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Potential pharmacological benefits of Ginger (*Zingiber officinale*) – A review

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Abstract

Ginger (*Zingiber officinale* Roscoe, Zingiberacae) is widely used as medicine since ancient times. This review summarizes the most relevant reports implying diverse pharmacological efficacies of ginger. Several scientific investigations focus on isolation, purification and characterization of active phytoconstituents from *Zingiber officinale* with pharmacological benefits. These include flavonoids, essential oils, carbohydrates, phenolic compounds, alkaloids, saponins, terpenoides, tannin, glycosides, steroids, minerals, proteins, lipids, fibers, fatty acids, lecithins, protease, calcium, phosphorous, potassium along with many vitamins like riboflavin, thiamine, vitamin C and niacin. It has the ability to act as antioxidative, anti-diabetic, anti-inflammatory, antimicrobial, neuro-protective and anti-carcinogenic agent to manage and cure a variety of ailments with minimal or no side effects. Further clinical and preclinical trials are warranted to elucidate the consumption of ginger as an alternative pharmacological adjunct.

Key words: *Zingiber officinale*, anti-oxidants, anti-diabetic and anti-microbial

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1. Introduction

Since the earliest times, traditional medicine systems are based upon plants. Even the modern era is dependent upon the same centuries old system to manage and treat disease. World Health Organization investigated that 80% population of the globe depend on folk medicines [1]. The demand of herbal medicines increase in both developed and under developed countries, therefore, the pharmaceutical companies are taking interest in herbal medicines [2].

Zingiber officinale (Zingiberacae) has been used in Indian and Chinese medicines for more than 25 era. It has been used in the world as a herbal remedy, condiment and cooking spice. Chinese people used *Zingiber officinale* as an anti-nausea remedy, as digestive aid and to cure bleeding ailments. Ginger is also used to cure toothache, baldness, respiratory and snakebite conditions. It is considered a dry, pungent and yang herb which is used for disorders caused by cold conditions. Ginger has been used widely in Ayurveda medicine to block excessive clotting, for arthritis and hypercholesterolemia treatment [3].

Z. officinale can grow in both tropical and in sub-tropical regions and can adopt both humid and warm conditions up to 1500 meter sea level. *Z. officinale* is produced in Bangladesh, Pakistan, India, US, Nepal, Taiwan, Nigeria, China and in other regions of world. Full grown *Z. officinale* plant is about 2 meter long. The shoots grow from bulb on the bottom of the ginger plant. The rhizome of *Zingiber officinale* grows underground. Its rhizome is thick and tuberous. Mostly rhizome is broad lobed, aromatic, enclosed like scars, fleshy and knobbly. While the leaves are long, green, blade slowly reduce to a point, sheathing bases and 2 to 3 centimeter broad [4].

2. Phytochemistry

Z. officinale rhizome constituents vary depending upon the area of origin as well as on rhizome conditions. *Z. officinale* rhizome is widely used in food products due to its flavor, aroma and nutritional composition. Rhizome extracts have elevated level of compounds such as gingerol, shogaols, zingerone and paradol. It was confirmed that gingerol and shogaol are the major components that show pharmacological activities [5]. From the volatile oil of *Z. officinale* rhizome, main active ingredients isolated are the zingiberene, sesquiterpenes, zingiberol and bisapolene [3].

Other rhizome constituents include fat, minerals, proteins, lipids, fibers, fatty acids, carbohydrates, lecithins, protease, calcium, phosphorous, potassium along with many

vitamins like riboflavin, thiamine, vitamin C and niacin [6]. It was reported by [7] that rhizomes possess essential flavonoids, oils, carbohydrates, phenolic compounds, alkaloids, saponins, terpenoides, tannin, glycosides, steroids, and proteins as the main phytochemical groups.

3. Antioxidant activity

Oxidative or radical stress can destroy molecules and antioxidants especially those of natural origin play an important role in against oxidative damage. Several studies suggested antioxidant efficacies of *Z. officinale* rhizomes [4, 8-11]. [12, 13] stated that *Z. officinale* extract possess free radical scavenging activity and gingerol inhibits lipid peroxidation. The oleoresin of ginger and oil extract also revealed significant antimicrobial and antioxidant activities [14]. Ginger components such as 1-dehydro-6-gingerdione and 6 dehydroshogaol are effective inhibitors of the NO compound in stimulated macrophages [15]. In another study, [16] observed that 6-shogaol has powerful antioxidant activity. Furthermore, [17] indicated that phenolic components possess strong antioxidative, anti-inflammatory and anti-carcinogenic properties. The active pungent compound 6-gingerol lessened gene expression decreased of cysts in ovaries and restored biological parameters to normal in rat models [18].

4. Anti-diabetic activity

Diabetes mellitus, a disabling metabolic disorder has affected about 150 million people worldwide [19]. Several studies indicated at anti-diabetic potentials of *Z. officinale*.

Diverse diabetes suppressive mechanisms of *Z. officinale* are proposed [20, 21]. It was observed by [22] that flavonoids components of *Z. officinale* act against diabetes mellitus either by avoiding glucose absorption or by enhancing glucose tolerance. The flavonoids either act as insulin mimetics or as insulin secretagogues. When [23] studied the hypoglycaemic potential of *Z. officinale* in streptozotocin induced diabetic mice, it decreased the cholesterol, triacylglycerol and serum glucose levels in diabetic rats as compared to control rats. The inhibition of carbohydrate digestive enzymes such as alpha glucosidase and alpha amylase through plants can be attributed to their phenolic components [24]. *Z. officinale* inhibits the enzymes that regulate carbohydrate metabolism and ultimately hyperglycemia in diabetic conditions.

Similarly, [25] conducted *in vitro* study to assess enzyme inhibitory potentials of *Z. Officinale* extracts. Ginger activities against two enzymes were found to connect with total phenolic constituents of shogaols and gingerol in extracts. However, [26] reported alpha glucosidase inhibitory effects of *Z. officinale* extracts with no effect on alpha amylase activity. Recently, it was stated by [27] that 6-paradol, a pungent ginger component can cause hypocholesterolemia and hypoglycemia. Similarly, [28] indicated reduced glucose level, insulin, leptin and enhanced lipid profile in high fat diet rats by the use of hydro ethanolic extract of *Z. officinale*.

5. Antimicrobial activity

Plant derived antimicrobial compounds have massive remedial potential. These are useful against infectious ailments with minimal side reactions that are associated with synthetic antimicrobial agents. The antimicrobial properties of plant extracts usually arise from secondary plant metabolites such as steroids, tannins, alkaloids, flavonoids, resins, gums and phenolic compounds [29]. [30] stated that antimicrobial properties of medicinal plant extracts depends on parameters such as technique employed, microorganism tested, plant material used and growth medium. For better study valuable quality of plant extracts should be preferred. Extraction and the solvent system possibly both modify final results. Different medicinal plant extracts may show different results.

Rhizomes of *Zingiber officinale* possess antimicrobial abilities [31, 32]. It has been investigated by [33] that ethanolic extract of *Z. officinale* rhizome inhibited bacterial growth. When methanolic extracts of *Z. officinale* were tested against nineteen strains of *Helicobacter pylori*, crude extracts that contain gingerols, inhibited the growth of all strains [34].

[35] reported antibacterial activities of crude flavonoids, polysaccharides, ethanolic and aqueous extracts of *Z. officinale* against microbes *S. pyogenes, H. influenza, S. aureus and S. pneumonia.* Ethanolic and flavanoids extracts revealed antibacterial properties against bacteria while aqueous and polysaccharide extracts showed no activity. Earlier, [36] demonstrated antimicrobial potencies of various extracts (ethyl acetate, water, *n*-hexane and ethanol) of *Z. officinale* rhizome against *Staphylococcus epidermidis, Streptococcus viridians* and *Coliform bacillus*. It was observed that all the extract except H_2O extract inhibited the bacterial growth. Ethanolic extract showed highest antibacterial activity. Strong antifungal activity of ethanolic extracts of *Z. officinale* against *C. albicans* was demonstrated by [37]. [38] conducted a study to examine antiviral action of gingerol, shogoal and ingenol isolated from *Z. officinale* rhizome. Gingerol was reported as effective inhibitor of *M. tuberculosis* and *M. avium.*

Table 1: Diverse Pharmacological benefits

Effective Components	Pharmacological activity	Mode of action	References

6 Shogaol	Anti-cancerous effect	Stimulation of apoptosis, inactivation of VEGF pathways lead to antineoplastic effects	[39]
Ginger extract	Osteoarthritis therapy	By decreasing inflammation mediators	[40,41]
6 Shogaol	Anti-inflammation effect	Suppression of pro-inflammatory chemokines and cytokines (RANTES, MCP-1)	[42]
Gingerol and its related compound	Antioxidant activities	By scavenging free radicals	[43]
Sesquiterpenes , shogaols, gingerols, monoterpenes and shogaols	Cure of vomiting and nausea	By anti-serotonin and anticholinergic activity	[44]
6-Gingerol	Anti-tumor activity	Via induction of apoptosis, modulation of genetics.	[45]
6-Shogaol (Alkanone from Ginger)	Antioxidant activity	Induces apoptotic cell death of human hepatoma p53 mutant mahlavu subline via an oxidative stress-mediated caspase	[46]
10-gingerol	Antimicrobial activity	Antibacterial activity against periodontal bacteria	[47]
Ginger extract	Anti-diabetic activity	By lowering glucose level, insulin, body weight etc. in rats	[48]
6-shogaol	anticancer activities against breast cancer	Inhibition of cell invasion reduction of matrix metalloproteinase-9 expression	[49]
Ginger extract in ethanol	Anti-hyperlipidemic effect	By decreasing cholesterol, triglycerides to elevate HDL	[50]
Ginger extract in ethanol Zingiberone	Hypoglycemic effect	Decreasing of blood sugar level by suppression of oxidative stress and anti-inflammation suppressors, to elevate insulin sensitivity	[51, 52]
Phenolic, 6 shogaol, flavonoids	Neuro-protective Effect	Acceleration of brain anti-oxidant resistance mechanisms	[52]
Terpenoides from Zingiber officinale	Induction of apoptosis in endometrial cancer cells	By the activation of p53.	[53]
Ginger and its constituent	Treatment of Colorectal cancer	By increasing the lymphocyte counts in colorectal cancer patients	[54]

Essential oil and oleoresin of Zingiber officinale Roscoe.	Antimicrobial and antioxidant activity	Scavenge ABTS+ free radical. Inhibit NO synthesis.	[14]
Active compound zerumbone	Treatment of cancer cells	Enhanced radiation-induced DNA damage and inhibited nuclear expression of DNA repair proteins ataxia-telangiectasia mutated (ATM) and DNA-PKcs	[55]
Zingiber officinale Essential oils	Anticancer Activity	Cytotoxic potential against Hela cells	[56]
Zingiber officinale	Induction of apoptosis	Programmed death in *T. vaginalis*	[57]
6-gingerol and 6-shogaol	Relief of oral ulcerative mucositis-induced pain	Blockage of sodium channel	[58]
Zingerone and its novel derivative	Anticancer activity	Inhibition of beta factor (TGF-β1) induced epithelial-mesenchymal transition	[59]
6-gingerol	Effect on adenosine monophosphate (AMP) activated protein kinase Nuclear factor kappa B pathway (AMPK- NF-Kb)	Up regulation of Sirt-6, enhanced phosphorylation of AMPK, down regulation of resistin, decrease of inflammatory molecules P65.	[60]

4. Conclusions

Ginger is an essential medicinal herb and widely used in Siddha, Chinese and in Ayurveda, medicine etc. Consumption of the *Z. officinale* plays a vital role in controlling of human ailments.

Biochemical analysis of ginger revealed its remedial potential and development of new drugs from ginger could be emphasized for prevention of numerous diseases.

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