like chocolate, is typically obtained in the form of chunks or bars. Both cocoa butter and chocolate are derived from cocoa beans.

Goji Berry

When it comes to preventing damage caused by free radicals and maintaining an even skin tone, goji berries pack a big punch thanks to the potent combination of antioxidants, vitamins (particularly A and C), and minerals that they contain. Goji berry extract is a primary component of a face lotion that both hydrates and lightens the skin. It is able to readily store moisture deep inside the skin, which allows it to swiftly replace moisture, lock moisture, prevent loss of moisture for 24 hours by producing a protective layer on the skin, and produce skin that is rich and faultless, as well as moist and delicate. The skin has a high capacity for absorbing moisture, and its ability to retain water helps it to seem healthy for a longer period of time.

Mango

Mangoes are rich in vitamin C and beta carotene, two nutrients that help the body produce collagen and defend against the damaging effects of UV radiation. Use this extract in conjunction with your regular sunscreen to provide your skin with the highest possible level of defence. A face mask that is both moisturizing and recommended for use by aestheticians is made using mangoes. Puffiness, dark circles, Crow's feet, eye bags, fine wrinkles, and fat particles beneath and around the eyes are all reduced as a result of using this product. Mangoes have been shown to have a powerful effect on the restoration of damaged skin, and there is now a product on the market in the shape of an eye cream that may heal, mend, and relax your skin, resulting in an even skin tone and a smooth, radiant complexion..

Edelweiss

Edelweiss, the national flower of Austria, contains anti-oxidants and protects against the effects of ultraviolet light. It is essential for native Swiss Alps survival and protects skin cells from the potentially detrimental effects of free radicals.

8.8.2. Plants for Healing Burnt or Damaged Skin

Aloe Vera

Aloe vera has 75 potentially active constituents: vitamins, enzymes, minerals, carbohydrates, lignin, saponins, salicylic acids and amino acids. Glucomannan, which is a mannose-rich polysaccharide, and gibberellin, which is a growth hormone, interact with growth factor receptors on the fibroblast, which stimulates the fibroblast's activity and proliferation. This, in turn, significantly increases collagen synthesis after topical and oral administration of *Aloe vera* (Chithra et al., 1998). Inhibition of the cyclooxygenase pathway and a reduction in the generation of prostaglandin E2 from arachidonic acid are both effects of aloe vera. C-glucosyl chromone is a new anti-inflammatory chemical that was only recently identified from gel extracts (Hutter et al., 1996). When aloe vera gel is applied to the skin, an antioxidant protein called metallothionein is produced in the skin.

This protein is responsible for scavenging hydroxyl radicals and preventing the suppression of superoxide dismutase and glutathione peroxidase in the skin. Aloe vera gel also has anti-inflammatory properties. It does this by inhibiting the creation and release of immunosuppressive cytokines that are produced from skin keratinocytes, such as interleukin-10 (IL-10), and so preventing the suppression of delayed type hypersensitivity that is caused by ultraviolet light (Byeon et al., 1998). The ability of mucopolysaccharides to bind water to the skin is an important function. As a result of aloe's ability to stimulate fibroblast, the production of collagen and elastin fibres is

increased, which in turn makes the skin more elastic and reduces the appearance of wrinkles.

Additionally, it has cohesive effects on the superficial epidermal cells that flake off, and it does this by glueing the cells together, which results in a softer skin texture. Additionally, the amino acids work to soften and smooth rough skin cells, while the astringent properties of zinc help to shrink pores. Its moisturizing properties have also been researched in the treatment of dry skin linked with occupational exposure. Researchers found that wearing aloe vera gel gloves enhanced the skin's integrity, decreased the appearance of tiny wrinkles, and brought down erythema levels.

Additionally, it has an impact that is anti-acne (West & Zhu, 2003). The presence of mannose-6-phosphate in *Aloe vera* has been shown to enhance fibroblast activity, leading to a rise in collagen and proteoglycan production as well as an increase in wound tensile strength. The binding of mannose 6-phosphate by aloe gel activates macrophages and fibroblasts, leading to an increase in the creation of collagen and proteoglycan, both of which are necessary for wound healing. The oxidative burst produced by human neutrophils may be prevented by mannose, which also protects the tissue. Because of all of the positive properties that *Aloe vera* has on the skin, it is common practice for cosmetic businesses to use aloe vera sap or other derivatives in their products such as cosmetics, moisturizers, soaps, sunscreens, incense, shampoos, and so on (Mukherjee et al., 2014).

Echinacea

Using cytokine-antibody arrays, researchers discovered that the bacteria known as *Propionibacterium acnes*, which are the primary cause of acne, triggered the release of significant levels of a number of pro-inflammatory cytokines. These cytokines included IL-6 and IL-8 (CXCL8). On the other hand, the *E. purpurea* fully nullified this impact and returned the cytokine levels to their previous levels of normalcy. *E. purpurea* possesses the potential to reverse the inflammation that is caused by bacteria (Sharma et al., 2011).

***Comfrey* (*Symphytum officinale*)**

Comfrey, scientifically known as *Symphytum officinale* L., may be found growing wild in Poland. The amine molecule known as allantoin, together with the phenolic acids known as rosmarinic, salicylic, and caffeic acid, as well as the mucilage polysaccharides and glycopeptides, are the active components of comfrey root (Monograph given by European Scientific Cooperative on Phytotherapy, 2009). Rosmarinic acid is responsible for inhibiting the production of prostaglandins, and

glycopeptides, in a dose-dependent manner, are responsible for inhibiting the release of prostaglandins (PGE2 and PGI2), in addition to 12-HETE and arachidonic acid.

Green Tea

Terpenes, terpenoids, and polyphenols are the primary components of green tea. The catechins epicatechin (EC), epigallocatechin (EGC), epicatechin gallate (ECG), and epigallocatechin gallate are the primary polyphenolic compounds found in green tea. Flavonoids are also present in green tea (EGCG) (Liu et al., 2008). Green tea has a possible wound healing impact because it can suppress the growth of pathogens, reduce the inflammatory response, and preserve healthy tissue. It's possible that the presence of terpenoids, polyphenols, carnosol, and carnosic acid is responsible for this wound healing action. Anti-inflammatory and antinociceptive properties of *Rosmarinus officinalis* L. essential oil in experimental animal models (Takaki et al., 2008).

According to the findings of an intriguing study that involved 1256 women in the United Kingdom between the ages of 65 and 76, it was found that tea drinkers had significantly greater mean bone mineral density (BMD) measurements (approximately 5%, adjusted for age and body-mass index). This was the case regardless of whether or not the women smoked, used hormone replacement therapy, drank coffee, or if milk was added to their tea (Thakur et al., 2022). The bone mineral density (BMD) readings of older women who drank tea were greater than those of older women who did not drink tea (Hegarty et al., 2000).

Lavender

The plant family known as Lamiaceae (formerly known as Labiatae) is often known as the mint family. Lavender is a member of this family. There are several species in this family; aromatherapy makes use of some of those species. Burns respond well to the analgesic, antimicrobial, and immune system booster properties of lavandula angustifolia. Essential oils should be administered topically to any areas that are showing signs of localised irritation. The oils used in massage, as well as those used in bathing and skin care, are absorbed into and through the skin (Hongratanaworakit & Buchbauer, 2007; Buckle 2010). They discovered that the majority of the essential oils they tested included eugenol, eugenyl acetate, thymol, capsaicin, curcumin, and carvacrol, and that the antiphlogistic actions were directly connected to the vascular reactivity of early inflammation. The essential oil of lavender is applied to small wounds and burns as an antibacterial, and it is also used to promote relaxation and sleep (Buckle 2010).

***Burdock* (*Arctium lappa and Arctium minus*)**

Phenolic compounds can be found in the leaves and the seeds (Ferracane, Graziani, Gallo, Fogliano, and Ritieni (2010). Seeds, roots, and leaves all contain active components that have anti-inflammatory, antioxidant, anti-nociceptive, and free radical scavenging properties (Erdemoglu et al., 2009). The researchers Liu, Chen, Schliemann, and Strack were isolated lignans from leaf extracts (2005). The primary active components that have been isolated from this plant include tannin, arctigenin, arctin, beta-eudesmol, caffeic acid, chlorogenic acid, inulin, trachelogenin 4, sitosterol-beta-D-glucopyranoside, lappaol, and diarctigenin. Inhibition of inducible nitric oxide synthase (iNOS) expression and production of nitric oxide (NO), suppression of pro-inflammatory cytokine expression, inhibition of the nuclear factor-kappa B (NF-B) pathway, activation of antioxidant enzymes, and scavenging of free radicals are the essential mechanisms underlying burdock's anti-inflammatory action.

It has been discovered that the extract of burdock can prevent degranulation and the production of cysteinyl leukotrienes (also known as Cys-LTs) by peripheral blood mononuclear cells (PBMCs) (Knipping *et al.*, 2008). Cys-LTs are inflammatory mediators that operate in a manner comparable to that of histamine and prostaglandins. The suppression of Cys-LT has been hypothesized to constitute an anti-inflammatory response. Burdock extract was also shown to significantly alleviate acute mouse ear edoema that was brought on by an allergic response that was generated. As a consequence of this, there is evidence to suggest that burdock has a significant effect in reducing inflammation (Ferracane, et al., 2010; Lin, Lu, Yang, Chuang, and Ujiie, 1996). Liu, Chen, Schliemann, and Strack (2005) have been evidently suggested that burdock has significant anti-inflammatory effect (Knipping et al., 2008). lignans that have the ability to prevent the generation of NO. There are a number of inflammatory illnesses that might potentially be treated by inhibiting the generation of NO in macrophages via the iNOS enzyme (Wang et al. 2007). In murine macrophage RAW264.7 cells that had been activated with lipopolysaccharide (LPS), the generation of NO was substantially suppressed by lappol F and diarctignin (Park et al., 2007).

***Thymus vulgaris* (Thyme)**

The essential components of thyme are phenols (such as thymol and carvacrol), flavonoids, borneol, linalool, rosmarinic acid, saponins, tannins, terpenoids, and acetophenone glycosides. Thyme is also known to contain borneol and linalool. Additionally, studies have shown that thyme has antioxidant and anti-inflammatory properties, including the ability to block the production of prostaglandin.

Roses

Rose water is usually made with roses as the primary ingredient. Rose water contains antioxidants that prevent the cells in the skin from being damaged by free radicals. Rose water also possesses anti-inflammatory characteristics, which means that it may be applied to the skin to alleviate the irritation produced by disorders such as eczema and rosacea. This property allows rose water to be utilized for both internal and external purposes. *Rosa alba*, *Rosa centifolia*, *Rosa damascena*, *Rosa centifolia* and *Rosa rugosa* are some common roses seen in gardens. *Rosa damascene* and *Rosa centifolia* are two species of rose that are used in industry to make rose oil and rose water. Due to the inclusion of phytochemicals, including citronellol, geraniol, nerol, stearopten, phenylethyl alcohol, and farnesol, as well as trace elements such as rose oxide, damascone, damascenone, and ionone, rose extracts are pricey but provide good results when used for skin care (Clarke, 2008).

***Lady's Mantle* (*Alchemilla spp.*)**

Alchemilla vulgaris L (Lady's Mantle), which is a member of the rose family, is an ingredient in ayurveda medications that are used to heal wounds, stop bleeding, and treat other skin conditions. The usage of lady's mentle in anti-wrinkle cream preparation is beneficial. UV rays are harmful to the proteins collagen and elastin, which keep the skin elastic and smooth. When collagen and elastin are overexposed to UV, their respective genes get damaged, which leads to the development of irreversible physical alterations such as wrinkles. It has a calming effect on hands that are both rough and sensitive. It has astringent properties. It is capable of producing styptic effects. It was discovered that *Alchemilla vulgaris* has a significant concentration of tannins, as well as flavonoids and proanthocyanidins (Falchero et al., 2009; Heikel, 1995).

Helichrysum

Helichrysum italicum (Roth) G. Don Fil is a medicinal plant that is a member of the Asteraceae family. It possesses potentially useful pharmacological actions and plays a key part in the traditional medicine of nations located in the Mediterranean. In the treatment of a variety of health conditions, including allergies, colds, cough, skin, liver, and gallbladder issues, inflammation, infections, and inability to sleep, the blossoms and leaves of this plant are the portions that are utilised the most (Mugunthan et al., 2023). As evidenced in animal models, phytochemicals such as acetophenones, flavonoids, and phloroglucinols have anti-inflammatory characteristics that are demonstrated by an inhibitory action on several pathways of arachidonic acid metabolism and other pro-inflammatory mediators (Antunes Viegas et al., 2014).

8.8.3. Moisturizers

By delaying the evaporation of water from damp skin surfaces, moisturizers slow down the wrinkling process and make wrinkles less noticeable. The 'Polysaccharides' component that is present in Skin has preventive benefits that help enhance the skin and keep it in healthy conditions. As a result, components that have a shielding effect on these skin polysaccharides are utilised both in the treatment of the skin and in the creation of an efficient cosmetic formulation. Studies have shown that plant or other natural sources that are rich in polysaccharides such as glucose, galactose, mannose, and ribose have the potential to increase the water content of the stratum corneum and reduce the transepidermal water loss. This is helpful in a significant reduction of the scaliness and the roughness of the skin. Other natural sources that are rich in polysaccharides include xylose, fructose, and arabinose (Maia Campos et al., 2013).

Anti-inflammatory

Some of the plants are used in medicines and recipes to help reduce inflammation and slow down the ageing process.

***Speedwell* (*Veronica officinalis*)**

Speedwell, or Veronica officinalis, is a violet-flowering plant in the family Plantaginaceae. It is often used as a food or medicine. On the basis of monitoring several biomarkers of oxidative stress, its extracts have been shown to protect against oxidative stress. Speedwell has been shown to have anti-inflammatory properties by reducing the expression of COX-2, which lessens the release of PGE2, an inflammatory mediator. Veronica officinalis doesn't have much of an effect on mast cells' ability to release granules. Instead, it stops gene and protein expression of the chemokine eotaxin in A549 lung epithelial cells, which is important for bringing in cells involved in inflammation when the lungs are sick. Also, when TNF- activated A549 cells' COX-2 expression was stopped through the NF-B signaling pathway, less of the inflammatory mediator PGE(2) was released (Gründemann et al., 2013).

***Cucumber* (*Cucumis sativus*)**

Human red blood cells showed that a phytochemical extract of *Cucumis sativus* flowers made in ethyl acetate had a strong anti-inflammatory effect in the lab (HRBC) (Muruganantham, et al., 2016).

8.8.4. Toning and astringent herbs

***Witch Hazel (Hamamelis virginiana* L.)**

Hamamelis virginiana L. shows high antioxidant activity due to the presence of high polyphenolic contents, and also promising anti-ageing activity via prohibition of collagenase and elastase (Thring et al., 2009). The reported anti-inflammatory mechanisms included decrease in pro-inflammatory cytokines IL-6 and TNF-α, increasing anti-inflammatory IL-10 secretion, and reduction of cyclooxygenase-2 (COX-2) and nitric oxide synthase expression (Mueller et al., 2010). Witch Hazel leaves contains strong antioxidants such as tannins e.g. proanthocyanidins, ellagitannins and some essential oils and polyphenols such as gallic acid which are responsible for the effects (Thring et al., 2011). Tannins from Witch Hazel also exhibit toner and astringent property.

Yarrow

Yarrow is one among highly effective astringents. It is containing astringent tannins and resins, along with anti-inflammatory and antiseptic oils that make it excellent wound healing constituent. It is believe to be have silica for repairing damaged tissue e.g. leaky gut syndrome where gut get damaged due to inflammation (Pursell, 2015).

Lemon Balm (Melissa officinalis L.)

Lemon balm or mentha or pippermint is used in the Iranian traditional system of medicine for the cure of ulcers and wounds. It can be used in astringent toner preparation by infusing the fresh plant in witch hazel. Peppermint or mentha oils is reviewed and documented for its antiseptic, antiinflammatory, nervine stimulant, astringent, decongestant, vasoconstrictor, and stomachic properties. Its pharmacological activity is due to menthol, main constituent of peppermint oil. Peppermint oil has at least 44% free menthol.

Lemon (Citrus limon Linn.)

C. limon belongs to the family of Rutaceae. *C. limon* oils ingredients have excessive in the d-limonene and l-limonene, terpenes, together constituting about 90 percent of the bulk of the oil. Traces of sesquiterpene, phellandrene and pinene also exist. The valuable portion of the oil is the remaining 10 percent which has oxygenated bodies, mainly the aldehyde citral, to which the odor of the oil. These phytochemicals have astringent, antiseptic, and detoxifying properties, for blemishes linked with oily skin. The monoterpene present in it is prominently effective to skin that's why it helps in wound healing (Price, 1995; Tisserand and Young, 2013).

Rosemary (Rosmarinus officinalis L.)

Sienkiewicz et al. (2013) stated that rosemary essential oil contains mainly 1,8-cineole (46.4%), camphor (11.4%) and α-pinene (11.0%). The constituents of the rosemary essential oil used by Jiang et al. (2011), was composed mainly by 1,8-cineole (26.54%) and α-pinene (20.14%). Bendeddouche et al. (2011), reported that the main elements of the tested essential oil were camphor (37.6%), p-cymene-7-ol (7.8%), 1,8-cineole (10.0%), and borneol (5.4%). Essential oils of rosemary are useful in regular massage for toning the skin and eliminating dryness. It provides skin a healthy and even shine when regularly applied. It can be used as component of moisturizers and other creams. Essential oils of rosemary are useful in making anti-ageing regimes due to potential role in stimulating circulation in the torso, aids digestion, clear phlegm, deepens the breath, lifts the spirits and promotes tissue repair (Carberry, 2018).

8.8.5. Plants for tropical use

As moisturizers

Moisturizers minimize the wrinkle process by preventing the loss of water from humid skin surfaces. 'Polysaccharides' content present in Skin have protective effects to improve and maintaining the skin in good conditions. Thus, ingredients having protective effect on these skin polysaccharides are used in on the skin and to develop an effective cosmetic formulation. Studies has shown that plant or other natural sources which are rich in polysaccharides such as galactose, glucose, ribose and mannose has a potential to elevate the stratum corneum water content and decrease the trans-epidermal water loss which is useful in a substantial reduction of the roughness and scaliness the of the skin (Maia Campos et al., 2013).

Anti-inflammatory

Some of the plants are utilized in pharmaceutical products or recipes for minimizing inflammation and decreasing the ageing rate.

***Speedwell* (*Veronica officinalis*)**

Speedwell (*Veronica officinalis;* Family-Plantaginaceae) is a violet-flowering plant, commonly used as an edible or medicinal herb. Its extracts have been reported for protective effects against oxidative stresses on monitoring several biomarkers of oxidative stress. Anti-inflammatory mechanisms have been identified in Speedwell by diminishing the release of inflammatory mediator, PGE2 by reducing COX-2 expression. *Veronica officinalis* has little effect on the degranulation capability of mast cells it rather prevents gene and protein expression of the chemokine eotaxin in A549 lung epithelial cells, which is necessary for deployment of inflammatory-associated cells in lung diseases. Furthermore, release of the inflammatory mediator PGE(2) gets

reduced through inhibition of COX-2 expression via the NF-κB signaling pathway in TNF-α-activated A549 cells (Gründemann et al., 2013).

Cucumber (Cucumis sativus)

Phytochemical extract of *Cucumis sativus* flowers prepared in Ethyl acetate had shown a significant anti-inflammatory *in-vitro* activity by human red blood cell (HRBC) (Muruganantham and Senthamilselvi, 2016).

8.8.6. Phytochemicals

Phytochemicals are bioactive compounds found in plants that offer powerful anti-aging benefits by protecting cells from damage, reducing inflammation, and promoting healthy aging pathways. They act as antioxidants, sirtuin activators, and modulators of cellular processes that contribute to longevity.

Key Phytochemical Categories and Their Anti-Aging Benefits

i. **Polyphenols**

Polyphenols are powerful antioxidants that protect against oxidative stress and inflammation. It activate sirtuins and promote cellular repair. For e*xamples:* **Resveratrol:** Found in red grapes, red wine, and peanuts. Activates SIRT1, mimicking the effects of caloric restriction, **Quercetin:** Found in apples, onions, and capers. Supports cellular senescence clearance and reduces inflammation, **Epigallocatechin Gallate (EGCG):** From green tea. Protects cells from oxidative damage and promotes autophagy, **Fisetin:** Found in strawberries. Acts as a senolytic, clearing out aging cells.

ii. **Carotenoids**

Carotenoids are fFat-soluble pigments that protect skin, eyes, and tissues from aging-related damage. Examples are **Beta-carotene:** Found in carrots and sweet potatoes. Supports skin health and reduces oxidative stress, **Lutein & Zeaxanthin:** Found in spinach and kale. Protect eyes from age-related degeneration and **Lycopene:** Found in tomatoes and these molecules support cardiovascular health and skin protection.

iii. **Flavonoids**

Flavonoids are anti-inflammatory and antioxidant compounds that improve blood flow and cellular resilience. *Examples:* **Anthocyanins:** Found in berries and purple foods. Protect cells from oxidative damage, **Hesperidin:** Found in citrus fruits. Supports vascular health and reduces inflammation.

iv. Glucosinolates & Isothiocyanates

Gosinolates & Isothiocyanates are compounds in cruciferous vegetables that support detoxification and cellular protection. *Examples:* **Sulforaphane:** Found in broccoli sprouts. Activates antioxidant pathways and supports detoxification, **Indole-3-Carbinol:** Found in cruciferous vegetables. Supports hormonal balance and DNA repair.

v. **Stilbenes**

Stilbenes are natural compounds known for longevity-promoting effects. *Examples:* **Resveratrol:** Boosts mitochondrial health and activates sirtuins and **Pterostilbene:** Similar to resveratrol but with better bioavailability.

vi. **Tannins**

Tannins are Antioxidants that protect cells from free radicals and reduce inflammation. *Examples:* Found in tea, wine, and pomegranates.

vix. Food Sources of Anti-Aging Phytochemicals

Food Sources of Anti-Aging Phytochemicals includes fruits: Berries, grapes, pomegranates, apples, citrus fruits, **Vegetables:** Cruciferous vegetables (broccoli, kale, Brussels sprouts), carrots, tomatoes, spinach, **Legumes & Nuts:** Lentils, peanuts, walnuts, **Herbs & Spices:** Turmeric (curcumin), ginger, rosemary and **Beverages:** Green tea, coffee, red wine (in moderation).

viix. Supplements for Phytochemicals

If dietary intake is insufficient, supplements like **resveratrol**, **quercetin**, **fisetin**, **EGCG**, and **sulforaphane** can provide concentrated benefits.

8.9. Sleep

Sleep is a vital component of human health. The amount of sleep a person needs changes with their age. A person's internal circadian rhythm is responsible for their sleep- wake cycle. Do we really know what the best and healthiest sleep pattern is for an individual's overall health. There are 3 basic pattern of sleep like monophasic- individual sleeps once per day, Biophasic- when someone sleep twice per day, poly-phasic sleep- when a person sleeps for periods of time throughout the day.

As we know that sleep is change according to age. Mander et al. (2017) told that both the macro-level structure of sleep (duration and stage of sleep) and micro level architecture of sleep (quantity and Quality of sleep oscillatious) change as we progress into our older age. Sleep is not just for resting. It's when your body repairs damage and rebuilds. Good sleep is associated with eating more nutrient dense foods, exercise and reducing stress because all these help to improve your sleep quality. Insufficient sleep results in puffy eyes and wrinkle.

Conclusion

While ageing is an inevitable biological process, growing research suggests that its rate and impact can be influenced by targeted interventions, including the use of nutritional supplements. Supplements such as antioxidants, vitamins, minerals, and compounds like resveratrol, coenzyme Q10, and NAD+ precursors have shown potential in supporting cellular health, reducing oxidative stress, and enhancing mitochondrial function—all of which are key to slowing age-related decline. Although many of these compounds are promising, it is important to approach supplementation with scientific caution. The effectiveness, appropriate dosage, and long-term safety of anti-ageing supplements continue to be areas of active investigation. Moreover, supplements should not replace a healthy lifestyle but rather serve as complementary tools alongside balanced nutrition, regular physical activity, stress management, and adequate sleep. In conclusion, supplements may offer valuable support in slowing aspects of the ageing process, but their use should be personalized, evidence-based, and integrated into a broader strategy aimed at healthy and graceful ageing.

Author Contributions: "Conceptualization, methodology, software, validation, formal analysis, investigation, resources, , writing—original draft preparation, and editing: KS and SM. Writing—original draft preparation, and editing, data curation and validation: BP and AK. The authors have read and agreed to the published version of the manuscript.

Funding: "This research and the APC were not funded by anyone".

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: All data are published in this article.

Acknowledgments: SM acknowledges and expresses gratitute to the Management, administration and Academic officials of MUIT, Noida Campus for their valuable support during preperation, and submission of the manuscript.

Conflicts of Interest: “The authors declare no conflict of interest.” “The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results”.

Citation: Singh K, Paital B, Mathur S, Kumar A (2025) Targeting Longevity: Supplements as Interventions to Modulate Aging Pathways and Enhance Healthspan. *In*: Paital B (ed) *Defy the Clock with Slow Aging*, 1st edn. Deep Science Publishing, USA, pp. 64-92, https://doi.org/10.70593/978-93-49910-64-5_8