CHAPTER 23

Asian Medicinal Remedies for Alleviating Aging Effects

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1. INTRODUCTION

Aging or senescence, fundamentally a complex process, following the reproductive phase of life, is an inevitable fact of life. Aging is characterized by a progressive decline in the efficiency of physiological processes that ensues and is manifested within an organism at genetic, molecular, cellular, biochemical, hormonal, organ, physiological, and system levels, which cumulatively results in the decrease of physical function, reduction in the fecundity, loss of vitality, etc. (Halliwell and Gutteridge, 2007). Although the basic mechanisms responsible for aging are still poorly understood, various hypotheses have been proposed. A growing body of evidence suggests that the free radical theory is the most accepted and scientific studies are emphatically substantiating this (Halliwell and Gutteridge, 2007).

Aging increases vulnerability to cancer and various metabolic and degenerative diseases. Aging impairs all the major organs and some of the most important and exclusive diseases include Parkinson's disease, Alzheimer's disease, dementia, cognitive impairment, atherosclerosis, hearing impairment, loss of vision, cataract formation, reduced lung capacity, impairment of kidney function, loss of elasticity and wrinkling of skin, reduced immunity, and vulnerability for cancer. Additionally, exposure to xenobiotic chemicals, pollutants, carcinogens, infections, radiations, and faulty lifestyle exacerbate the aging process and increase the incidence of age-related diseases (Halliwell and Gutteridge, 2007).

2. ANTIAGING CHEMICAL COMPOUNDS

Preventing/retarding of the aging process has been a long sought goal and agents that can prevent aging, especially by improving memory, vision, and virility, and by preventing wrinkling of skin and graying of hair, are in great demand. However, the use of these agents mostly available over the counter is scientifically not validated and is based on

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anecdotal evidences. Nonetheless, the market of such products is on the rise in both developed and developing countries. However, several of the antiaging remedies, especially those used in skin care, are reported to possess deleterious effects that with time may negate the beneficial effects. In this context, there is a need for safe products that are effective and devoid of any side effects.

3. PLANTS USED AS ANTIAGING COMPOUNDS

Since antiquity, plants have been an integral part of Ayurveda, Chinese, Unani, Siddha, Arabic, Sri Lankan, and Tibetan systems of traditional medicine and recently are being investigated for their effectiveness as antiaging agents according to protocols and norms suggested in the modern system of medicine. The main reasons for the increased interest in medicinal plants include their cost-effectiveness, easy availability, and safety. Scientific studies carried out in the recent past have shown that some of the plants like *Rhodiola rosea* (golden root), *Lycium barbarum* (lycii berry), *Vaccinium myrtillus* (bilberry), *Ginkgo biloba* (ginkgo), Ginseng, *Silybum marianum* (milk thistle), *Curcuma longa* (turmeric), *Gynostemma pentaphyllum* (jiaogulan), *Withania somnifera* (ashwagandha), *Vitis vinifera* (grapes), and *Centella asiatica* (gotu kola) are useful in preventing aging. In the ensuing section, the scientifically validated observations and mechanisms responsible for the prevention/amelioration of aging by these plants are addressed.

3.1 *Curcuma longa* (Turmeric)

The perennial herb *Curcuma longa* L., whose rhizome is commonly referred to as turmeric, is an important spice for Asians, especially Indians, and is one of the primary ingredients that has made the Indian curry so famous a recipe in the West. Curcuma is an important medicinal plant and, for over 4000 years, has been used in various folk and traditional Asian and African systems of medicine to treat a wide variety of ailments. The rhizome and its active principle, a group of curcuminoids, are widely used as culinary spices, preservatives, food additives, cosmetics, and as oleoresin in food and pharmaceutical industries. In the last two decades, there has been considerable interest among the biomedical scientists to explore the possible therapeutic benefits of turmeric and its active principle curcuminoids, and innumerable studies have validated the ethnomedicinal uses.

Turmeric has been used as an oral and topical agent to treat a wide variety of ailments, including infective wounds, amenorrhea, liver disease, common colds, pulmonary dysfunction, atherosclerosis, cancer, neurodegenerative diseases, pancreatitis, and rheumatoid arthritis (Aggarwal and Harikumar, 2009; Miquel et al., 2002; Salvioli et al., 2007). Preclinical studies have shown that turmeric enhances learning ability and spatial memory via the modulation of central serotoninergic system activity, and increases tolerance to stress conditions (Pyrzanowska et al., 2010). Animal studies have also shown that the application of turmeric prevents aging of the skin and also ultraviolet B

(UVB)-induced skin aging by inhibition of increase in matrix metalloproteinase-2 expression (Sumiyoshi and Kimura, 2009).

Polyphenols of turmeric are shown to induce heme oxygenase 1 and Phase II detoxification enzymes in neurons. This renders protective effects and protects the neurons against oxidative challenges and stress that may contribute to aging of brain and bring about neurodegenerative changes (Scapagnini et al., 2010). Turmeric extract is also shown to reduce glutamate levels in the hippocampus of aged rats, and this action has proposed to be responsible for the reduction of glutamate-mediated excitotoxicity, in an experimental model of neurodegenerative disease (Pyrzanowska et al., 2010). Studies have also shown that curcumin possesses antiamyloidogenic effects (Shytle et al., 2009) and improves cognitive task and locomotory activities. Administering curcumin has been shown to increase the activities of oxidative defense system and to restore the activity of mitochondrial electron transport chain in the brain cells of mice treated with D-galactose (Kumar et al., 2011). Curcumin treatment is also shown to extend the life span and modulate the expression of age-associated aging genes in *Drosophila melanogaster* (Lee et al., 2010).

3.2 Green Tea (*Camellia sinensis*)

Green tea is an antiaging herb of repute and is used by the Asian population for centuries. The aqueous soluble polysaccharides (Quan et al., 2011) and polyphenols are scientifically shown to be responsible for the antioxidant action of green tea (Khan and Mukhtar, 2007; Povichit et al., 2010). Green tea is rich in polyphenols like epicatechin, epicatechin-3-gallate, epigallocatechin, epigallocatechin-3-gallate, theanine, and caffeine. These polyphenols are potent antioxidants and are far more effective than vitamin C and vitamin E (Khan and Mukhtar, 2007). In vitro assays have shown that green tea possesses free radical scavenging effects (Povichit et al., 2010), and has the ability to inhibit protein glycation (Povichit et al., 2010) and also ameliorate the metabolic syndrome (Basu et al., 2010). Additionally, the antioxidant effect of green tea was also observed in animal models of study confirming the fact that the in vitro observations translate into the animal systems (Wojciech et al., 2010).

Green tea possesses antioxidant rejuvenating potency and its role in the amelioration of senescence-mediated redox imbalance in aged rat cardiac tissue has been established (Kumaran et al., 2009). Polyphenols of green tea possess iron-chelating, neurorescue/neuroregenerative, and mitochondrial stabilization actions, and the ability to prevent deposition of amyloid proteins. It is of immense value in preventing dementia, Parkinson's disease, and Alzheimer's disease (Mandel et al., 2008). Administering green tea extract has also been shown to be effective in enhancing learning and memory in aged rats and may be useful in reversing age-related neural deficits (Kaur et al., 2008).

Prolonged consumption of green tea is also shown to protect proteins and lipids against oxidation and to reduce lipofuscin deposition in the rat hippocampal formation as well as improving spatial memory during aging (Assuncao et al., 2010). Long-term green tea ingestion improved antioxidant systems and activated the transcription factor cyclic adenosine monophosphate (cyclic AMP) response element-binding in the aging rat's hippocampal formation, leading to neuroprotection mediated by upregulation of brain-derived neurotrophic factor (BDNF) and B-cell lymphoma-2 (Bcl-2) (Assuncao et al., 2010). Studies in animal models of carcinogenesis have shown that green tea and epigallocatechin gallate (EGCG) can inhibit tumorigenesis during the initiation, promotion, and progression stages (Lambert and Elias, 2010).

Green tea-catechin intake is reported to prevent experimental tumor metastasis in senescence-accelerated mice model via inhibition of a reduction in immune surveillance potential with age, as indicated by prevention of decrease in natural killer T cell activity (Shimizu et al., 2010). Green tea possesses antiaging effects and is known to reduce wrinkles and improve skin moisturization (Chuarienthong et al., 2010). The protective effect of green tea against skin aging is mainly attributed to the catechins (Hsu, 2005), and the polyphenols are reported to possess chemopreventive, natural healing, and antiaging effects on human skin (Hsu, 2005). Green tea-containing sunscreens also possess protective effects against ultraviolet radiation (UVR)-induced photoaging and immunosuppression (Li et al., 2009).

3.3 *Rhodiola rosea* (Golden Root)

Rhodiola rosea, also known as 'golden root,' is a member of the family Crassulaceae. Its yellow flowers smell similar to roses and, therefore, the species name is attributed as rosea. The roots of the plants are the most sought, and have been used in the traditional system of medicine in Europe and Asia most importantly as an antistress and adoptogenic agent. It is also referred to as Cosmonauts' plant, as it was carried by Russian cosmonauts in space to protect themselves against the deleterious effects of ionizing radiation in space. Studies indicate that the *R. rosea* extract possesses protective properties against free radical-mediated oxidative damage, adoptogenic effects, and potential to increase the life span of organisms (Jafari et al., 2007; Wiegant et al., 2009). Salidroside, the principal phytochemical of *R. rosea*, has also been shown to possess antioxidant effects (Guan et al., 2011; Zhang et al., 2010) to prevent apoptosis and premature senescence in cultured rat neural cells (Chen et al., 2009; Zhang et al., 2007).

3.4 *Vaccinium myrtillus* (Bilberry)

Bilberry contains several types of species and belongs to the genus Vaccinium of the family Ericaceae. *Vaccinium myrtillus* L is the most recognized and well-studied species, but there are several other closely related species and morphotypes. The plants bear edible berries that are high in nutritive value and are obviously of dietary use. The plants are of medicinal use in treating several diseases like diabetes, several ocular diseases, and vascular disorders. The extracts of both leaf and fruits, and the phytochemicals have been shown to scavenge free radicals in vitro (Faria et al., 2005; Piljac et al., 2009; Rahman et al., 2006). The flavanoids present in the extract are also reported to possess antioxidant properties and are a major skin-rejuvenating supplement (Kahkonen, 2001).

Preclinical studies with cultured human retinal pigment epithelial (RPE) cells have shown that the anthocyanins and other phenolics present in bilberry upregulate the oxidative stress defense enzymes heme-oxygenase (HO)-1 and glutathione S-transferase-pi (GST-pi) (Milbury et al., 2007). The leaf extracts also enhanced glutamate decarboxylase gene expression in dermal fibroblasts, resulting in the stimulation of cell growth, hyaluronic acid, and glutathione synthesis. In addition, the extract also showed inhibitory activity on collagenase and elastase, enzymes responsible for the ragging and wrinkled nature of skin; it also decreased the melanin content in B16 melanoma cells and suppressed release of histamine from mast cells. Together, all these observations clearly indicate that the leaf extracts are a promising natural ingredient against aging of skin (Kenichi, 2006).

Animal studies have also shown that bilberry reduces oxidative stress and protects brain cells against oxidative damage (Sinitsyna et al., 2006; Yao and Vieira, 2007) and protects animals from senescence-induced macular degeneration and cataracts (Fursova et al., 2005). It has also been shown to ameliorate cardiotoxicity from ischemia-reperfusion injury in animals (Ziberna et al., 2010), and modulate the expression of inflammatory molecules in humans evaluated and observed to be at a higher risk for cardiovascular death (Karlsen et al., 2010).

3.5 *Ginkgo biloba* (Ginkgo)

The *Ginkgo biloba* tree is arguably one of the oldest known trees on earth, with fossil records dating back to more than 200 million years. It is a highly unusual nonflowering plant and is regarded as a 'living fossil.' The leaves are an integral component of Chinese traditional medicine for treating various ailments. Ginkgo has been reported to influence fundamental aspects of human physiology by improving blood flow to tissues including the brain, and by enhancing cellular metabolism. The plant possesses flavonoids (kaempferol, quercetin, and isorhamnetin), coumaric acid, diterpenes (called ginkgolides A, B, C, and M), sesquiterpenes (bilobalide), and the organic acids vanillic, protocatechic, and hydroxykinurenic. These phytochemicals are responsible for the various pharmacological effects that include antioxidant, anti-inflammatory, and circulation-stimulant properties.

Preclinical studies have demonstrated that Ginkgo possesses protective effects against age-related neurodegenerative changes and diseases (DeFeudis and Drieu, 2000). Experiments have also shown that the lactone of ginkgo attenuates lipid peroxidation and apoptosis of cerebral cells in aging mice (Dong et al., 2004). It is also reported to prevent age-related caspase-mediated apoptosis in rat cochlea, thereby indicating its usefulness in preventing the age-related decrease in auditory functions (Nevado et al., 2010). Administration of Ginkgo extract prevented oxidative stress, mitochondrial DNA damage, and mitochondrial structural changes in brain and liver cells of aging rats (Sastre et al., 1998). Administering Ginkgo extract to aged mice has also been shown to restore the mitochondrial function as indicated by amelioration of decreased mitochondrial levels of cytochrome c oxidase, adenosine triphosphate (ATP), and glutathione in platelets and hippocampus (Shi et al., 2010).

A multicenter, double-blind, drug versus placebo trial of patients with cerebral disorders has also shown that ginkgo extract is effective against cerebral disorders resulting due to aging; the difference between control and treatment groups became significant at 3 months and increased during the following months (Taillandier et al., 1986). Myriad studies have shown the beneficial effects of ginkgo in neurological disorders with dementia (Leuner et al., 2007). A clinical study demonstrated that an antiwrinkle cosmetic preparation containing ginkgo increased skin moisturization and smoothness, and reduced roughness and wrinkles (Chuarienthong et al., 2010). Ginkgo is known to ameliorate oxidative stress and to prevent age-related eye diseases (Rhone and Basu, 2008). Ginkgo is also reported to improve distal left anterior descending coronary artery blood flow and endothelium-dependent brachial artery flow-mediated dilation in healthy elderly adults, thereby imparting its cardioprotective effects at least in part (Wu et al., 2008).

3.6 *Panax ginseng* (Ginseng)

Globally, among all medicinal plants, Ginseng is probably the most famous and extensively investigated plant. The generic name Panax is derived from the Greek word *panakos* meaning a panacea, a virtue ascribed to it by the Chinese, who consider it a sovereign remedy in almost all diseases for more than 2000 years. Ginseng is a slow-growing perennial plant and the fleshy root bears resemblance to the human body. Due to this morphological feature, it is also known as 'man-root.' There are 11 species of ginseng, but the most important and well-studied species are the *Panax ginseng* (Asian, Korean, or Chinese ginseng) and *Panax quinquefolius* (also called American, Canadian, or North American ginseng). The ginsenosides are reported to be responsible for myriad benefits.

In the traditional Chinese system of medicine, ginseng is referred to as the ultimate tonic that benefits the whole body. Ginseng has been used to improve the body's resistance to stress and to increase vitality, general well-being, immune function, libido, and athletic performance. Preclinical studies suggest that it possesses adaptogenic, immunomodulatory, anti-inflammatory, antineurological, hypoglycemic, antineoplastic, cardiovascular, central nervous system (CNS), endocrine, and ergogenic effects (Jia et al., 2009). Furthermore, it improves memory, learning performance, and motor activity (Jia et al., 2009).

Preclinical studies have shown ginseng to possess antioxidant (Kim et al., 2010; Liu et al., 2011; Ye et al., 2011), anti-inflammatory (Kim et al., 2010; Liu et al., 2011;

Saw et al., 2010), anti-apoptotic, antihyperglycemic, and cardioprotective effects (Jia et al., 2009). Ginkgo is shown to provide protection against neurodegeneration by multiple mechanisms. In different experimental models of Alzheimer's disease, ginseng is shown to attenuate β-amyloid and glutamate-induced toxicity, enhance clearance of β-amyloid by stimulating the phagocytic activity of microglia, promoting neuron survival, and increasing the levels of neurotrophic factor (Jia et al., 2009; Luo et al., 2011; Wollen, 2010; Xie et al., 2010). Randomized, double-blind, placebo-controlled trials have shown marginal benefits of ginseng on cognitive functions in a healthy population and patients with dementia; however, there is lack of convincing high-quality clinical evidence to show a cognitive enhancing effect of ginseng (Geng et al., 2010).

3.7 *Silybum marianum* (Milk Thistle)

Silybum marianum, also called milk thistle, is an annual or biannual plant belonging to the Asteraceae family. Milk thistle has red to purple flowers and shiny pale green leaves with white veins. Originally a native of Southern Europe through to Asia, it is now cultivated throughout the world for its medicinal and pharmaceutical value. The medicinal parts of the plant are the ripe seeds. Silymarin, an extract from this plant is a mixture of flavonolignans such as silybin, isosilybin, silydianin, and silychristin. Silymarin is a potent antioxidant, anti-inflammatory compound (Aghazadeh et al., 2010; Asghar and Masood, 2008; Wang et al., 2010) with strong hepatoprotective activity (Aghazadeh et al., 2010; Song et al., 2006; Valenzuela et al., 1989). Silymarin is also reported to mitigate oxidative stress in aging rat brain by reducing lipid peroxidation and attenuating antioxidants (Galhardi et al., 2009; Nencini et al., 2007). Preclinical studies have shown that silymarin attenuated the amyloid β-plaque burden and behavioral abnormalities in an Alzheimer's disease mouse model (Murata et al., 2010). Silymarin has also been observed to prevent skin aging, and is included as an ingredient of some cosmeceutical preparations (Singh and Agarwal, 2009).

3.8 *Lycium barbarum* (Lycii Berry)

The fruits of *Lycium barbarum* (Solanaceae), also called Fructus Lycii, have been an integral component of traditional Chinese medicine for thousands of years and are also of dietary use. *L. barbarum* is supposed to be an effective antiaging agent and has the ability to nourish the eyes, livers, and kidneys. The polysaccharides isolated from the aqueous extracts of *L. barbarum* have been identified as one of the active ingredients responsible for biological activities. *L. barbarum* is shown to possess antioxidant effects in vivo (Bucheli et al., 2011; Cheng and Kong, 2011; Reeve et al., 2010). The polysaccharides extracted from *L. barbarum* were effective in scavenging 2,2-diphenyl-1-picrylhydrazyl (DPPH) and 3-ethylbenzothiazoline-6-sulfonic acid (ABTS) free radicals, superoxide anion, and hydroxyl radical in vitro (Lin et al., 2009). Animal studies have also shown that the polysaccharides exhibited antiaging function and the ability to prevent beta amyloid peptide-induced neurotoxicity (Yu et al., 2006) and reduce age-related oxidative stress (Li et al., 2007).

3.9 *Gynostemma pentaphyllum* (Jiaogulan)

Jiaogulan is a herbaceous vine belonging to the Cucurbitaceae family. It is a herbal medicine of repute and is reported to possess powerful antioxidant and adaptogenic effects. Pharmacological studies have shown that it possesses myriad activities like antiaging, anticancer, antifatigue, antiulcer, hypolipidemic, and immunomodulatory effects. Its administration is associated with increase in life expectancy and delay in aging. The extract of the plant is also shown to be effective in ameliorating galactose-induced oxidative damage of DNA in aged rats (Sun et al., 2006).

Administering Gynostemma to patients is shown to reduce the general signs and symptoms of aging, such as fatigue, lack of energy, diarrhea, poor memory, and insomnia. It is also supposed to be useful in treating Alzheimer's (Cheng, 2005). Gypenosides, the major phytochemicals of *G. pentaphyllum*, are also known to possess antioxidant (Shang et al., 2006; Wang et al., 2010a), antidiabetic (Zhang et al., 2009), antiapoptotic (Wang et al., 2007, 2010b), and immunomodulatory (Sun and Zheng, 2005; Zhang et al., 1990) activities. Gypenosides were shown to possess neuroprotective effects due to their antioxidant and antiapoptotic actions (Shang et al., 2006; Wang et al., 2010a,b,c).

3.10 *Withania somnifera* (Ashwagandha)

Withania somnifera Dunal (Ashwagandha) is a popular medicinal plant widely used in the various folk and traditional systems of medicine in India. It is an important constituent of many polyherbal preparations and is used either alone or as a composite formulation to improve learning ability and increase energy, vigor, endurance, strength, health, as well as vital fluids, muscle fat, blood, lymph, semen, and cell production. It is also of use in counteracting chronic fatigue, weakness, dehydration, bone weakness, loose teeth, thirst, impotency, premature aging emaciation, debility, convalescence, and muscle tension. It is exceedingly being prescribed for a variety of musculoskeletal conditions (e.g., arthritis, rheumatism), and as a general tonic to increase energy, improve overall health and longevity, and prevent disease in children and elderly people (Sharma et al., 2011). The biologically active chemical constituents are alkaloids (isopelletierine, anaferine), steroidal lactones (withanolides, withaferins), saponins (sitoindoside VII and VIII), and withanolides (sitoindoside IX and X) (Mishra et al., 2000).

Preclinical studies have clearly shown that ashwagandha possesses anti-inflammatory, antitumor, antistress, antioxidant, immunomodulatory, hemopoetic, and rejuvenating properties. It also appears to exert a positive influence on the endocrine, cardiopulmonary, and central nervous systems (Mishra et al., 2000). Ashwagandha is also observed to protect against ischemia-reperfusion-induced apoptosis in cardiac tissue of rats (Mohanty et al., 2008), and gentamycin-induced nephrotoxicity in mice (Jeyanthi and Subramanian, 2009). in vitro and in vivo studies have also shown that ashwagandha extract and its phytochemicals prevent/protect against neurodegerative diseases such as Parkinson's disease and Alzheimer's disease (Jayaprakasam et al., 2010; Kumar and Kumar, 2009; Rajasankar et al., 2009a,b). Ashwagandha is proposed to be a potential herbal medicine for the treatment of Alzheimer's disease (Wollen, 2010) and the withanamides isolated from the ashwagandha fruits are reported to be effective in protecting against beta-amyloid-induced neurotoxicity (Jayaprakasam et al., 2010; Kumar et al., 2010).

3.11 *Vitis vinifera* (Grapes)

For thousands of years, the fruit and the plant *Vitis vinifera*, commonly referred to as grapes have been grown and harvested for medicinal, nutritional, and economic value. Grapes are one of the richest sources of anthocyanins, which possess anti-inflammatory, antiaging, and anticarcinogenic properties (Xia et al., 2010). The major constituents of grape are epicatechin gallate, procyanidin dimers, trimers, tetramers, catechin, epicatechin, and gallic acid, procyanidin pentamers, hexamers, and heptamers, and their gallates. Grapes are among the best-known antiaging agents and have been linked to a variety of health benefits, the most important being the anticancer and cardioprotective effects. Grapes possess free radical scavenging, and antioxidant and antilipid peroxidation effects, which contribute to the observed hepatoprotective, neuroprotective, renoprotective, adaptogenic, and nootropic activities (Xia et al., 2010).

Resveratrol, a polyphenol phytoalexin present in the red wine and grapes, is shown to possess diverse biochemical and physiological properties, including estrogenic, antiplatelet, and anti-inflammatory properties as well as a wide range of health benefits that include cancer prevention, antiaging, and cardioprotection (Yang et al., 2012; Xia et al., 2010). Resveratrol has been shown to induce the expression of several longevity genes, including Sirt1, Sirt3, Sirt4, FoxO1, Foxo3a, and pre-B cell colony-enhancing factor (PBEF) and contribute to retarding aging and senescence (Das et al., 2011). Randomized clinical trials have also shown that administering grape juice improved memory in older adults with mild cognitive impairment (Krikorian et al., 2010). Additionally, the grape seed anthocyanins have been reported to increase the antioxidants and to prevent oxidative stress in aging animals (Sangeetha et al., 2005). Studies have also shown that catechins, isolated from the skin of grapes, inhibited the activation of c-Jun N-terminal kinases (JNKs) and the enzymes of the mitogen-activated protein kinase (MAPK) family involved in UV-induced carcinogenesis (Wu et al., 2006). The grape polyphenols are also shown to be effective in preventing skin aging primarily due to their antioxidant, anti-inflammatory, and DNA repair-promoting actions (Nichols and Katiyar, 2010; Ndiaye et al., 2011).

3.12 *Centella asiatica* (Gotu Kola)

Centella asiatica, commonly known as gotu kola, is a herbaceous plant belonging to the family Mackinlayaceae. It is a mild adaptogen and has been used as a medicinal herb for thousands of years in India, where it is commonly used in antiaging preparations for the skin. According to Charaka, often considered the Father of Indian Traditional System of Medicine – Ayurveda, gotu kola is a very useful medicinal plant in preventing aging. It is ranked high in the top ten herbs known for antiaging properties and this may be in part due to its antioxidative effects (Chaudhary, 2010). The plant also possesses neurotonic effects and is known to improve memory and stimulus reflex. It is also supposed to be effective in the treatment of tuberculosis, syphilis, amebic dysentery, and common cold (Ponnusamy et al., 2008).

Scientific studies have shown gotu kola to protect against neurodegerative diseases in animal models. Administration of gotu kola extract is shown to be effective in preventing oxidation of proteins, lipid peroxidation, and prooxidant processes, and to concomitantly increase the antioxidant enzymes in corpus striatum and hippocampus in rats with Parkinson's disease (Haleagrahara and Ponnusamy, 2010). Gotu kola is also known to improve the neural antioxidant status in aged rats (Subathra et al., 2005), to ameliorate 3-nitropropionic-acid-induced oxidative stress in mice brain (Shinomol et al., 2010), to decrease lead-induced neurotoxicity in mice (Ponnusamy et al., 2008), to mitigate glutamate-induced neuroexcitotoxicity in rats (Ramanathan et al., 2007), and to improve antioxidant status and cognitive skills in rats (Veerendra Kumar and Gupta, 2002). Topical treatment with gotu kola is also reported to be effective in remodeling photoaged skin and to prevent skin aging in human volunteers, thereby validating the ethnomedicinal uses (Haftek et al., 2008).

4. CONCLUSION

Pharmacological studies, with experimental systems of study, suggest that the aforementioned Asian medicinal plants are effective in preventing/retarding/ameliorating aging and aging-related ailments. However, in order for many of them to be accepted by modern systems of medicine to be relevant for clinical/pharmaceutical use, detailed investigations are required to bridge the gaps in the current understanding of knowledge and provide scientifically validated evidence. The three main lacunas are the incompleteness of the pharmacological studies, the lack of phytochemical validation, and the lack of scientifically conducted studies in humans. Detailed studies on the mechanistic aspects with different and more robust preclinical models are required especially with the active principles. Additionally, the phytochemicals which are responsible for the observed pharmacological properties are known to be varying depending on the plant age, part, and geographical and seasonal conditions. Studies should be performed with well-characterized extracts with knowledge on the levels of different vital bioactive components as only then will the observations be reproducible and valid. Pilot studies with a small number of healthy individuals should be initially performed to understand the maximum tolerable dose as information accrued from these studies can be of use in validating preclinical observations. Nonetheless, in view of the established safety of usage of such plants for several centuries for the amelioration of overall health in the aging population, such medicinal plants will definitely find application as formulations for prophylactic use in the future.

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