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Health from the roots - benefits of ginseng supplementation

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ABSTRACT

Background: Ginseng has been used in traditional Chinese medicine for thousands of years as a cure for various diseases. The term “ginseng” is a popular name for herbal drugs that are based on the roots of several distinct species of plants, mainly Korean or Asian ginseng (*Panax ginseng* C.A. Meyer) and American ginseng (*Panax quinquefolius*). In this study, we aimed to analyze the health benefits of ginseng.

Materials and methods: We analyzed publications found in PubMed and Google Scholar. Articles were selected on the basis of keywords such as “ginseng’’, “*Panax ginseng*”, “ginsenosides”, and “health benefits”. For the final analysis, the eligible articles were published from 2010--2024.

Results: All of the research findings regarding the benefits of ginseng on cognitive function are consistent with their results. Ginseng supplementation has a positive effect on cognition in humans. Seniors are the group of patients who benefit the most from ginseng. Additionally, studies have suggested positive effects on obesity, coronary disease and diabetes.

Conclusions: *Panax ginseng* supplementation can be recommended for patients, as it seems to be relatively safe for them and has several positive effects on health. Further studies are needed to investigate the influence on human health better.

Keywords: “ginseng”, “*Panax ginseng*”, “obesity”, “diabetes”, “*Panax quinquefolius*”

INTRODUCTION

In modern society, many civilization diseases affect many individuals. Because of the widespread use of the internet, online shopping and easy access to information, various dietary supplements to prevent the development of these diseases have become popular. Both natural and artificial dietary supplements are advertised as miracle drugs for all kinds of medical conditions. Not all of these compounds have been confirmed in scientific studies of health properties. Some dietary supplements have been used for hundreds of years in natural medicine. One such agent is ginseng, which has been used in traditional Chinese medicine for thousands of years as a cure for fatigue, anorexia, insomnia, impotence, cardiovascular diseases and many other conditions [1]. The term “ginseng” is used as a reference for herbal remedies, which are based on the roots of several distinct species of plants, mainly Korean or Asian ginseng (*Panax ginseng* C.A. Meyer), Siberian ginseng (*Eleutherococcus senticosus*) and American ginseng (*Panax quinquefolius*). There are nearly twenty spices of ginseng in total, as listed in Table 1 below [2,3]. All of these species are in the Araliaceae plant family, but each has its own specific effects on the body due to differences in chemical composition [4]. Ginseng can be found in the form of fresh roots, red ginseng or white ginseng, depending on the processing method used during preparation.

Table 1. Different species of ginseng [2,3].

1.	*Panax ginseng* C. A. Meyer (Korean ginseng)
2.	*Panax japonicas* C. A Meyer (Japanese ginseng)
3.	*Panax major* Ting
4.	*Panax notoginseng* Burkill F. H. Chen (Sanchi ginseng)
5.	*Panax omeiensis* J. Wen
6.	*Panax pseudoginseng* Wallich
7.	*Panax quinquefolius* L. (American ginseng)
8.	*Panax sinensis* J. Wen
9.	*Panax sipuleanatus* H. T. Tsai & K. M. Feng
10.	*Panax trifolius* L. (Dwart ginseng)
11.	*Panax wangianus* Sun
12.	*Panax zingiberensis* C. Y. Wu & K. M. Feng
13.	*Panax vietnamensis* Ha et Grushv. (Vietnamese ginseng)
14.	*Panax assamicus* Ban.
15.	*Panax bipinnatifidus* Seem.
16.	*Panax sikkimensis* Ban.
17.	*Panax sokpayensis* Shiva K. Sharma et Pandit
18.	*Panax zingiberensis* C. Y. Wu et K. M. Feng (Ginger ginseng)

Ginseng is a product rich in ginsenosides, which are bioactive triterpene steroidal saponins. Current studies have identified nearly 200 types of ginsenosides; however, Rb1, Rb2, Rc, Rd, Re, and Rg1 are considered major ginsenosides [5]. These substances accumulate not only in the roots of the plant but also in the leaves, stems and fruits. Ginsenosides, especially Rb1, Rg1, Rg3 and Rh2, have anti-inflammatory effects [6]. Moreover, the saponins present in ginseng appear to have antidiabetic, cardiovascular-protective and anticancer effects [3]. Owing to their steroidal structure, ginsenosides are able to interact with cell membranes, membrane-bound channels and intracellular receptors [7]. This ability enables bioactive compounds in ginseng to have positive effects on the human body. Ginseng also has powerful antioxidant activity, which reduces oxidative stress in cells

and oxidative damage by enhancing antioxidant defense mechanisms [8]. Oxidative stress results from the excessive production of reactive oxygen species (ROS) in some of the most common diseases, such as dementia, diabetes, rheumatoid arthritis and degenerative motor nervous system diseases [9]. Oxidative stress caused by damage to mitochondrial DNA also contributes to aging [9]. Therefore, the use of antioxidants present in ginseng has the potential to slow the progression of diseases and the process of aging. The use of 0.5 to 2 g per day of dried Korean ginseng or 100 to 300 mg per day of extract containing 1.5% to 7% ginsenosides is recommended [10]. Notably, ginseng abuse above the recommended dosage can cause allergies, cardiovascular and renal toxicity, genital organ bleeding, gynecomastia, hepatotoxicity or hypertension [11]. There is also evidence of ginseng and warfarin interactions [11]. Patients and physicians should be aware of those limitations and follow the recommendations. Nevertheless, ginseng is a promising dietary supplement with several positive effects on human health.

MATERIALS AND METHODS

Search engines such as PubMed and the Google Scholar browser were scanned by each author. The following keyword combinations were used: "ginseng", "*Panax ginseng* C.A. Meyer", "ginsenosides", "saponins", "*Eleutherococcus senticosus*", "*Panax*", "obesity ginseng", "diabetes ginseng", "cognitive functions ginseng" and "health benefits ginseng". The authors also checked the bibliographies of the analyzed articles in terms of related articles. When duplicate reports were observed during the search, only the most complete report was included in the analysis. Eligible studies met the following inclusion criteria: 1) were published since 2010; 2) were published in English or Polish; 3) were published in periodical publication; 4) focused on the effects of ginseng on human health; 5) provided a clear presentation of the applied methodology; and 6) applied proper methodology. Parameters such as the selection of research groups, group comparability, and determination of the exposure or outcome of interest in case–control studies or cohort studies, as appropriate, were assessed.

RESULTS

The results of our analysis are presented in the following sections, which offer an overview of previous studies on the benefits of ginseng supplementation. Important conclusions and recommendations for medical professionals are emphasized.

Cognitive function

Since ancient times, ginseng has been used in traditional Chinese medicine to improve cognitive function. Recently, researchers have attempted to investigate whether ginseng influences memory and can be used in neurological conditions. In 2018, very interesting results from an evaluation of Korean seniors were published. Lho et al. analyzed the influence of long-term (>5 years) and short-term (<5 years) ginseng supplementation on the CERAD total score (Consortium to establish a Registry for Alzheimer's Disease Assessment Packet Neuropsychological Battery total score) and MMSE score (Mini-Mental State Examination) among the studied population. In total, 3918 participants over 60 years of age were evaluated at the 2-year and 4-year follow-ups. The results presented in this study suggest that prolonged ginseng use may support cognitive function later in life. Patients who had a history of ginseng

intake for more than 5 years presented better cognitive function than individuals who never consumed ginseng. In the group of subjects who had taken ginseng for less than 5 years, a difference between them and the group who did not use ginseng was not observed. After the analyses, which included age, sex, years of education and other factors, concluded that supplementing ginseng for more than 5 years resulted in higher CERAD total scores than the no-use group of patients did [12]. These findings indicate that long-term use of ginseng is beneficial later in life.

Another study that investigated the benefits of ginseng intake on human cognitive functions was published in 2019. Korea Park et al. examined 90 subjects with mild cognitive impairment. The participants were divided into two subgroups: one received 3 g of *Panax ginseng* powder, and the other received placebo (starch) for 6 months. The effects on cognitive functions were measured via the K-MMSE (Korean version of the MMSE), the K-IDAL (Korean version of Instrumental Activities of Daily Living) and the SNSB (Seoul Neuropsychological Screening Battery). Patients who consumed ginseng for 6 months achieved better results on the Rey complex figure test (RCFT) immediate recall test and on the RCFT 20-min delayed recall test than did those in the placebo group. The RCTF and RCTF with a 20-min delay were used to assess visual memory in the SNSB test. No significant differences were observed in the K-MMSE scale score, probably because the scanned population scored over 27 points on this scale. No significant changes could have been observed in such a small margin [13]. Nevertheless, these results indicate that ginseng has positive effects on cognitive functions in humans, especially visual memory.

Evidence of the improvement in cognitive function after ginseng supplementation also comes from studies investigating human brain structure. Scientists from South Korea tracked changes in the gray matter volume of the whole brain via magnetic resonance images in two groups of healthy subjects. One group (n=18) received 1000 mg of Korean red ginseng per day for 8 weeks, and the other group (n=19) was given a placebo for 8 weeks. At the start of the experiment and after the 8-week period, the two groups were scanned via MRI and tested using different scales to assess executive function, attention and memory. Researchers compared the results between those two groups and group-in-time interactions. After 8 weeks of ginseng supplementation, the gray matter volume of the left parahippocampal gyrus increased significantly in the ginseng group. This part of the brain is associated with visual memory and coordination. Additionally, ginseng supplementation improved the cognitive function measured in this study compared with that in the placebo group. The described improvement was significant in subjects who received ginseng but not in those who received placebo [14]. An increase in gray matter volume in the parahippocampus may be a significant neural change resulting from ginseng supplementation, potentially contributing to cognitive enhancement.

Promising results have also been obtained from investigations of the effects of *Panax quinquefolius* extract on the human brain. The influence of American ginseng extract was tested on 32 healthy young participants. Scholey et al. administered capsules with different doses of Cereboost™ (American ginseng extract) at 0 (placebo), 100, 200 or 400 mg. During the four active days of the trial, the research team measured blood glucose levels, cognitive functions via the COMPASS battery (The Computerized Mental Performance Assessment System) and mood changes via mood scales. All of the tests were performed four times: before ginseng was administered, one hour after, three hours after and six hours after administration. Each of the testing days was established at 7-day intervals to ensure that no accumulation of ginseng occurred. The COMPASS battery is designed to assess attention, working memory secondary memory and executive functions. Compared with the placebo, all of the ginseng doses improved cognitive function in the subjects and had a positive effect on mood. The best effects were observed for the 200 mg dose in most of the components of the COMPASS battery. For example, immediate word recall accuracy and numerical working memory speed were significantly improved in the group that consumed 200 mg of ginseng. In all of the groups, in addition to placebo, American ginseng had a positive effect on working memory. Moreover, American ginseng appears to have a calming effect. The group that was administered 100 mg of Cereboost™ on the mood scale presented increased calmness 3 and 6 hours after ingestion. No effects on blood sugar levels were observed. In addition to the fact that different spices of ginseng contain diverse ginsenosides, e.g., the American spice does not contain Rf ginsenoside, which is present in Asians, the effect on cognitive function is still valid [15].

Ginseng can be used not only in its raw form. There is evidence that heat-processed ginseng, such as sun ginseng (SG)-135, is rich in ginsenosides that are not present in the raw material (Rk1, Rk2, Rs4, Rs5 and more). These saponins are active ingredients with memory-enhancing potential. Heo et al. investigated the potential treatment efficiency of heat-processed ginseng for cognitive impairment in patients with Alzheimer's disease. The research team involved forty patients with moderate-to-severe Alzheimer's disease. Patients were divided into four equal groups. Each group was administered different doses of SG-135 (SG powder capsules, Ginseng Science Inc., Korea) as follows: 1.5 g per day (n = 10), 3 g per day (n = 10), 4.5 g per day (n = 10), and 0 g per day as a control group (n = 10). For the assessment of cognitive functions, researchers used the Alzheimer's Disease Assessment Scale (ADAS) and K-MMSE before ginseng supplementation and 12 weeks and 24 weeks after ginseng supplementation. Patients who were supplemented with SG-135 had higher scores on the ADAS scale and MMSE scale than controls did. Compared with those who received the lower dose, those who received the highest dose (4.5 g per day) improved their cognitive function faster (12 weeks). Additionally, the patients receiving the highest dose achieved the best results on all of the scales, and only those with the highest dose achieved a

statistically significant improvement in the K-MMSE score [16]. These results support the evidence that ginseng enhances cognitive functions in neurological diseases.

Obesity

Obesity is a global problem, especially in the modern world. This disease has a strong negative influence on human health, leading to serious medical complications such as diastolic heart failure, chronic kidney disease (CKD), nonalcoholic fatty liver disease (NAFLD) and type 2 diabetes mellitus (T2DM) [17]. Some studies have attempted to assess whether ginseng has an antiobesity effect and could be used as a supplement in the weight loss process. These promising results are derived from a relatively small study among Korean obese middle-aged women. Ten female participants consumed *Panax ginseng* extracts for 8 weeks, after which their body composition parameters were compared to those at baseline. After ginseng intake, significant decreases in weight and BMI were observed, with differences of –1.06 ± 1.41 kg and −0.48 ± 0.59 kg/m^2, respectively. However, no significant decreases in waist circumference, body fat percentage, high-density lipoprotein-cholesterol, triglyceride, total cholesterol, or glucose were detected [18].

More evidence of a beneficial influence on obesity comes from studies in animal models. Ginseng supplementation has the ability to prevent obesity and dyslipidemia in high-fat diet-fed castrated mice. The described process could be a result of the inhibition of adipogenesis-related gene expression. Moreover, in this study, ginseng extract was shown to stop adipogenesis while acting like testosterone in castrate mice [19]. In another animal-based study on female genetically obese mice that received approximately 4.5 g ginseng extract/kg BW/day for 13 weeks, an antiobesity effect was also observed. Compared with control mice, ginseng-treated mice had lower body weights and adipose tissue masses. The results of the present study suggested that this effect might be caused by the inhibition of VEGF and FGF-2 expression in adipose cells. This results in a reduction in the expression of angiogenic factors and thus might be useful in the treatment of obesity in humans [20].

Diabetes mellitus

Diabetes mellitus is a persistent illness in which symptoms such as elevated blood glucose levels or hyperglycemia arise due to abnormalities in insulin secretion, insulin action, or a combination of both. This disease can lead to microvascular and macrovascular complications, which can result in neuropathy, nephropathy, retinopathy and many other conditions [21]. The prevalence of diabetes has increased in the human population in recent years; therefore, effective methods for treating and preventing this disease have been investigated by scientists. One of the promising substances that may be used as a supplement in diabetes is ginseng. Several studies conducted in animal models as well as in human patients have shown the benefits of *Panax* administration in diabetes. In one study conducted

by Bang et al. on patients with impaired fasting glucose (IFG), impaired glucose tolerance (IGT), or newly diagnosed type 2 diabetes mellitus (T2DM), ginseng supplementation was shown to lower glucose levels. The study involved 41 patients with IFG, IGT and T2DM who finished the trial. The patients were divided into two groups: one received 5 g of Korean red ginseng (n=21), and the other received placebo (n=20) for 12 weeks. After this period, the serum and whole blood glucose levels during the oral glucose tolerance test, which included 75 g of glucose, were compared between the two groups. None of the patients took anti-diabetic medication during the trial. The subjects with IFG/IGT (n=11) presented significant decreases in serum glucose levels and whole blood glucose at 30 min. Individuals with newly diagnosed diabetes (n=10) tended to have decreased whole blood glucose levels at 30 min. These results were not observed in the placebo group [22].

It appears that ginseng might also be used as a supplementary treatment method in patients who have had diabetes for years and who have experienced medical complications related to this disease. Park et al. examined patients who were diagnosed with T2DM more than 6 months before the trial and who suffered from diabetic neuropathy. The participants were divided into two groups: one group received 3 g of Korean ginseng per day for 24 weeks, and the second group received placebo for the same amount of time. Thirty patients in the ginseng group and 31 in the placebo group completed the experiment. The mean diabetes duration among the participants was 12 years. The study revealed that in the ginseng group, peripheral neuropathy improved, particularly in individuals with a longer duration of diabetes and preexisting neuropathy. In contrast, insulin sensitivity improved in those with a relatively shorter duration of diabetes. No significant differences were observed in blood pressure, HbA1c or BMI between the two groups [23].

Korean ginseng was taken into consideration not only as a potential treatment supplement for diabetes. In research published in 2018 by Vuksan et al., American ginseng was tested as a potential add-on therapy in patients with T2DM treated with conventional treatment. Compared with those in the placebo group, the HbA1c in the American ginseng group decreased by 0.29±0.1% after 8 weeks of supplementation with 3 g per day ginseng. The glycemic benefits were accompanied by a decrease in systolic blood pressure and blood lipids. The limitation of this study is the small study group of only 24 participants [24]. In addition, the results seem to be interesting, as in the studies regarding Korean ginseng, no differences were observed in HbA1c or blood pressure compared with the placebo groups.

Studies conducted on animal models have shown that ginseng has potential in the treatment and prevention of diabetes. For example, fermented ginseng extract (FGE) has been tested in mouse models of type 2 diabetes. After 8 weeks of administration, FGE-treated animals presented lower levels of blood glucose, HbA1c and higher levels of serum insulin after 6 and 8 hours of fasting than the control group did [25]. In other studies, including a

T2DM mouse model, animals that consumed *Panax notoginseng* saponin (PNS) for 12 weeks presented improvements in body weight, body fat content, serum lipids and antioxidative function compared with those in the control group [26]. These effects need to be investigated in the human population; however, the results are very interesting.

DISCUSSION

All of the studies regarding the benefits of ginseng on cognitive function are consistent with their results. Healthy adults, as well as seniors with mental impairments, who supplement ginseng achieve higher scores on cognition tests than controls who do not use ginseng. The only difference observed during the analysis was the amount of time the ginseng was used to achieve benefits. The long-term use of ginseng is undoubtedly beneficial; however, short-term supplementation with ginseng seems to be beneficial in some cases. Further studies with larger study groups and longer observations are needed to achieve reliable results. In the case of obesity, most of the results confirming the antiobesity effects of ginseng have been derived from studies in animal models. The conclusions from those studies are promising; however, more studies including humans are needed. Ginseng has also been investigated as a potential treatment for elevated sugar levels. In this case, the results from the studies are not consistent. In the studies cited above, the effect of *Panax* on glycemia was observed to be beneficial in some cases. The effects on blood sugar levels were not observed in healthy patients; however, the effects on those with diabetes or prediabetes were significant. This difference might indicate that the benefits of ginseng on glycemia occur only in patients who already have issues with blood glucose levels. Notably, most of the studies included small study groups, which is considered the greatest limitation. Additionally, different types of ginseng do not contain the same ginsenosides; thus, their effects on human health might depend on the exact chemical composition of the plant used. Moreover, ginseng can be used in many forms, such as dried roots or heat-processed roots, which change the amount or type of supplemented ginsenoside. In Table 2, we present an overview of the selected ingredients present in ginseng and their influence on human health.

Table 2. Types of ginsenosides and their health properties.

Ginsenosides:	Function:
Rg1	cardioprotective, reducing cardiac fibrosis, neuroprotective, therapeutic in neurological disorders e.g. anxiety, depression, epilepsy, stroke, PD, and Huntington disease, improve learning and memory function in Alzheimer's disease models [5], [28], [27]
Rd	neuroprotective, therapeutic in neurological disorders e.g. anxiety, depression, epilepsy, stroke, PD, and Huntington disease, anti-inflammatory, antioxidant, anti-apoptosis, inhibition of Ca^{2+} influx and protection of mitochondria, and promote nerve regeneration. reducing hyperglycemia, increasing glycogen synthesis and decreasing hepatic gluconeogenesis, alleviate insulin resistance and obesity, enhancing glucose tolerance [5], [29], [30]

Rg3	neuroprotective, therapeutic in neurological disorders e.g. anxiety, depression, epilepsy, stroke, PD, and Huntington disease, memory-enhancing effects in model of alcoholic dementia, anti-tumor efficacy in a number of cancer types, anti-inflammatory, antioxidant, anti-aging, therapeutic potential in MASLD, obesity, and diabetes [5], [16], [30]
Rb1	regulation of mitochondrial energy metabolism, improving insulin resistance thus beneficial effects on diabetes, beneficial effect on insulin sensitivity, acts against hyperglycemia and insulin resistance, reducing inflammatory cytokine production in the liver [30], [31]
Re	facilitate human sperm capacitation and acrosome reaction, enhancing intracellular NO production. Neuroprotective, therapeutic in neurological disorders e.g. anxiety, depression, epilepsy, stroke, PD, and Huntington disease [32], [5]
Rc	enhancing sperm progression in vitro, Neuroprotective, therapeutic effects in various neurological disorders such as anxiety, depression, epilepsy, stroke, amyotrophic lateral sclerosis, AD, PD, and Huntington disease [32], [5]
Rb2	cardioprotective effect in vitro, neuroprotective in various neurological diseases [33], [5]

Ginseng has potentially beneficial effects on other aspects of human health, which are not described in detail above. Moreover, it can be used as a supplement for treating coronary disease, which helps reduce hypertension and has cardioprotective, antioxidative and anti-inflammatory effects [34].

CONCLUSIONS

Panax ginseng supplementation can be advised for patients, especially older patients. Several positive effects on human health described above are beneficial for adults at any age. Ginseng administration has relatively rare side effects, so it could be used as a supplement for individuals with neurological conditions, diabetes and obesity. Nevertheless, medical professionals should be aware of the side effects and interactions with prescribed drugs and pay attention to the symptoms reported by patients. Ginseng is undoubtedly a fascinating herb, and its properties require further research.

Author's contribution

Conceptualization, D.S., and K.S.; methodology, A.B.; software, M.W.; check, M.W.; formal analysis, A.B.; investigation, A.B., D.S.; resources, K.S.; data curation, D.S.; writing - rough preparation, K.S.; writing - review and editing, M.W., K.S.; visualization, A.B.; supervision, K.S.; project administration, D.S.; receiving funding – no funding was received.
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