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Phytochemical Profiles of Ginseng Varieties: A Pharmacological Perspective

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ABSTRACT:

Background: This review provides an in-depth look at Ginseng, covering their taxonomy, phytochemistry, medicinal uses, and pharmacological action. It highlights the presence of bioactive compounds like Ginseng, polyphenols, and trigonelline, and explores their traditional and modern uses in treating various diseases. The review showcases the potential of Ginseng Plant for pharmaceutical and nutraceutical applications and calls for further research to fully utilize their benefits.

Methods: Literature has been collected through SciFinder, Web of Science, Google Scholar, PubMed, and a library. This review shares updated information on the botany, distribution, health benefits, phytochemistry and pharmacology of Ginseng Plant.

Result: Bioactive components of Ginseng exhibited a wide array of activities such as Anti-inflammatory, anti-microbial, antioxidant, Stimulation and insulin secretion. This curative potential highlighted its various beneficial outcomes in the field of drug research and increasing scientific interest in the identification of bioactive compounds responsible for various pharmacological activities. This legume is gaining importance for its use in the pharmaceutical, food and cosmetic products.

Conclusion: Existing literature authenticates the potential benefits of Ginseng Plant from Nutritional as well as medicinal perspective. This Plant needs to be explored for identification, isolation, and characterization of bioactive compounds against varied ailments.

Key Word: American ginseng; callus; somatic embryo; suspension culture; hairy root; adventitious Root; ginsenoside

Introduction:

Concerns about animal welfare, long-term sustainable livestock production, and food and consumer safety have grown as a result of global warming and the growing demand from consumers for food and meat derived from animals, especially in recently industrialising
nations with hot climates.{1} For the livestock business, heat stress is a significant environmental concern, as it represents the animal response to situations with high temperatures and high humidity, and also generates undesirable outcomes, from discomfort to demise. Animals that are stressed by the heat alter their physiology and behaviour to dissipate body heat; they eat and move less. spending more time dozing, consuming alcohol, and panting. The significance of how animals react to environmental difficulties are common to all animal species. But compared to other farm animals, chickens are more vulnerable to heat stress.animals because of their quick metabolism rates.{2}
High rates of illness and mortality, poor meat and egg quality, and poor production performance (such As reduced feed intake and daily weight gain) are all clear indicators of heat stress in chicken. Heat Stress also causes immunosuppression and damages intestinal barrier function, which raises the risk of Contracting infectious infections. Against dangerous microbial infections and antigens from the intestinal Lumen, the intestinal barrier serves as the first line of defence.{3}[4] Furthermore, a layer of epithelial cells forms the intestinal barrier, which is sealed by tight junctions made mostly of transmembrane proteins including occludins and claudins. Selective barriers known as tight junctions control the movement of paracellular particles. Heat stress can disrupt the intestinal mucosa's capacity to operate as a selective barrier by weakening the tight junctions and increasing the mucosa's permeability. It squelches microorganisms and absorbs nutrients.[5][6]{7}
Additionally, heat stress was shown to lessen the efficiency of broiler chickens, raise viable coliform and Clostridium levels, and decrease the Increased intestinal permeability and jejunal injury are caused by occluding and zonula occludens-1 protein levels shape Additionally, animals that are under heat stress have higher levels of reactive oxygen species. Heat shock proteins are then produced and released by the organism when it moves into an oxidative stress state.{8}
The diverse spectrum of actions of heat shock proteins form a cytoprotective system. Antibodies target these proteins, which in turn trigger the immune system and boost cellular immunity. These proteins are crucial for the anti-inflammatory response and antigen presentation. In addition to increasing antioxidant enzyme activities and relieving and reducing intestinal mucosal oxidative damage by blocking lipid peroxidation, the regulation of heat shock proteins considerably preserved the integrity of the intestinal mucosa of heat-stressed broilers. On the other hand, these heat stress-related protective effects were totally eliminated when birds were treated with inhibitors of heat shock proteins.{9} Dietary supplements are an efficient way to combat heat stress in addition to conventional environmental management techniques. For instance, betaine is frequently utilised in farm animals' defence against

heat stress. In eastern Asia, ginseng is a widely valued herbal remedy that improves immunity, reduces stress, and encourages regeneration. Typical ginsenosides, a class of naturally occurring triterpene saponins, make up ginseng extract. {10}{11} Numerous investigations have demonstrated that Ginsenosides perform a variety of tasks, such as modulating antioxidant enzymes and intestinal barriers. Safety For example, superoxide dismutase (SOD) transcription is induced by ginsenoside Rb2.by way of the SOD gene promoter region being activated. The compound called ginsenoside found in wild ginseng inhibits the reduction in colonic epithelial cells from a mouse colitis model in zonula occludens-1, indicating that Ginseng works well to improve intestinal transit and to create and maintain tight junctions.barrier operation. {4}[5][6][7].

Red ginseng significantly reduced lipid peroxidation and ROS-associated gene expression in rats during heat stress, according to research by Kim and colleagues. Furthermore, heat-stressed rats' weight loss persisted despite red ginseng's suppression of heat shock protein 70 gene expression. As far as we are aware, there aren't many systematic research that information on ginseng extract's impact on heat shock and animal performance under heat stress gut barrier integrity and the protein response[13][14] Therefore, the goal of the current study is to ascertain how ginseng extract affects the parameters of heat shock protein response and intestinal barrier function. It is based on in vitro and in vivo tests using Caco-2 cells, the worm Caenorhabditis elegans, and developing broilers. C.{15} elegant was employed as a useful model to investigate how ginseng extract affects important processes that are known to be involved during the hormetic stress response, like the forkhead box protein O's nuclear translocation (FOXO) daf-16 transcription factor. For research on intestinal epithelial cells, Caco-2 barrier function Because of their transepithelial parallels to mammalian intestinal epithelia. Electrical resistance (TEER). {11}

Finally, the impacts detected in C.elegans and Caco-2 cells were compared to effects on farm animal Health and heat stress response using growing broilers.{11][12][13][14]

Botanical Profile of Ginseng:

Taxonomy of Ginseng:

1. Kingdom: Plantae
2. Clade: Angiosperms
3. Clade: Eudicots
4. Clade: Asterids
5. Order: Apiales
6. Family: Araliaceae
7. Genus: Panax
8. Species: P. ginseng

Occurrence and Distribution:

Ginseng is developed normally somewhere in the range of 33°N and 48°N, which relates to the subarctic and calm environment areas in Korea (between 33°7/N and 43°1/N), Manchuria (somewhere in the range of 43°N and 47°N), and the Sea region of Siberia. Different natural elements like soil and climatic, for example, hydrogen particle, supplements, microbial populaces and dampness content influence plants. {20} Regularly, precipitation, measure of daylight and air temperature are incorporated among climatic variables[16][17]

There are two types of ginseng in Canada, the American ginseng (P.quinquefolius) and the Bantam ginseng (Panax trifolius). Siberian ginseng, Eleutherococcus senticosus, is the most normally involved ginseng in the US. {21} While not viewed as a genuine ginseng, it has a place with the ginseng family and is local to Siberia, Korea, Japan and China Wild ginseng can be either Asian or American and can be handled to be red ginseng Asian and American ginseng shows various properties and restorative qualities in pharmacology, despite the fact that the major bioactive elements of Asian ginseng and American ginseng are ginsenosides[18][19] The Brazilian ginseng roots (BGR) are generally utilized in people medication as pain relieving, calming, tonic, hostile to diabetic, sexual enhancer, and antiulcer-gastric, with a few explores depicting its viability. {22}

Description of plant part

2.3.1 Stem:

Stems of ginseng are thin and may reach a height of around one metre. They are smooth-textured, often green, and support the leaves and flowers.

2.3.2. Leaves:

The leaves of ginseng are palmate, which means that several leaflets radiate from a single point. Leaflets are dark green and fairly glossy, usually numbering five to seven per leaf.

Flowers:

In late summer, the tiny, greenish-white blooms emerge in umbrella-like clusters. Though not very spectacular, they aid in reproduction, which results in the growth of seeds.

Fruits:

The fruits are little red berries with seeds inside of them. Once pollination has occurred, these berries mature and, if eaten by animals, can disperse the genetic material of the plant.

Figure: Ginseng Plant and Seed

Traditional Uses of Ginsengs:

For at least 2,000 years, Chinese people have utilized ginseng, the root and rhizome of Panax ginseng C.A. Meyer (Araliaceae), as a medicinal herb (Goldstein, 1975; Hu, 1977; Liu and Xiao, 1992). Ginseng is a high-quality herb with numerous pharmacological uses, including restorative, tonic, nootropic, antiaging, and more, according to Shen Nong Ben Cao Jing, the oldest Chinese materia medica book[39][40]. Traditional Chinese medicine (TCM) differs from Western medicine in that it prioritizes individual therapy and primarily uses herbs to improve pathological conditions and restore the body's equilibrium. According to Lei et al. (1995), the majority of Chinese traditional medicine textbooks today. the viability and utilizations of ginseng are by and large summed up as follows: for neurotic circumstances, for example, hypodynamia, languor and anorexia, it is reasonable to utilize ginseng joined with Tuckahoe, Atractylodes macrocephala and Licorice root. For conditions, for example, windedness and soft tone, ginseng is frequently utilized along with Astragalus mongholicus. For fever, hydrodipsia and diabetes, it is additionally reasonable to utilize ginseng joined with Cypsum fibrosum, Anemarrhenae, Snakegourd root and Rehmannia dried rhizome.[36][37] For palpitation, sleep deprivation and horrible absent mindedness, ginseng is typically utilized along with Salvia miltiorrhiza and Jujube seed. Other than these signs, ginseng has likewise been utilized to treat discharge and barrenness, and at a higher measurement or along with Aconite root to truly treat sick patients[33],[38]. In any case, ginseng ought not be utilized along with Eranthis hyemalis and Excrementum pteropi.

Phytochemistry profile of Ginseng:

The Rb1/Rg1 ratio and the total amount of ginsenosides are used to standardise ginseng products. Specifically, ratios vary by species: Panax ginseng (Asia ginseng) is characterised by Rb1/Rg1 values typically between 1 and 3, whereas Panax quinquefolius (American ginseng) is characterised by Rb1/Rg1 values of about 10 or more. Also, species separation is done based on whether the marker chemicals are present or not [29]. To distinguish Panax quinquefolius and rule out adulteration, ginsenoside Rf is absent. Different quantitative findings might be observed based on the approach used while reviewing the vast quantity of literature created regarding the analytical procedures for ginsenosides. In Panax ginseng, the total ginsenoside content ranged from 4 to 9% for root hair and from 0.2 to 2% for main roots. These findings support the advice we received from our pharmacology professor twenty-five years ago: "It is wise to purchase ginseng root hair at a low cost because per kg of root hair contains a higher amount of active ginsenosides than per kg of main root does." The total ginsenoside content of Panax quinquefolius roots has been found to range from 4 to 10%. Although ginsenosides are primarily found in the root of ginseng, they are also found in considerable amounts in the leaf and berry sections of the plant.

Pharmacological Activity/ Profile of Ginseng:

ANTIMICROBIAL PROPERTIES:

- **Anti-Pseudomonas aeruginosa effect**

Koh and Tham (2011) observed that notoginseng root and flower extracts all shown an anti-swarming activity against P. aeruginosa in their in vitro testing. However, the author did not examine their reduction of P. aeruginosa growth. Interesting findings indicate that Asian ginseng (a) does not inhibit P. aeruginosa growth at concentrations of 0.5–2.0%, but it significantly prevents P. aeruginosa from forming biofilm; (b) disperses the majority of mature biofilms formed by P. aeruginosa stains that are 7 days old; (c) increases swimming and twitching motility, but reduces P. aeruginosa swarming at concentrations as low as 0.25%; (d) oral administration of Asian ginseng in mice promotes phagocytosis of P. aeruginosa PAO1 by airway phagocytes, but had no effect on an APO1-film mutant's ability to be phagocytosis (Wu et al., 2011). Additionally, in two additional studies, Asian ginseng did not exhibit any antibacterial effect in vitro against P. aeruginosa growth[39]. However, an in vivo experiment revealed that the administration of Asian ginseng improved bacterial clearance and reduced lung pathology in rats, both normal and athymic, that were chronically infected with P. aeruginosa (Song et al., 1997 and 1997b).

- **Anti-Helicobacter pylori effect:**

Study on Asian ginseng, either white or red, has been the subject of all the aforementioned anti-H. pylori studies, but American and notoginseng ginseng have been the subject of very less study[41],[42]. Additionally, the anti-adhesion properties of acidic polysaccharides and the growth inhibition properties of protopanaxadiol and panaxytriol are most likely responsible for Asian ginseng's anti-H. pylori actions both in vitro and in vivo. Nonetheless, because intestinal microbiota can convert glycosides ginsenosides Rb1 and Rg3 into the active molecule protopanaxadiol, they may also be crucial to the in vivo anti-H. pylori action (Bae et al., 2002).

- **Antifungal activities:**

In our surroundings, fungi are widely present. Numerous ailments, such as asthma, allergies, infections or rashes on the skin and nails, lung infections (pneumonia) with symptoms resembling the flu or TB, bloodstream infections, and meningitis, can be brought on by infectious fungi. One of the biggest health risks to those with weakened immune systems is fungus infections (Perfect, 2012)[42][34]. Antifungal resistance is a growing worry these days, particularly for patients suffering from invasive fungal infections such as those brought on by the yeast fungus Candida, which can result in life-threatening conditions like incapacity and death. Recent studies have examined the antifungal properties of notoginseng, American ginseng, and Asian ginseng. In vitro antifungal activity of notoginseng RNase was demonstrated against Physalospora piricola and Coprinus comatus[44][42].

Future perspective:

In 2012, cultivated ginseng was certified as a new resource food. In 2014, the China Food and Drug Administration added it to the list of medicinal and food origin. In 2016, fresh ginseng output in China reached 28,900 tons, ranking first, resulting in an output value of $7,500 million in Jilin's ginseng business. However, the entire value of the ginseng sector does not match the ginseng yield in China. Furthermore, the molecular mechanism of ginseng for clinical use remains unknown. To further strengthen and develop the ginseng business chain, we must construct a pollution-free ginseng planting technology system in farms and investigate molecular pathways for tonifying frailty-related illnesses. Optimizing processing techniques and generating healthy products with high commercial value[42][43].

Conclusion:

Plant tissue culture technology has advanced considerably in the last few years. Significant advancements have been achieved in the cultivation of American ginseng tissue and the Enhancement of ginsenoside production. To boost the biomass and ginsenoside content of American Ginseng, researchers have looked at standardising and optimising the growing conditions in vitro. When Compared to traditionally cultivated roots, a significant amount of biomass may be harvested in a Significantly shorter length of time. Large-scale in vitro ginseng production still faces several challenges, Though. It takes a lot of time and labour to generate somatic embryos from the callus of American Ginseng. In general, 4-5 months of culturing are required to obtain a high incidence of somatic Embryogenesis; from somatic embryos, normal plantlets develop in around 6 months. Production of Ginsenosides must rise to meet the demand for their commercial use.(102) Compared to Asian ginseng Tissue culture, which has been industrialised in South Korea, Japan, and China, American ginseng Industrialisation is trailing behind. Thus, more investigation is needed into how to convert lab-scale in Vitro culture of American ginseng into an industrial-scale culture, particularly in areas pertaining to Ginsenoside biosynthesis pathways and in vitro culture conditions optimisation. The only way to protect This threatened plant species and keep it useful to humanity is to produce ginsenosides industrially Utilising American ginseng tissue culture techniques.

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