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Physiological and pharmaceutical effects of Ginger (*Zingiber officinale Roscoe*) as a valuable medicinal plant

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ABSTRACT

Ginger has been used by traditional Chinese and Indian medicine for over 25 centuries. Fresh ginger contains 80.9% moisture, 2.3% protein, 0.9% fat, 1.2% minerals, 2.4% fibre and 12.3% carbohydrates. The active components of ginger is reported to stimulate digestion, absorption, relieve constipation and flatulence by increasing muscular activity in the digestive. In traditional Chinese medicine, ginger is used to improve the flow of body fluids. It stimulates blood circulation throughout the body by powerful stimulatory effect on the heart muscle and by diluting blood. The effect of an aqueous extract of ginger on platelet thromboxane-B2 and prostaglandin-E2 (PGE2) production was examined after giving rats a raw aqueous extract of ginger daily for a period of 4 weeks, either orally or intraperitoneally.

Key words: Ginger, Medicinal Plant, Pharmacological effects

INTRODUCTION

Ginger has been used by traditional Chinese and Indian medicine for over 25 centuries [5]. Ginger was brought to Mexico by the Spaniards and later introduced to Jamaica, the latter currently being one of the world's foremost producers of this species [2]. Ginger is used in Mexican traditional medicine, mainly for gastrointestinal complaints. In recent times, ginger has been introduced into various tropical countries where diverse chemotypes have been developed [21]. Ginger is primarily used to treat nausea, but it is also used as an anti-inflammatory, a pain remedy, a warming remedy and a cholesterol-lowering herb. Randomized controlled trials support its use in preventing nausea. Case studies suggest usefulness in treating migraines and inflammatory arthritis, but no randomized trials have been reported. Animal studies suggest thermogenic effects, but this has not been evaluated in humans. Data are insufficient to recommend ginger as a cholesterol-lowering supplement. Given its long history of use as a food, ginger is presumed safe for supplemental use. Because of its effects on platelet aggregation and thromboxane synthesis *in vitro*, some herbalists suggest caution for patients taking anticoagulants or those scheduled for surgery; on the other hand, no clinically significant anticoagulant effects have been documented. It is on the Generally Recognized as Safe (GRAS) list, but no studies have specifically evaluated ginger's safety during pregnancy, lactation or during childhood. A related species has uterotonic effects in animals, which has led some herbalists and the German Commission E to recommend that ginger be avoided during pregnancy.

BOTANY

Medicinal species: *Zingiber officinale*.

Common names: Ginger, African ginger, Black ginger, Cochin ginger, Gan jiang, Gegibre, Ingwer, Jamaican ginger, Race ginger [4].

Botanical Family: Zingiberaceae. Ginger is closely related to two other cooking spices, turmeric and cardamom.

Plant description: Ginger is a 2 - 4 foot tall perennial with grass like leaves up to a foot in length. It is the underground root or rhizome that is used for culinary and medicinal purposes.

Where it's grown: Indigenous to warm tropical climates, ginger is widely grown in Asia, Africa, India, Jamaica, Mexico, and Hawaii [7].



Ginger foliage

Nutrient Composition

Fresh ginger contains 80.9% moisture, 2.3% protein, 0.9% fat, 1.2% minerals, 2.4% fibre and 12.3% carbohydrates. The minerals present in ginger are iron, calcium and phosphorous. It also contains vitamins such as thiamine, riboflavin, niacin and vitamin C. The composition varies with the type, variety, agronomic conditions, curing methods, drying and storage conditions [9].

Chemistry

In the fresh ginger rhizome, the gingerols were identified as the major active components and gingerol [5-hydroxy-1-(4-hydroxy-3-methoxy phenyl) decan-3-one] is the most abundant constituent in the gingerol series. The powdered rhizome contains 3-6% fatty oil, 9% protein, 60-70% carbohydrates, 3-8% crude fiber, about 8% ash, 9-12% water and 2-3% volatile oil. The volatile oil consists of mainly mono and sesquiterpenes; camphene, beta-phellandrene, curcumene, cineole, geranyl acetate, terphineol, terpenes, borneol, geraniol, limonene, linalool, alpha-zingiberene (30-70%), beta-sesquiphellandrene (15-20%), beta-bisabolene (10- 15%) and alpha-farnesene. In dried ginger powder, shogaol a dehydrated product of gingerol, is a predominant pungent constituent upto biosynthesis 3-5. Oleoresin, which is isolated by acetone and ethanol extraction, contains 4-7.5% of dried powder, pungent substances namely gingerol, shogaol, zingerone and paradol. The oleoresin has also been found to contain zingiberol, the principal aroma contributing component as well as zingiberene, gingediol, diarylheptanoids, vitamins and phytosterols.

Applications in Herbal Therapy

- Against nausea and vomiting (antiemetic) during motion sickness and seasickness (Langner et al., 1998). Apparently, this effect is not mediated through the central nervous system (CNS), but rather, ginger's active principles act directly on the gastrointestinal tract [21, 24].
- To reduce vomiting in patients treated with cytotoxic compounds [25].
- To promote digestion and as an antifatulent or carminative to reduce gas and bloating [16].
- To improve blood circulation [5, 9].
- To lower blood glucose in the treatment of diabetes [12, 1].
- To treat migraine headache [2].
- As a sialagogue, to promote salivation [26, 8].

Pharmacological Effects

Effects on the gastrointestinal tract

The active components of ginger is reported to stimulate digestion, absorption, relieve constipation and flatulence by increasing muscular activity in the digestive tract. The effectiveness of ginger (940 mg) in motion sickness was compared to that of dimenhydrinate (100 mg) in 18 male and 18 female college students, who were self rated as having extreme or very high susceptibility to motion sickness [23]. The study concluded that ginger was superior to dimenhydrinate in preventing motion sickness. Ginger administration (1g) prior to elective gynaecologic laparoscopy was also found to be effective in preventing postoperative nausea and vomiting. The effect of ginger was similar to that observed with 100 mg metoclopramide. In addition, a double blind study in 27 pregnant women suffering from morning sickness demonstrated that oral administration of 250 mg of powdered ginger 4 times daily over 4 days significantly reduced symptoms of nausea and vomiting [26].

Antimicrobial effects

Ginger has strong antibacterial and to some extent antifungal properties. In vitro studies have shown that active constituents of ginger inhibit multiplication of colon bacteria. These bacteria ferment undigested carbohydrates causing flatulence. This can be counteracted with ginger. It inhibits the growth of *Escherichia coli*, *Proteus sp*, *Staphylococci*, *Streptococci* and *Salmonella* 21, 22. The ginger extract has antimicrobial action at levels equivalent to 2000 mg/ ml of the spice. Ginger inhibits *aspergillus*, a fungus known for production of aflatoxin, a carcinogen 23,24. Fresh ginger juice showed inhibitory action against *A.niger*, *S.cerevisiae*, *Mycoderma SPP*. And *L. acidophilus* at 4, 10, 12 and 14% respectively at ambient temperatures [18].

Effects on cardiovascular system

In traditional Chinese medicine, ginger is used to improve the flow of body fluids. It stimulates blood circulation throughout the body by powerful stimulatory effect on the heart muscle and by diluting blood [17]. The improved circulation is believed to increase the cellular metabolic activity, thus contributing to the relief of cramps and tension. A Japanese study showed that active constituents in ginger reduced the blood pressure and decreased cardiac workload. Ginger reduced the formation of proinflammatory prostaglandins and thromboxane thus lowering the clotting ability of the blood [15]. The inhibition of platelet aggregation by ginger is more than the similar effects observed with garlic and onion [11]. Ginger can prevent the increase in cholesterol levels following intake of cholesterol-rich diet. Ginger is also known to possess antioxidant properties.

Effect on blood pressure

Several pieces of evidence, mainly from rat studies, have suggested that ginger exerts many direct and indirect effects on blood pressure and heart rate [10]. More recently, Ghayur and Gilani [7] reported that the crude extract of ginger induced a dose-dependent (0.3–3 mg/kg) fall in the arterial blood pressure of anesthetized rats. In Guinea pig paired atria, the crude extract exhibited a cardiodepressant activity on the rate and force of spontaneous contractions. In rabbit thoracic aorta preparation, the crude extract relaxed the phenylephrine-induced vascular contraction at a dose 10 times higher than that required against K-induced contraction. Ca²⁺ channel- blocking activity was confirmed when the crude extract shifted the Ca²⁺ dose–response curves to the right, similar to the effect of verapamil. It also inhibited the phenylephrine control peaks in normal Ca²⁺-plus and Ca²⁺-free solutions, indicating that it acts at both the membrane-bound and the intracellular Ca²⁺ channels. When tested in endothelium-contraction at a dose 14 times less than that required for relaxing the PE-induced contraction. The vasodilator effect of the crude extract was endothelium-independent because it was not blocked by either L-NAME (a non-selective inhibitor of nitric oxide synthase used experimentally to induce hypertension) or atropine and also was reproduced in the endothelium-denuded preparations in the same dose range. These data indicate that the blood pressure-lowering effect of ginger is mediated through blockade of voltage-dependent calcium channels. In another paper, the same group [6] concluded that the blood pressure lowering action of aqueous ginger extract was through a dual inhibitory effect mediated via stimulation of both muscarinic receptors and blockade of Ca²⁺ channels. Interestingly, they also noted that the different constituents of ginger might have opposing actions on the reactivity of blood vessels.

Effect on blood clotting

The effect of an aqueous extract of ginger on platelet thromboxane-B₂ (TBX₂) and prostaglandin-E₂ (PGE₂) production was examined after giving rats a raw aqueous extract of ginger daily for a period of 4 weeks, either orally or intraperitoneally (IP). A low dose of ginger (50 mg/kg) administered either orally or IP did not produce any significant reduction in the serum TBX₂ levels. However, ginger administered orally caused significant changes in

the serum PGE2 at this dose. High doses of ginger (500 mg/kg) were significantly effective in lowering serum PGE2 when given either orally or IP. However, TXB2 levels were significantly lower in rats given 500 mg/kg ginger orally, but not IP. These results suggest that ginger could be used as an anti-thrombotic and anti-inflammatory agent [3].

CONCLUSION

The present review sought to document and comment on the publications that have appeared on ginger and its constituents in the last 10 years or so. The papers reviewed provide another example of how it may be possible to explain the action(s) of folk medicines in terms of conventional biochemistry and pharmacology. Ginger and many of its chemical constituents have strong anti-oxidant actions. As several metabolic diseases and age-related degenerative disorders are closely associated with oxidative processes in the body, the use of either ginger or one or more of its constituents as a source of anti-oxidants to combat oxidation warrants further attention. Ginger and many of its chemical constituents have been shown, in numerous clinical studies, to be useful in combating postoperative vomiting and vomiting of pregnancy. It may be worthwhile investigating the effect of ginger on vomiting during cancer chemotherapy, as the crude drug and its constituents have themselves anti-cancer actions. More studies are also required on the kinetics of ginger and its constituents and on the effects of their consumption over a long period of time. Ginger is considered to be a safe herbal medicine with only few and insignificant adverse/side effects.

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