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A review of Ginseng species in different regions as a multipurpose herb in traditional Chinese medicine, modern herbology and pharmacological science

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Ginseng is the most famous of the Chinese herbs throughout the world, and has been one of the most valued herb in China. Traditional Chinese medicine as an essential element of alternative and complementary medicine, advanced over thousands of years with its own distinctive arrangement of therapies, diagnostics theories and in Asian countries, particularly China. In most parts of the world, especially western countries, Ginseng has been largely employed in recent decades and has become renowned for its important function in treating and preventing so many diseases. *Panax ginseng* consisted of a number of active constituents, like ginsenosides, nitrogenous substances, carbohydrates, phytosterol, organic acids, essential oils, amino acids, peptidoglycans, it's repeated, nitrogen-containing compounds, fatty acids, vitamins, minerals and other phenolic compounds. Ginsenosides are classified into two main groups known as protopanaxadiol (PPD) and protopanaxatriol (PPT). Pharmacological activities of ginseng extracts are effects on the central nervous system, antipsychotic action, tranquilizing effects, protection from stress ulcers, increase of gastrointestinal motility, anti-fatigue action, endocrinological effects, enhancement of sexual behaviour, acceleration of metabolism, or synthesis of carbohydrates, lipids, RNA, and proteins. More clinical studies are necessary to uncover the numerous substances and their effects in ginseng that contribute to public health.

Key words: Ginseng, traditional Chinese medicine, herbology, pharmacological science.

INTRODUCTION

The ancient Chinese have identified 11,146 medicinal species from 383 families, and more than 400 of which are widely used throughout the world (Drasar and Moravcova, 2004; Soleymani and Shahrajabian, 2012; Ogbaji et al., 2018; Shahrajabian et al., 2018; Soleymani et al., 2018; Shahrajabian et al., 2019a, 2019b). *Panax ginseng* (Giseng) is a well-known herb in traditional Chinese medicine (TCM) (Hsu et al., 2013; Li et al., 2017).

Panax means cure for all disease, as it combines the

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Greek words pan meaning all and zxos meaning medicine (Jeong et al., 2012). In TCM, food and medicine are understood to share similar origin but with diverse applications and uses (Chan et al., 2010). Thus, the Chinese commonly incorporates variety of TCM herbs into their diet to make a number of healthy food recipes that are more appealing of better taste, improved texture, and will most importantly improve one's health (Guo et al., 2008). TCM originates in ancient China with a 5000-year history. Rooted in ancient eastern philosophies such as Taoism, TCM focuses on a holistic view between humans and nature. Through the observations of universal principles within nature, TCM inquire from a macro level into the microcosm of human physiology and the mutual relationships between our body's internal workings and the external environment (Cheung et al., 2017).

Traditional Chinese medicine is still commonly used in China. More than half of the population regularly uses traditional remedies, with the highest prevalence of use in rural areas. About 5000 traditional remedies are available in China; they account for approximately one fifth of the entire Chinese pharmaceutical market. *P. ginseng* is often described as the lord or king of herbs (Wen and Zimmer, 1996), which occupies an esteemed spot in TCM and traditional oriental medicine in most countries (Xie et al., 2005).

Panax quinquefolius is employed in TCM to treat cases of deficiency connected with symptoms like irritability, thirst, dryness of the mouth, fatigue, and respiratory tract (Chen et al., 2004). The most important common names of ginseng in different parts of the world are American ginseng, sang, give finger root, redberry, tartar root, man's health, dwarf groundnut, root of life, garantogen, ninsin, jinshard, garent-oquen, and little man. The name ginseng comes from the Chinese words, Jen Sheng stands for man herb due to the rhizome of the plant or human-like shape of the root. The word *Panax* implies cure all and refer to the traditional belief that ginseng has healing properties for all bodily disease (Kim et al., 2018).

Till date, fourteen (14) plants, which include 12 species and two infra specific taxa, have been grouped under the genus *Panax* (Shin et al., 2015). The three main types of commercial ginseng are the Chinese ginseng (*Panax notoginseng* (*Burk*.). *F*. *H*.), the American ginseng (*P. quinquefolius L.*), and the Korean ginseng (*P. ginseng* Meyer), and have been used all over the world as herbal medicines for thousands of years (Kim et al., 2012). Ginseng is also part of Sasang Constitution Medicine (SCM) and Korean Oriental Medicine (KOM) (Choi et al. 2006).

Recent researches have revealed that processing of ginseng modifies its chemical profile and may alter its pharmacological activities and properties (Xie et al., 2012; Wan et al., 2015). The origin of ginseng dates back to prehistory. In China, Shennong (Divine Peasant) also known as Emperor Yan, the Yellow Emperor, one of the three Emperors, the Emperor who is said to have commenced herbal medicine about 5500 years ago, is reported to have tasted hundreds of plants to as certain number of medicinal herbs (Zheng, 1985). According to Yun (2001), three hundred and sixty-five kinds of herbs are listed and are separated into three groups based on their toxicity level. The much better ones are non-toxic and serve to strengthen vibrant energy, and can be taken on a regular basis.

GINSENG TAXONOMY, PLANTATION AND DIFFERENT SPECIES IN VARIOUS PARTS OF THE WORLD

This is a perennial plant with fleshy roots, grows slowly, and identifies with the *Panax* genus in the Araliaceae family. It is grown in cooler climatic regions of the Northern Hemisphere, majorly in eastern Siberia, Korea, and northern China (Komatsu et al., 2005; Chhotaram et al., 2010; Park et al., 2012; Kim and Yang, 2018). Ginseng faces an array of stressful conditions, including biotic attack by bacteria, fungi, and nematodes. Fungi are the main causative agents of ginseng root rot disease, among which *Cylindrocarpon destructans* is the most culpable pathogen, other important pathogens include *Alternaria panax* (spotting disease, *Botrytis cinerea* (blight), *Rhizoctonia solani* (damping off), and *Pythium* species (root rot) (Kim et al., 2019).

Plant taxonomy

Kingdom: Plantae
Division= Angiosperms
Sub division= Eudicots
Class= Asterids
Order=Apiales
Family= Araliaceae
Subfamily= Aralioideae
Genus= *Panax*
Species= *ginseng*

Ginseng is cultivated naturally between 33°N and 48°N, which corresponds to the subarctic and temperate climate regions in Korea (between 33°7′N and 43°1′N), Manchuria (between 43°N and 47°N), and the Maritime province of Siberia (Choi et al., 2007; Ryu et al., 2012). Different environmental factors like soil and climatic such as hydrogen ion, nutrients, microbial populations and moisture content affect plants. Normally, precipitation, amount of sunshine and air temperature are included among climatic factors (Ryu et al., 2012).

The physiological characteristics of *P. ginseng* in relation to air temperature have been reviewed comprehensively in the literature (Mahfuzur and Zamir, 2005). Park (1979) studies show that ginseng does not

favour high temperature; hence it was necessary to develop culture methods that will help avoid the result of large increases in the air temperature of the arable land. In deep mountains, wild ginseng is cultivated under trees and prefers an exceedingly cold climate. The optimal temperature ranges between 10 and 20°C during the leafing phase and between 21 and 25°C during the flowering and fruiting phases (Mork et al., 1981).

High temperature adversely affects ginseng by initiating photosynthesis cessation, drying of leaves, and early defoliation (Ohh, 1981). Besides this, root rot, leaf spot disease, and anthracnose are also consequences that emanates from high temperature (Mahfuzur and Zamir, 2005). In the case of a temperature above 21°C, there will be great increase in leaf spot disease incidence (Ohh and Park, 1980). Among the ginseng species, Korean ginseng (*P. ginseng*), Chinese ginseng (*P. notoginseng*), and American ginseng (*P. quinquefolius*) are the most common throughout the world (Lee and Kim, 2014).

Liu et al. (2008) reported that based on the grown environment and the cultivated method, the commercial trade ginseng is classified into three grades of ginseng, Cultivated Ginseng (CG), Mountain Cultivated Ginseng (MCG), and Mountain Wild Ginseng (MWG), and CG is cultivated artificially in forms and contributes the major quantity of ginseng in the current market. There are two species of ginseng in Canada, the American ginseng (*P. quinquefolius*) and the Dwarf ginseng (*Panax trifolius*). The Dwarf ginseng does not have economic value since it does not possess any medicinal qualities. Among the other species of ginseng, the *P. ginseng* is also valuable, but cannot be cultivated in our climates.

Szymanska et al. (2013) reported that as a perennial herb, American ginseng is native to Eastern North American, and grows in deciduous and mixed forests in the northeast of the United States of America and Canadian provinces of Quebec and Ontario. With wild ginseng population decreasing, and *P. quinquefolius* a slow-growing plant, ginseng is grown in many regions and countries: in Wisconsin, Michigan, North Carolina, and a number of other states in the USA, in Ontario and British Columbia in Canada (Punja, 2011), and near Lublin in plant (Kochan et al., 2008).

Siberian ginseng, *Eleutherococcus senticosus*, is the most commonly used ginseng in the United States. While not considered to be a true ginseng, it belongs to the ginseng family and is native to Siberia, Korea, Japan and China. Siberian ginseng has been shown to have many properties comparable to those of true ginseng and some studies indicate that it may improve physical and mental performance. Wild ginseng is ginseng that has not been planted and cultivated domestically, rather it is that which grows naturally and is harvested from wherever it is found to be growing; wild ginseng is relatively rare and even increasingly endangered, due in large part to high demand for the product in recent years, which has led to the wild plants being sought out and harvested faster so that new ones can grow. Wild ginseng can be either Asian or American and can be processed to be red ginseng (Seervi et al., 2010).

Asian and American ginseng shows different properties and medicinal values in pharmacology, even though the major bioactive ingredients of Asian ginseng and American ginseng are ginsenosides. In the ginseng market, American ginseng is more expensive than Asian ginseng (Li et al., 2010). Optimal light required for growing Asian and American ginseng (*P. ginseng* Meyer and *P. quinquefolius* L., respectively) is characterized as follows: too little light, which reduces root yield; and too much light which leads to photo inhibition of photosynthesis, photo bleaching and leaf death; generally, optimal light intensity for Asian ginseng ranged from 5 to 20% (Proctor and Palmer, 2017). Brazilian ginseng (*Pfaffia glomerata* (Spreng.) Pedersen, Amaranthaceae), is a medicinal plant that is largely used as adaptogenic herb. It commonly grows in Africa and Americas and is highly considered both pharmaceutically and commercially, largely due to β-ecdysone accumulation in its roots.

Brazil remains the greatest supplier of *P. glomerata* in the world. Due to the similarity in morphology of its root to those of *P. ginseng* (Korean ginseng), the species came to be known as the Brazilian ginseng (Neves et al., 2016). In *P. glomerata*, different substances have been reported: triterpenoid (glomeric acid), nortriterpenoid (pfameric acid), ecdysterone, subrosterone, oleanolic acid and glucopyranosiloleanolate (Shiobara et al., 1993). Some species have different TCM natures. *P. ginseng* is hot while, *P. quinquefolius* is cool (Schlag and McIntosh, 2013). Modern biochemical and molecular studies have proved the TCM belief that there exist conflicting effects between American and Asian ginsengs (Sievenpiper et al., 2004).

Sengupta et al. (2004) observed that Asian ginseng roots extracts had higher Rg1:Rb1 ratios compared to American ginseng and showed that while angiogenesis results from Rg1 dominance, the opposite effect of limiting growth of cancer cells is promoted by Rb1 dominance. Brazilian ginseng (*P. glomerata*) is a plant native from the countries of South America, particularly of some states of Brazil, like Sao Paulo, Parana, Mato Grosso and Goias. Due to the similarity in their pharmacological effects, it is employed commercially as an alternative for Asian ginseng (*Panax* species). The Brazilian ginseng roots (BGR) are traditionally used in folk medicine as analgesic, anti-inflammatory, tonic, anti-diabetic, aphrodisiac, and antiulcer-gastric, with several researches describing its efficacy (Neto et al., 2005; Vardanega et al., 2017).

The ginseng products distributed on the market can be largely classified as fresh ginseng and its primary processing products in its original shape, red ginseng, and dried ginseng. In herbal market, ginseng is commercially obtainable in fresh, red, white and other

Table 1. Species of Ginseng (Yun, 2001).

Panax ginseng C. A. Meyer (Korean ginseng)
Panax japonicas C. A. Meyer (Japanese ginseng)
Panax major Ting
Panax notoginseng (*Burkill*) *F. H. Chen* (Sanchi ginseng)
Panax omeiensis J. Wen
Panax pseudoginsengWallich
Panax quinquefolius L. (American ginseng)
Panax sinensis J. Wen
Panax stipuleanatus H. T. Tsai&K. M. Feng
Panax trifolius L. (Dwarf ginseng)
Panax wangianus Sun
Panax zingiberensis C.Y. Wu&K.M. Feng
Panax vietnamensis Ha et Grushv. (Vietnamese ginseng)

processed products (Sun et al., 2009, 2011). Zhao et al. (2015) reported that in the market, there is a huge price variation among the different grades of ginseng; the price trend is usually as follows: wild American ginseng (WAG) > cultivated American ginseng (CAG) > Asian ginseng (ASG). Dried ginseng product is not cooked but dried by sunlight, hot wind, or other methods (Cho et al., 2014). The white ginseng is usually prepared by air-drying, the fresh ginseng is prepared by simple washing, the black ginseng is generated by an intensive and long steaming process, the stoved ginseng is prepared by a stoving process, the frozen ginseng is produced by a freezing process, and the red ginseng is commonly made by a moderate steaming or heating process (Kim et al., 2000; Wang et al., 2006) (Table 1).

BIOACTIVE PHYTOCHEMICALS OF GINSENG AND THEIR THERAPEUTIC ROLES

P. ginseng comprises 80 to 90% organic, approximately 10% inorganic substances, including several active constituents like ginsenosides orsaponins, nitrogenous substances, carbohydrates, essential oils, phytosterol, fatty acids, organic acids, amino acids, peptidoglycans, carbohydrate, compounds containing nitrogen, vitamins, minerals and other phenolic compounds (Attele et al., 1999; Gillis, 1997; Xie et al., 2005; Guo et al., 2015; Lu et al., 2017; Beccaria et al., 2018).

Lakshmi et al. (2011) mentioned that more often than ever, medicinal plants are being used as drugs in treatment of humans either singly or in combination. Also, previously unknown vital chemical substances with potential therapeutic effect can be found among medicinal plants. It has been shown that the key active components of *P. ginseng* are ginsenosides which boast a number of beneficial effects. Ginsenosides are grouped into two major groups known as protopanaxatriol (PPT) and protopanaxadiol (PPD), due to the hydroxylation pattern at C6 and sugar moieties attachment (Pengelly and Bennett, 2011; Pace et al., 2015) (Tables 2, 3, 4 and 5).

Patel and Rauf (2017) also mentioned antioxidant, anti-inflammation, anti-fatigue, antidiabetic, antitumor, immunomodulation, anti-obesity, cardioprotective, antimicrobial, neuroprotective and aphrodisiac properties. They have presented the potential of ginseng as a complementary and alternative medicine (CAM). Ginseng polysaccharides comprised starch-like glucan and pectin with pectin accounting for around 20% of water-soluble polysaccharides (Zhang et al., 2009; Sun et al., 2019). Ginsenosides are distributed in many parts of the ginseng plant including the root, leaf and berry (Kim et al., 2014).

Different parts of the plant contain distinct ginsenoside profiles (Attele et al., 1999), which may exhibit different pharmacological activities (Kim et al., 2014). Shi et al. (2007) revealed that the leaf and root hair contain higher ginsenoside levels than the root. Wan et al. (2015) concluded that the contents of malonyl ginsenosides, amino acids, and polysaccharides, based on decreasing order, ranked as follows: fresh ginseng >frozen ginseng >white ginseng >stoved ginseng >red ginseng >black ginseng. They have also mentioned that processing should be paid more attention for the quality control of ginseng products. A lot of studies have been conducted on the pharmacological properties of Ginseng extract such as lipid-lowering, anti-allergic, antidiabetic, anti-inflammatory, hypoglycaemia and anti-stress, anti-aging, is repeated, anticarcinogenic, anti-fatigue, anti-adhesive, antidepressive, hypocholesterolemic and hypolipidemic, hepatoprotective activities, immune-modulatory activities, improving working memory and perceptual systems, stimulation and inhibition of central nervous system, and inhibiting the growth of tumor cells, especially in female reproductive system (Kim et al., 2013; Cho et al., 2014; Sun et al., 2015; Uluisik and Keskin, 2016; Silvestrini et

Table 2. *Panax* bioactive phytochemicals and their proven therapeutic roles (Patel and Rauf, 2017).

P. ginseng (Chinese ginseng)
P. quinquefolius (American ginseng)
Ginsenoside (Rb, Rc, Rd, re, Rf, Rg, Rh)
Polysaccharides
Oligosaccharides
Saponins
Anticancer effect
Protection against diabetic retinopathy and cardiomyopathy
Neural stem cell proliferation
Attenuation of β-amyloid generation
Protection from ischemia-induced oxidative stress and apoptosis
Protection from impairment of hippocampal neurons
Attenuation of pathogen virulence factors production
Treatment of erectile dysfunction
Fatigue alleviation in multiple sclerosis
Prevention of atopic dermatitis and rheumatoid arthritis
Amelioration of high fat diet-induced obesity

Table 3. Ginsenosides classification in *Panax* spp. (Leung and Wong, 2010).

Protopanaxadiol group (PPD)	Protopanaxatriol group (PPT)	Others
Rb1, Rb2, Rb3	Re	F11 ocotillo saponin (*P. quinquefolius* only)
Rc	Rf (*P. ginseng* only)	Oleanane saponins
Rd	Rg1, Rg2	Quinquenosides
Rg3	Rh1	-
Rh2	-	-
Rs1	-	-

al., 2017; Ardalanian and Fadaei, 2018; Zhang et al., 2018; Balusamy et al., 2019).

Kim et al. (2011) confirmed the use of Ginseng as an antioxidant supplement. Kim et al. (2018) also found that *P. ginseng* might be a potential alternative medicine for the prevention and treatment of natural aging-induced osteoporosis in human. Kuo et al. (2003) reported that glutamine and arginine were the two major free proteinogenic amino acids in the ginseng plants and together they constituted over 50% of all the free amino acids detected in the root. Uluisik and Keskin (2016) *P. ginseng* root powder may be useful for hepatic damage and fibrosis associated with high cholesterol diet. These beneficial effects of ginseng on liver enzymes is attributed to its active components knows as ginsenosides. Lee and Rhee (2017) reported that the potential use of ginseng in the prevention and treatment of chronic inflammatory diseases such as diabetes, rheumatoid arthritis, and allergic asthma. Qi et al. (2015) found that ginseng appears to be a prospective radio-protector that can potentially attenuate the deleterious effects of radiation on normal human tissue, and mostly for cancer patients going through radiotherapy which might be related to its immunomodulation and antioxidative properties (Tables 6, 7 and 8)..

RED AND WHITE GINSENG

When fresh ginseng is skinned, and then sun-dried or hot air-dried without application of steam, white ginseng is obtained. White ginsengs are separated based on their final shapes after the drying process into curved, half-curved, and straight ginseng (Song et al., 2014). While curved ginseng is obtained by rolling the whole length of the ginseng root into a round shape prior to drying; and half-curved ginseng is obtained by folding the roots upward to condense the entire length to about half the original length; straight ginseng is skinned and maintains the original shape from the field.

Table 4. Different concepts of the Ginseng products between countries.

Country (Region)	Type	Type
Korea	Root	Processed product
	Food	Food
China	Drug	Health food/New resource for food
Hong Kong	Food	Food
Taiwan	Drug	Food
Japan	Food	Food
Vietnam	Drug	Food
USA	Food	Dietary supplement
Canada	Food	Food/Health Food
France	Drug	Food supplement
Russia	Drug	Drug/Food
Thailand	Drug	Food
Spain	Drug	Food

Table 5. Some pharmacological effects of ginsenosides (Pengelly and Bennett, 2011).

Compound	Pharmacological action
Rb1	Estrogen-like activity Antidiabetic, insulin sensitizing Anti-obesity Angiogenesis inhibitor Neurotropic, neuroprotective
Rc	Inhibit proliferation of breast cancer cells
Re	Antidiabetic Antioxidant, cardioprotective
Rg1	Neurotropic, neuroprotective Ligand for glucocorticoid Receptor Suppresses oxidative stress Promotes angiogenesis
Rg2	Neuronal Ach inhibitor
Rg3	Inhibits proliferation of prostate cancer cells
Rh1	Activates estrogen receptor
Rh2	Cytotoxic, inhibits breast cancer cell proliferation Inhibits proliferation of prostate cancer cells
F11	Assists memory improvement neuroprotective

The one that is not skinned before being steamed or otherwise heated to be finally dried is red ginseng. Korean red ginsengs are classified into Yang-sam, Chun-sam and Ji-samon the basis of their rhizome firmness, characteristics of body tissues, colors, proportion of main roots to lateral roots, etc. During the steaming process, there is gelatinization of ginseng starch, giving rise to activation of effective ingredients and an upsurge in saponin. Even though colors and shapes of Korean ginsengs differ based on processing type, with minimal variation in ingredients, in the world, their collective efficacy and advanced properties of each remains the

Table 6. Essential ginseng effects and their likely actions on different body systems (Radad et al., 2004).

Subject	Ginseng's effect	Possible action
Whole body	General tonic and adaptogen	Resistance against adverse conditions (Physical, chemical and biological factors). Restores body 's homeostasis Anti-aging effects
Central nervous system	Neuroprotection either *in vivo* or *in vitro*	Potentiates nerve growth factor Antioxidative and anti-apoptotic mechanisms Reduces lipid peroxidation Inhibits excitotoxicity and Ca^{2+} over-influx into neurons Maintains cellular ATP levels Preserves structural integrity of neurons
	Glial cells	Prevents astroglial swelling Inhibits microglial respiratory burst activity and NO production by activated microglia
	Increasing cognitive performance (learning and memory)	Modulates neurotransmission Direct effect on hippocampal neurons
Cardiovascular system	Antihypertensive	Relax vascular smooth muscle cells through NO and Ca^{2+} medicated mechanisms Inhibits production of endothelin which plays a role in blood vessel constriction
	Anti-atherosclerotic effect	Prevents platelet aggregation Shows antagonistic action for platelet activity factor Suppresses thrombin formation
	Acceleration of wound healing	Promotes functional neovascularisation through endothelial proliferation
Inflammation and allergy	Anti-inflammatory and anti-allergic effects	Inhibits cytokine production such as IL-1β, IL-6 and TNF-α Abrogates cycooxygenase-2 gene expression Suppresses histamine and leukotrienes release from mast cells Stabilizes inflammatory cells such as neutronphils and lymphocytes Antifibroblastic activity
Immune system	Immunostimulant	Enhances interferon induction, phagocytosis, natural killer cells, and B and T cells
Carcinogenesis	Anticarcinogenic effect	Suppresses malignant transformation

Table 6. Cont.

		Inhibits proliferation of tumor cells Inhibits tumor invasiveness, metastasis and angiogenesis
Aphrodisiac effect	Enhancement of male copulatory behaviour	Relaxes corpus cavernosum smooth muscles via NO mediated processes Increases serum testosterone levels and reduces plasma levels of prolactin hormone Direct effects on anterior pituitary and hypothalamic dopaminergic mechanisms
Hyperglycemia	Antihyperglycemic activity	Increases plasma insulin levels, the number of insulin receptors and insulin sensitivity

Table 7. Key points about *Panax ginseng* (Kiefer and Pantuso, 2003).

Efficacy	Psychologic functioning: effective; conflicting evidence Physical performance: ineffective Immune system: effective Diabetes: modest effect; evidence limited
Adverse effects	Nausea, diarrhea, euphoria, insomnia, headaches, hypertension, hypotension, mastalgia, vaginal bleeding, blood pressure abnormalities
Interactions	Caution advised about concomitant use with phenelzie (Nardil), warfain (Coumadin), oral hypoglycemics, insulin, or caffeine, and about use in patients with hypertension or bleeding
Bottom line	A safe, well-tolerated herbal medicine that may be used for a variety of medical conditions

Table 8. Some information of clinical literature regarding interactions.

Drug	**Interaction with ginseng**
Alcohol	*P. ginseng* increases the clearance of alcohol (Lee et al., 1987)
Anti-platelet agents, Anti-coagulants, Pentazocine	*P. ginseng* potentiates the effects of various drugs including anticoagulants such as warfarin (Lee et al., 2008), the antiplatelet activity of NSAIDs such as aspirin, and pentazocine (Mitra et al., 1996)
Antidiabetic agents	Ginseng can reduce blood glucose levels (Reay et al., 2005; Sotaniemi et al., 1995) and therefore the use of both in combination use may lead to additive effects.
Phenelzine	*P. ginseng* should not be combined with monoamine oxidase inhibitors such as phenelzine, as it may lead to headache, tremor and mania (Jones and Runikis, 1987)

best (Gui and Ryu, 2014).

In TCM practice, White ginseng and red ginseng are used for different purposes; white ginseng is used to supply qi and promote the production fluids of body fluids as well as enhance physical fitness and disease resistance, while red ginseng has a warming effect and is used for boosting yang and replenishing vital essence (Zhang et al., 2012, 2019).

Xu et al. (2018) reported that both white and red ginseng is the most widely used in clinical applications because of their considerable pharmacological activity. But, red ginseng exhibits more potential anticancer activity than white ginseng likely because of the abundant amount of rare ginsenosides generated from processing such as ginsenosides Rg3 and Rh2 (Li et al., 2011; Kim et al., 2014). It is believed that various processing techniques modify the therapeutic effects of *P. ginseng* (Keum et al., 2000). For boosting fluids, white ginseng is better and is regarded as warmer and stronger for supplementing Qi. It has been demonstrated that in terms of chemical compositions, red and white ginseng are different, hence their different biological effects (Park et al., 2001). It has been anecdotally considered that white ginseng, which has a low PPD/PPT ratio, increases body temperature, whereas red ginseng, which has a high PPD/PPT ratio, does not (Cho et al., 2017). As white ginseng and red ginseng possess different bioactivities and clinical purposes, discrimination of the white one and the red one are very significant for quality control, standardizing the processing procedures, as well as the effective and safe usage of ginseng (Zhou et al., 2018).

Horacek et al. (2010) explained that red ginseng is steam-cured after harvesting, thus generating a glossy reddish-brown color, and thereafter dried. It is believed that to modify its biochemical composition and prevent the bioactive ingredients from possible breakdown, the root needs to undergo steaming; hence it remains the preferred ginseng product. After harvest, white ginseng is peeled and dried. It is assumed that during drying, bioactive constituents are broken down by enzymes in the ginseng root, making white ginseng to contain fewer bioactive components compared to red ginseng (Horacek et al., 2010).

In the Chinese pharmacopoeia, ginsenosides Rg1, Rb, and Re (the main components of Red ginseng and White ginseng) are still used as chemical markers for quality control (Zhao et al., 2019). Like Asian ginseng, white American ginseng (WAG) is prepared by air-drying; if fresh American ginseng is processed by steaming, from white color to red, the steamed product is called red American ginseng (RAG) (Wan et al., 2018).

During the steaming process, extensive conversion of original ginsenosides in white ginseng to degradation compounds in red ginseng was observed, leading to different ginsenoside profiles (Sun et al., 2011). Akhter et al. (2018) also indicated that polysaccharides are major active component of American ginseng root which showing various biological activities including anticarcinogenic, anti-aging, immunostimulatory and antioxidant effects. Chung et al. (2014) reported that of the two kinds of ginseng, white ginseng is air-dried, and red ginseng is produced by steaming raw ginseng at 98 to 100°C for 2 to 3 h. Korean ginseng contains saponin, an element of glycosides; nitrogenous compounds such as protein, amino acid, nucleic acid and alkaloid; fat-soluble ingredients such as fatty acid, ethereal oil, polyacetylene, phenolic compound, phytosterol and terpenoid; saccharides such as monose, oligosaccharide, polysaccharide and pectin; vitamins and inorganic substances; and many other useful ingredients. Thus, ginseng contains an abundance of diversified chemical elements hardly found in other medicinal herbs (Proctor et al., 1990; Vinh et al., 2017) (Tables 9, 10 and 11).

GINSENOSIDES AND PHENOLICS OF GINSENG

Ginsenosides and phenolics in ginsengs are among the most important health-beneficial compounds in Asian ginseng (Chung et al., 2012). More than 25 ginsenosides including Rb, Rg, Rc and Ro, as well as more than 10 phenolics such as ferulic, gentistic, cinnamic, syringic, and p-hydrobenzoic acids, have been reported so far, their amounts differ among cultivars, cultivation conditions and processing (Shibata, 2001; Choi et al., 2006; Fishbein et al., 2009; Chung et al., 2012).

Ginsenosides Rb_1, Rb_2, RC, Rg_2, etc., are the major extract constituents at normal temperature (<100°C), while less polar ginsenosides such as Rg_3. Rg_6, F_4, Rs_5, Rs_4, Rg_5, and Rk_1 are the unique extract constituents at higher temperatures (>120°C) (Zhang et al., 2017). Wu et al. (2018) also reported that ginsenosides are usually divided into three groups: (1) the protopanaxadiol ginsenosides (PPD), (2) the protopanaxatriol ginsenosides (PPT), and (3) the oleanonic acid-type saponins; five major ginsenosides, Rb1, Rb2, Rc, Re, and Rg1, belong to the PPD and PPT types, constituting more than 80% of all ginsenosides. Others, such as Rg3, Rg2, F1, Rh2 and Rh4 are minor or rare ginsenosides which were found to have special physiological activities (Wei et al., 2011).

Some studies have demonstrated that many ginsenosides only exist in red ginseng such as ginsenosides-Rg_3, -Rg_5, -Rg_6, -Rh_1, -Rh_2, -Rk_1 -Rk_3 and -Rs_3-Rs_7, and fortunately, some of them have remarkable biological activities (Zhou and Yang, 2015). Kim et al. (1987) noted that the main ginsenosides are glycosides that contain an aglycone with a dammarane skeleton, and include protopanaxadiol-type saponins such as ginsenosides Rb1, Rb2, Rc, and Rd, as well as protopanaxatriol-type saponins such as ginsenosides Re and Rg1, constituting more than 80% of the total ginsenosides. Black ginseng contains some new ginsenosides (Rg3, Rg5, F4, Rg6, Rk3, Rs3, Rs4, etc.)

Table 9. Comparison of protein and free amino acid contents between Korean Ginseng and ginsengs of other countries.

Classification	Korean Ginseng			American Ginseng	Chinese Ginseng
	Main root	Lateral roots	Fine roots		
Soluble protein (mg/g dry weight)	38.0	29.5	19.6	11.4	17.0
Thermostable protein (mg/g dry weight)	28.1	22.3	12.8	10.1	7.3
Free amino acid (mg/g dry weight)	73.7	54.9	14.8	32.8	24.7

Table 10. Comparison of typical ginsenoside composition of American ginseng (*P. quinquefolius L.*) and Asian ginseng (*P. ginseng C. A. Meer*) (Schlag and McIntosh, 2006).

Chemical composition	American ginseng	Asian ginseng
Total ginsenosides	40-60 g/kg	20-40 g/kg
Major ginsenosides	Rb1, Re, Rd	Rb1, Rg1, Rb2
Pseudoginsenoside F11	1.0-2.0 g/kg	0
Ginsenoside Rf	0	1.0-2.0 g/kg
PPD-group to PPT-group	>2.0	<2.0
Rb1: Rg1	>5.0	<5.0
Rg1: Re	<1.0	>1.0
Rb2: Rc	<0.4	>0.4

Table 11. Concentration of medical ingredients (Comparison of saponin in ginsengs of various sources).

Ingredient	Korean Ginseng	Korean Ginseng	Hwagi-sam	Sanchi-sam	Bamboo-sam
	Red Ginseng	White Ginseng	(American ginseng)	(Chinese ginseng)	(Japanese ginseng)
Total kinds of saponin	30	23	14	15	8
Panaxadiols	18	15	9	6	6
Panaxatriols	11	7	4	9	4
Oleananes	1	1	1	-	1

which are not present in white ginseng, and exhibits more potent biological activities than white and red ginseng (Sun et al., 2009).

Qi et al. (2011) found that ginsenosides are dammarane-type saponins that naturally occur in many forms. Rg1, Rb1, Rc, Rd and Re (5, 1, 2, 3 and 4) are the major ginsenosides that commonly occur in both American and Asian ginseng. Schlag and McIntosh (2013) explained that the major ginsenosides are classified by structural type as protopanaxatriol (PPT) ginsenosides and have 20(S)-protopanaxatriol (20[S]-dammar-24-ane-3β,12β,20-triol) glycosides or as protopanaxadiol (PPD) ginsenosides and have 20(S)-protopanaxadiol (6α-hyroxy-20[S]-protopanaxadiol) glycosides. Rg1 (5) and Re (4) are PPT ginsenosides, whereas Rb1 (1), Rc (2), and Rd (3) are PPD ginsenosides.

At room temperature, as fresh ginseng appears to be easily degraded, it has traditionally undergone processing into red ginseng through root steaming followed by drying or into white ginseng through drying of the root (Lee et al., 2015; Park et al., 2016). In Korea, red ginseng and other several ginseng products are popularly used as either nutritional supplements or functional foods. Recent researches have shown that compared to fresh and white ginseng, red ginseng has biological benefits while inducing fewer side effects (Babiker et al., 2014; Lee et al., 2015). Korean

Red Ginseng is known to havea number of biological activities which include memoryenhancement, improving the blood circulation, boosting the immune system, antioxidant effects, positive effects on menopausal disorder, and antifatigue effects (Babiker et al., 2014). Olgun et al. (2016) indicated that Korean red Ginseng (KRG) has been extracted from the roots of *P. ginseng*. KRG has beneficial effects on learning and memory impairment. KRG has been found to be effective in various problems that cause hearing loss such as gentamycin toxicity, age-related hearing loss, or 3-nitropropionic acid-induced cochlear damage. Ginseng effectively prevents liver injury, mainly through down regulation of oxidative stress and inflammatory response

(Youssef, 2016).

Oh et al. (2015) reported the influence of ginseng in enhancing cognitive performance in Alzheimer's disease (AD), and improves movement's deficit in Parkinson's disease. Fatmawati et al. (2014) also reported that *P. ginseng* might be an important herbal medicine in preventing diabetic complications. Van Kampen et al. (2014) discovered that ginseng extract maybe a potential neuroprotective therapy for the treatment of Parkinson. Choi et al. (2006) reported that Korean and Chinese ginseng reduced systolic and diastolic BP, and red ginseng reduced headache symptoms. American ginseng showed antihypertensive effect on diastolic BP and reduced headache symptom.

However, there was no statistical significance in the between-group analysis. Lee et al. (2013) demonstrated that ginseng effectively reduces adipose tissue and prevents obesity in diet-induced obese mice that this process may be mediated in part through the anti-angiogenic actions of ginseng. Rocha et al. (2018) found that *P. ginseng* is effective in the control of abdominal pain in irritable bowel syndrome patients, analogous to trimebutin. Wang and Ng (2004) reported that the ribonuclease isolated from Chinese ginseng flowers; the root ribonuclease exhibits antifungal and inhibitory activities toward HIV-1 reverse transcriptase. Shin and Yoon (2018) demonstrated that ginseng may be able to prevent obesity, hyperlipidemia, and hepatic steatosis in men with testosterone deficiency.

Gray et al. (2016) found that ginseng protects against chromatin damage and thus maybe beneficial to reproductive fitness. Lee and Oh (2015) revealed that when red ginseng is administered over long periods, age-related decline of learning and memory is ameliorated through anti-inflammatory activity. Sharma and Goyal (2015) also insist on potential role of *P. ginseng* to become a pivotal chemo-preventive agent that can reduce cancer in mammals. Hwang et al. (2017) concluded that *P. ginseng* can prevent aging by inhibiting wrinkle formation and increasing moisture in the human skin. Park et al. (2017) reported that Korean Red Ginseng has beneficial effects on chronic liver disease, a condition encompassing non-alcoholic fatty liver disease, alcoholic liver disease, chronic viral hepatitis, and hepatocellular carcinoma. Lee and Son (2011) found the strong positive potential for glucose metabolism, psychomotor function, and pulmonary disease, but not for physical performance enhancement.

CONCLUSION

In order for Chinese medicine, and in particular, TCM, to become more integrated into medical practice in the West, there is a need to bridge the many conceptual and practical differences between western medicine and Chinese medicine. Among the ginseng species, Korean ginseng (*P. ginseng*), Chinese ginseng (*P. notoginseng*), and American ginseng (*P. quinquefolius*) are the most common through the world. Cultivated Ginseng (CG), Mountain Cultivated Ginseng (MCG), and Mountain Wild Ginseng (MWG) are three categories of ginseng. Dwarf ginseng (*P. trifolius*) is another type of ginseng in Canada. Siberian ginseng, *E. senticosus* is also another common ginseng in the United States. Brazilian ginseng (*P. glomerata* Spreng. Pedersen, Amaranthaceae), is a medicinal plant largely used as adaptogenic herb. Although, field cultivation of ginseng is occurring in Asia and Europe, these endeavours are small in scale and have not made any significant impact on the supply structure of the market. This versatile medicinal plant is the unique source of various types of chemical compounds, which are responsible of the various activities of the plant. As the public scenario is changing towards the use of non-toxic plant products having Traditional Medicinal Asian Crops, development of modern drugs from *P. ginseng* should be emphasized for the control of various diseases.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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