

Medicinal properties of Ginger (*Zingiber officinale* Rosc.)

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Abstract

The medicinal plants find application in pharmaceutical, cosmetic, agricultural and food industry. The efficacy of some herbal products is beyond doubt, the most recent examples being *Silybum marianum* (Linn.) Gaertn (silymarin), *Artemisia annua* Linn. (artemesinin) and *Taxus baccata* Linn. (taxol). Randomized, controlled trials have proved the efficacy of some established remedies, for instance *Zingiber officinale* Rosc. commonly known as ginger. After extensive pharmacological studies, it has been concluded that ginger has significant anti-inflammatory, anti-emetic and chemo-protective effects. The article summarises various scientific studies and tries to analyze the current status of research in the pharmacological activities of ginger.

Introduction

Ginger (*Zingiber officinale* Rosc.) is a creeping perennial on a thick tuberous rhizome, which spreads under ground. In the first year, a green, erect reed like stem about 60 cm high grows from this rhizome. The plant has narrow; lanceolate to linear-lanceolate, 15-30 cm long leaves which die of each year. The odour and taste are characteristic, aromatic and pungent.

Ginger, valued as a spice has been used through ages in almost all systems of medicine against many a maladies. The plant is indigenous to Southeast Asia and is cultivated in a number of countries including India. The smell and taste of the drug

are typical and aromatic. The medicinal part of the herb is dried roots.

It is now recognized as a drug of choice for nausea and vomiting. It has also been found useful in pregnancy related morning sickness. In rheumatoid arthritis and osteoarthritis it is used as a natural pain reliever and an anti-inflammatory agent. It is also useful in curing ulcer and preventing heart attack and stroke. A number of active constituents and medicinal properties have been reported during the last decade.

The present article provides a comprehensive account of important medicinal properties of this versatile herb.

Traditional use

Ginger is known as *Sunthi* in Ayurveda and description of the plant appears in the old text like *Charaka*, *Sushruta*, *Vagbhatta* and *Chakra-dutta*.¹ The use of drug is mentioned in form of *Trikatu*, a famous Ayurvedic remedy for the treatment of digestive disorders. In *Ashtanga Hridaya*, the plant has been used in *Rasna Saptak Quath* (a decoction based on seven medicinal herbs), and a traditional remedy for arthritis.² Pharmacologically, the drug in Ayurveda has been described as appetizer. It is also indicated in ointment form for local application in pains.

Phytochemistry

Ginger is a rich source of volatile oil. Zingiberol, zingiberene, phellandrene and linalool are important constituents of the oil. They account for the aroma of the drug. The pungency of the ginger is due to gingerols and shogoals. Investigations have shown gingerol and shogoals to be mutagenic.³ In addition, ginger contains a special group of compounds called diarylheptanoids including gingerenone.⁴ The standardization

of the drug is based on presence of pungent principles of the plant.

Pharmacological activities

In folk medicine, the plant is used as carminative, expectorant and astringent. Recently, a number of studies have been conducted which show various pharmacological effects of the plant.

Hypolipidemic

Number of studies has been published about the cholesterol lowering effects of ginger.^{5,6} The effects of ethanolic extracts of ginger were studied in cholesterol fed rabbits. The marked rise in serum and tissue cholesterol, serum triglyceride, serum lipo-proteins and phospholipids that followed 10 weeks of cholesterol feeding, was significantly reduced by the ethanolic ginger extract and results were compared with Gemfibrozil, a standard orally effective hypolipidemic drug. The severity of



Ginger foliage

aortic atherosclerosis as judged by gross grading was more marked in pathogenic, i.e. the hypocholesterolemic group, while animals receiving ginger extract along with cholesterol showed a lower degree of atherosclerosis. The results indicate that ginger is definitely an anti-hyperlipidemic agent.⁷

Anti-emetic

Cisplatin causes nausea, vomiting and inhibition of gastric emptying. In a study, acetone and ethanolic extracts of ginger demonstrated anti-emetic effect against cisplatin-induced emesis in dogs. The acetone and 50% ethanolic extract of ginger in the doses of 100, 200 and 500 mg/kg (p.o.) and ginger juice in the doses of 2 and 4 ml/kg, were investigated against Cisplatin effect on gastric emptying in rats. All three ginger preparations significantly reversed cisplatin-induced delay in gastric emptying. The ginger juice and acetone extract were more effective than 50% ethanolic extract. The reversal produced by the ginger acetone extract was similar to that caused by the 5-HT₃-receptor antagonist ondasteron; however, ginger juice produce better reversal than Ondasteron. Therefore, ginger, an anti-emetic for cancer chemotherapy, may be useful in improving the gastrointestinal effects of cancer chemotherapy.⁸ Other studies also indicate role of ginger in the treatment of nausea and vomiting.⁹

Chemo-protective

Early *in vitro* studies have shown that the water or organic solvent extract of ginger possesses anti-oxidative and anti-inflammatory properties. In a study, researchers evaluated whether ethanol extract of ginger possesses anti-tumour promoting effects in a mouse skin tumorigenesis model. Because skin tumour promoters induced epidermal ornithine decarboxylase (ODC), cyclo oxygenase, and lipo oxygenase activities, and edema and hyperplasia are conventionally used markers of skin tumours promotion.¹⁰

Pre-application of ginger on to the skin of SENCAR mice resulted in significant inhibition of 12-O-tetradecanoylphorbol-13-acetate (TPA)-caused induction of epidermal ODC, cyclooxygenase and lipooxygenase activities and ODC m-RNA expression in a dose dependent manner. Pre-application of ginger extract to mouse skin also afforded significant inhibition of TPA-caused epidermal edema (56%) and hyperplasia (44%).

In long-term tumours studies, topical application of GE 30 min. prior to that of each TPA application to 7, 12-dimethyl benz (a) anthracene-initiated SENCAR mice resulted in a highly significant protection against skin tumour incidence and its subsequent multiplicity. The animals pre-treated with ginger showed substantially lower tumour body burdens

compared with non-ginger-treated controls. The results of this study provide clear evidence that ginger possesses anti-skin tumour-promoting effects, and that the mechanism of such effects may involve inhibition of tumour promoter-caused cellular, biochemical, and molecular changes in mouse skin.

Anti-viral

Rhinoviruses are among those viruses which cause the common cold therefore, the dried rhizomes of ginger have been investigated for anti-rhino-viral activity in plaque reduction test. Fractionation by solvent extraction, solvent partition and repeated chromatography guided by bioassay, allowed the isolation of several sesquiterpenes with anti-rhino-viral activity. The most effective of these was β -sesquiphellandrene.¹¹

Antimotion and anti-nauseant

The pharmacological actions related to antimotion sickness effects of ginger were studied. There were no significant effects on parameters of rotatory movement-induced electronystagmogram of rabbit changed to high amplitude slow wave pattern after intravenous injection of ginger juice. Rabbit gastric contraction *in situ* was shortly suppressed after gastric juice intravenous administration. In the isolated rat fundus strip preparations, however, ginger juice

reduced the spontaneous contractile frequency, and enhanced the spontaneous contractile amplitude, which was followed by inhibition.

Ginger juice produced longitudinal contraction of the guinea-pig isolated ileum, which was followed by rapid tachyphylaxis. This contraction effect was not effected by hexamethonium and 5-HT, but could be inhibited by cold storage, hyoscine, morphine, diphenhydramine, promethazine and substance P desensitization. Naloxone could eliminate disinhibition produced by morphine. By using dose-response relationship plot, non-competitive antagonisms were observed between ginger juice and Ach (Acetylcholine) and between ginger juice and histamine in isolated guinea-pig ileum.

It is suggested that the pungent constituents of ginger release substance P from sensory fibres. The released substance P in turn either stimulates cholinergic and histaminic neurons to release

Ach and histamine, respectively, or produces direct muscle contraction by activating M and HI receptors correspondingly. It is proposed that after being excited by substance P, M and HI receptors are inactive temporarily and unable to be excited by agonists, therefore, ginger juice exhibits anticholinergic and antihistaminic action. Ginger juice produces antimotion sickness action possibly by central and peripheral anticholinergic and antihistaminic effects.¹² Two more studies have confirmed the role of ginger in the treatment of motion sickness.^{13,14}

Anti-inflammatory

The inhibitors of prostaglandin biosynthesis are directly associated with anti-inflammatory and anti-platelet aggregation activities.¹⁵ The rhizomes of ginger contain potent inhibitors against prostaglandin biosynthesizing enzyme (PG synthetase). Gingerols and diarylheptanoids were identified as



Ginger rhizome

active compounds. Their possible mechanism of action that was deduced from the structures of active compounds indicated that the inhibitors would also be active against arachidonate 5-lipoxygenase, an enzyme of leukotriene (LT) biosynthesis. This was verified by testing their inability effects on 5-lipoxygenase prepared from RBL-1 cells. A diarylheptanoid with catechol group was the most active compound against 5-lipoxygenase, while yakuchinone A was the most active against PG synthetase. This also accounts for rational use of the drug in arthritis and rheumatism in Ayurveda.¹⁶

In another study eugenol present in ginger oil was shown to be the anti-inflammatory constituent of ginger. Oral administration of eugenol, a major component of clove oil, and ginger oil was administered orally to rats following induced severe arthritis in the paw and knee. The oil was given for 26 days, it caused a significant suppression of paw and joint swelling. The researchers concluded that eugenol and ginger oil have anti-inflammatory properties.¹⁷

Ginger and hyperemesis gravidarum

Thirty women participated in a double-blind randomized crossover trial of the efficacy of a natural product, the powdered root of ginger, and placebo in hyperemesis gravidarum. Three

patients had to be withdrawn. Each woman swallowed capsules containing either 250 mg ginger or lactose four times a day during the first 4 days of the treatment period. Interrupted by a 2 days washout period the alternative medication was given in the second 4-days period.

The severity and relief of symptoms before and after each period were evaluated by two scoring systems. The scores were used for statistical analyses of possible differences. Subjectively assessed, 19 women (70.4%) stated preference to the period in which ginger, as was later disclosed, had been given ($P=0.003$). More objectively assessed by relief scores a significantly greater relief of the symptoms was found after ginger treatment compared to placebo ($P = 0.035$).

No side effects were observed. The possible mutagenic and antimutagenic characters of ginger reported in a study of *Escherichia coli* have not been evaluated with respect to any significance in humans. Powdered root of ginger in daily doses of 1 g during 4 days was better than placebo in diminishing or eliminating the symptoms of hyperemesis gravidarum.¹⁸

Ginger and migraine

Migraine is considered as a neurological disorder with little convincing evidence of the involvement of some vascular

phenomenon. Recent understanding of the mechanisms behind migraine pain generation and perception have considerably helped the development of modern migraine drugs. Most migraine drugs in use have side effects and are prescribed with caution for a limited duration. Ginger is reported in Ayurvedic system of medicine to be useful in neurological disorders. It is proposed that administration of ginger may exert abortive and prophylactic effects in migraine headache without any side effects.¹⁹

Anti-ulcerogenic

The cytoprotective and gastric anti-ulcer studies of ginger have been carried out in albino rats. Cytodestruction was produced by 80% ethanol, 0.6M HCl, 0.2M NaOH and 25% NaCl. Whereas ulcerogenic agents including Indomethacin, Aspirin and Reserpine produced gastric ulcers, beside hypothermic restraint stress and by pylorus ligated Shay rat technique.

The results of this study demonstrate that the extract in the dose of 500 mg/kg orally exert highly significant cytoprotection against 80% ethanol, 0.6M HCl, 0.2M NaOH and 25% NaCl induced gastric lesions. The extract also prevented the occurrence of gastric ulcers induced by non-steroidal anti-inflammatory drugs and hypothermic restraint stress. These observations suggest cytoprotective and anti-ulcerogenic effect of the ginger.²⁰

By monitoring the effects on HCl/ethanol-induced gastric lesions in rats, a new anti-ulcer principle named 6-gingesulfonic acid was isolated from the dried rhizome of ginger together with three new monoacyldigalactosylglycerols named gingerglycolipids A, B and C. Their chemical structures were elucidated on the basis of chemical and physicochemical evidence. 6-Gingesulfonic acid showed more potent anti-ulcer activity than 6-gingerol and 6-shogaol.²¹

The effects of ginger, a pungent stomachic natural medicine, on HCl/ethanol-induced gastric lesions in rats, were examined. The orally administered acetone extract at 1000 mg/kg and zingiberene, the main terpenoid from acetone extract, at 100 mg/kg significantly inhibited gastric lesions by 97.5 and 53.6%, respectively. 6-Gingerol, the pungent principle, at 100 mg/kg significantly inhibited gastric lesions by 54.5%. These results suggest that zingiberene, the terpenoid and 6-gingerol are important constituents in stomachic medications containing ginger.²²

Conclusion

Medicinal herbs are rich source of synthetic and herbal drugs. They contain a wide range of chemical compounds, commonly referred to as phytochemicals. Ginger is a hot herb today and number of studies has shown it to be a useful medicinal agent. Its

potential as an effective anti-inflammatory and anti-emetic agent cannot be ruled out. Gingerol, the active constituent of ginger has been isolated and studied for pharmacological and toxic effects. Large-scale clinical studies are required to justify ginger as suitable phytopharmaceutical drug although initial data seems to be promising.

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Ginger in Ayurveda

Ginger is amongst important herbs described in Ayurveda. It is named as 'Mahaushadhi', which means, use of this great herb improves growth of body. General properties of this useful herb are: sweet, pungent, warm, *kapha*, *vata* alleviating. Ginger is good appetizer, relishing, aphrodisiac, light, beneficial for heart and can be used for various health problems. Fresh ginger is not recommended in skin diseases, anaemia, painful and burning urination, bleeding diseases, ulcers, fever, burning sensation, during summer and autumn.

Some simple and useful formulations of Ginger

1. Chewing of fresh ginger with a small quantity of salt and lemon juice before meals is a good appetizer; it enhances taste perception and purifies the tongue and throat.
2. Dry ginger powder 2-5g taken with warm water is beneficial for rheumatic patients.
3. In cough it should be given with honey in the form of paste.
4. Warm decoction of dry ginger powder is useful for heart patients.
5. Warm juice of fresh ginger should be dropped in the ear for earache.
6. In piles, dry ginger powder should be administered with *Plumbago zeylanica* Linn. (roots of *chitraka*).
7. In abdominal diseases ginger juice can be taken with equal quantity of milk.
8. Dry ginger is faecal astringent, i.e., it dries up the watery portion of faeces and causes constipation while surprisingly fresh ginger is purgative, i.e., it removes constipation. [Contributed by Vaidya (Mrs) Ritu Sethi, TKDL, NISCAIR].