The Longwood Herbal Task Force

(http://www.mcp.edu/herbal/default.htm) and

The Center for Holistic Pediatric Education and Research

(http://www.childrenshospital.org/holistic/)

Ginger (*Zingiber officinale*)

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Principal Proposed Use: Nausea due to motion sickness, morning sickness, general anesthesia or chemotherapy

Other Proposed Uses: Headaches and arthritis, chills associated with viral infections, high cholesterol

Overview

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.

Historical and Popular Uses

Ginger is used worldwide as a cooking spice, condiment and herbal remedy. The Chinese have used ginger for at least 2500 years as a digestive aid and antinausea remedy and to treat bleeding disorders and rheumatism; it was also used to treat baldness, toothache, snakebite, and respiratory conditions[1]. In Traditional Chinese Medicine (TCM), ginger is considered a pungent, dry, warming, yang herb to be used for ailments triggered by cold, damp weather. Ginger is used extensively in Ayurveda, the traditional medicine of India, to block excessive clotting (i.e. heart disease), reduce cholesterol and fight arthritis. In Malaysia and Indonesia, ginger soup is given to new mothers for 30 days after their delivery to help warm them and to help them sweat out impurities. In Arabian medicine, ginger is considered an aphrodisiac[2]. Some Africans believe that eating ginger regularly will help repel mosquitos[1].

Ginger migrated westward to Europe by Greek and Roman times. The Greeks wrapped ginger in bread and ate it after meals as a digestive aid. Subsequently, ginger was incorporated directly into bread and confections such as gingerbread. Ginger was so valued by the Spanish that they established ginger plantations in Jamaica in the 1600's. The Eclectic physicians of the 19th century relied on ginger to induce sweating, improve the appetite and curb nausea, and as a topical counterirritant.

Nowadays, ginger is extensively cultivated from Asia to Africa and the Caribbean and is used worldwide as a nausea remedy, as an anti-spasmodic and to promote warming in case of chills[3,4]. Ginger is also extensively consumed as a flavoring agent; it is estimated that in India, the average daily consumption is 8 -10 grams of fresh ginger root[5]. The German Commission E approves the use of ginger root as a treatment for dyspepsia and prophylactic against motion sickness[6].

Botany

Medicinal species: Zingiber officinale Roscoe

Common names: Ginger, African ginger, Black ginger, Cochin ginger, Gan jiang, Gegibre, Ingwer, Jamaican ginger, Race ginger[7,8]

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[9].

Biochemistry

Ginger: Potentially Active Chemical Constituents

- Phenolic compounds: shogaols and gingerols
- Sesquiterpenes: bisapolene, zingiberene, zingiberol, sesquiphellandrene, curcurmene
- Other: 6-dehydrogingerdione, galanolactone, gingesulfonic acid, zingerone, geraniol, neral, monoacyldigalactosylglycerols, gingerglycolipids

The active ingredients in ginger are thought to reside in its volatile oils, which comprise approximately 1-3% of its weight[10]. The major active ingredients in ginger oil are the sesquiterpenes: bisapolene, zingiberene, and zingiberol[11,12]. The concentrations of active ingredients vary with growing conditions. Ginger's active ingredients have a variety of physiologic effects. For example, the gingerols have analgesic, sedative, antipyretic and antibacterial effects in vitro and in animals[13,14].

In rats, an intravenous (i.v.) bolus of gingerol had a half life of 7.23 minutes[15]; it is not clear how this relates to pharmacokinetics after oral administration in humans.

Experimental Studies

Ginger: Potential Clinical Benefits

1. Cardiovascular: Cardiotonic, antilipemic
2. Pulmonary: none
3. Renal and electrolyte balance: none
4 Gastrointestinal/hepatic: Antinausea/antiemetic, carminative and antiulcer
5. Neuropsychiatric: See Immune modulation: anti-inflammatory for headache
6. Endocrine: Hypoglycemic
7. Hematologic: Antiplatelet
8. Rheumatologic: See Immune modulation: Anti-inflammatory for arthritis
9. Reproductive: none
10. Immune modulation: Anti-inflammatory for arthritis and headache
11. Antimicrobial: Antiviral, antibacterial, antifungal
12. Antineoplastic: Antineoplastic
13. Antioxidant: Antioxidant
14. Skin and mucus membranes: none
15. Other/miscellaneous: Warming/diaphoretic

1. **Cardiovascular:** Cardiotonic, antilipemic. See also Hematologic: antiplatelet
   a. Cardiotonic
      i. *In vitro data:* In isolated guinea pig atrial muscles, gingerol enhanced contractility[16].
      ii. *Animal data:* In animals, gingerol had inotropic and chronotropic effects[16,17].
      iii. *Human data:* There are no reports of ginger's effects on cardiac function in humans.
   b. Antilipemic
      i. *In vitro data:* In homogenated liver from mice and rats, ginger extracts interfered with cholesterol biosynthesis[18].
      ii. *Animal data:* In rabbits fed high cholesterol diets, ginger extracts had antilipemic effects, reducing atherogenesis and high lipid levels[19]. However, in hypercholesterolemic rats, the data on ginger's effects has been conflicting; some studies reported positive effects and others found no effects[20,21]. In experimental

mice, ginger significantly impaired cholesterol biosynthesis and lowered serum cholesterol concentrations[18].

iii. *Human data:* A single dose (10 grams) of ginger had no impact on serum lipids in one study[22]. There are no studies evaluating the effects of long-term ginger supplementation on serum lipids in humans or evaluating potential interactions with lipid lowering medications.

2. **Pulmonary:** none
3. **Renal and electrolyte balance:** none
4. **Gastrointestinal/hepatic:** Antinausea/antiemetic, carminative and antiulcer

a. Antinausea/antiemetic

i. *In vitro data:* none

ii. *Animal data:* In mice, ginger's effect in enhancing intestinal motility was similar to metoclopramide's[23]. In shrews, dogs and rats, ginger extracts effectively reduced chemotherapy-associated vomiting[24,25]. Ginger also protected frogs against experimentally induced emesis[26]. An herbal combination including ginger and ginkgo was as effective as metoclopramide in another animal study of experimentally-induced nausea[27]. Studies in rats and mice suggest that ginger produces its antiemetic effects by stimulating peripheral anticholinergic and antihistaminic receptors and/or by antagonizing 5-hydroxytryptamine (serotonin) receptors in the gut[28,29].

iii. *Human data:* Both during fasting and after a standard test meal, ginger extracts significantly enhanced gastroduodenal motility in 12 normal volunteers[30].

Several randomized, controlled trials support ginger's use as an antiemetic for nausea secondary to several conditions: morning sickness, chemotherapy-associated nausea, post-operative nausea and motion sickness.

In a randomized, double-blind, placebo-controlled cross-over trial of 30 women with hyperemesis gravidarum, ginger (250 mg four times daily) proved significantly more effective than placebo in preventing and reducing nausea[31].

Ginger also proved useful in treating chemotherapy-induced nausea in a small pilot study of 11 adult patients; their nausea scores fell from an average of 2 (out of

maximum of 4) to 0.7 after taking 1.5 grams of powdered ginger[32]. Another case series also supported ginger's use as an antiemetic in patients undergoing chemotherapy[33].

Data on ginger's effectiveness in preventing post-operative nausea have been conflicting. In two randomized, double blind studies of women undergoing gynecologic surgery, those treated with ginger had significantly less post-operative nausea and vomiting than those treated with placebo; ginger was as effective as metoclopramide in preventing post-operative gastrointestinal symptoms[34,35]. Two other randomized, controlled trials failed to document any statistically significant benefits of pre-operative ginger (500 –2000 mg) on post-operative nausea or vomiting[36,37].

Several studies have evaluated ginger's effectiveness in preventing motion sickness or sea sickness and the potential mechanisms for this effect[38]. In an open study of 1741 tourists traveling by sea, ginger supplements (250 milligrams every two hours) were as effective as both non-prescription and prescription medications in preventing sea sickness[39]. In a randomized cross-over trial of eight healthy volunteers, ginger supplements were significantly more effective than placebo in alleviating vertigo associated with motion sickness[40]. In a randomized controlled trial of naval cadets, ginger was significantly more effective than placebo in preventing sea sickness, both vomiting and vertigo[41]. In an early trial involving 36 college students prone to motion sickness, ginger was as effective as dimenhydrinate in preventing nausea[42]. In a randomized, controlled trial in healthy volunteers, ginger was an effective antiemetic, but its mechanism of action appeared not to rely on alterations in gastric emptying[35].

In a study evaluating potential mechanisms for ginger's ability to reduce motion sickness, ginger had no impact on experimentally induced nystagmus associated with motion sickness; the investigators concluded that ginger's primary effect was on the stomach rather than the central nervous system[43]. In one NASA-sponsored study in healthy volunteers, ginger (500 – 1000 mg) had no apparent effect

on gastric emptying[44]. However, other studies have reported enhanced intestinal motility following oral administration of ginger[23].

b. Carminative and antiulcer: Ginger has been used historically as a carminative, to enhance digestion and reduce intestinal gas and flatulence.

i. *In vitro data:* none

ii. *Animal data:* In mice, zingiberene and gingerol significantly reduced gastric ulceration experimentally induced by ethanol and hydrochloric acid[45]. These results were confirmed in several subsequent studies in which several of ginger's constitutents, including beta-sesquiphellandrene, beta-bisabolene, gingesulfonic acid, curcumene and 6-shogaol, demonstrated antiulcer effects, protecting gastric mucosa against alcohol, non-steroidal anti-inflammatory drugs and hydrochloric acid[46-47].

Rats given ginger extracts (gingerols) had enhanced bile secretion[48].

iii. *Human data:* A Chinese case series reported that an herbal mixture containing ginger was effective in halting upper gastrointestinal hemorrhage[49].

There are no randomized controlled trials in humans evaluating ginger's effect as a carminative or ulcer remedy.

5. **Neuropsychiatric:** See Immune modulation: anti-inflammatory for migraine headaches.

6. **Endocrine:** Hypoglycemic

i. *In vitro data:* none

ii. *Animal data:* An Indian homeopathic journal reported in the late 1970's that freshly squeezed ginger juice had hypoglycemic effects in both diabetic and non-diabetic rats[50].

iii. *Human data:* There are no reports of hypoglycemia or interference with glycemic control in humans who ingest ginger as part of their normal diet or as a dietary supplement.

7) **Hematologic:** Antiplatelet: Some cautious physicians have advised that ginger may alter bleeding time and should not be used concurrently with anticoagulant medications[51].

i. *In vitro data:* Ginger extracts inhibited platelet cyclooxygenase production, thromboxane generation and platelet aggregation in a dose-dependent fashion[52,53,54]; gingerol also inhibited thromboxane-mediated platelet aggregation[55].

ii. *Animal data:* none

iii. *Human data:* In 20 healthy young male volunteers, ginger supplementation (5 gms daily) significantly inhibited the platelet aggregation induced by ADP (adenosine diphosphate) and epinephrine[56]. In human volunteers who took a huge (10 gram) one-time dose of dried ginger, there was a marked inhibition of platelet aggregability[22]. Another study showed no significant impact of fresh or cooked ginger (doses up to 15 grams of fresh ginger or 40 grams of cooked ginger) on thrombotic activity or platelet thromboxane production[57].

There are no reports of bleeding problems in persons consuming up to 5 grams daily of dried ginger[58], however, ginger's effects on platelet activation may have therapeutic implications that bear further investigation for persons with atherosclerotic disease. There may be differences in ginger's effects depending on whether fresh or dried preparations are used.

8. **Rheumatologic:** none
9. **Reproductive:** none
10. **Immune modulation:** Anti-inflammatory for arthritis and headache: In Ayurvedic medicine, ginger is used as an anti-inflammatory remedy for arthritis and headache pain[59].
    i. *In vitro data:* Ginger extracts block the formation of inflammatory compounds such as thromboxane, leukotrienes and prostaglandins[60-61].
    ii. *Animal data:* In the rat model of chronic severe inflammatory arthritis, ginger oil effectively reduced swelling and inflammation[62]. Ginger compounds also had antipyretic effects comparable to aspirin in rats[13,63].
    iii. *Human data:* A 42-year-old woman with a 16-year history of migraines experienced enormous relief after supplementing her diet with 1.5 –2 grams of dried ginger daily[59].

Adult volunteers who ate 5 grams of raw ginger daily had a 25% reduction in thromboxane concentrations[64]. A case series of seven patients with rheumatoid arthritis reported improved symptoms following supplemental ginger[65]. In another case series of 56 patients (28 with rheumatoid arthritis, 18 with osteoarthritis and 10 with muscular discomfort) who were given powdered ginger supplements, more than three-quarters of the arthritis patients reported varying degrees of relief in pain and swelling; all the patients with muscular discomfort experienced relief. None of the patients reported

adverse effects during the period of ginger consumption which ranged from three months to 2.5 years[66].

There are no randomized controlled trials evaluating the effectiveness of ginger against migraines or arthritis.

11. **Antimicrobial:** Antiviral, antibacterial, antifungal: In many tropical countries, spicy condiments, including ginger, are used to preserve foods that spoil easily such as fruits and meats[67,68].
    a. Antiviral
        i. *In vitro data:* Several of ginger's sesquiterpenes displayed antirhinoviral effects[69].
        ii. *Animals data:* none
        iii. *Human data:* none
    b. Antibacterial
        i. *In vitro data:* Ginger extracts have antibacterial effects against both gram positive and gram negative bacteria such as *Clostridium, Listeria, Enterococcus, and Staphylococcus* species, but some of this effect is destroyed by heating (eg., cooking)[13,67,70].
        ii. *Animal data:* none
        iii. *Human data:* none
    c. Antifungal
        i. *In vitro data:* Some of ginger's chemical constituents, diarylheptenones, gingerenones A, B and C and isogingerenone B, have displayed antifungal activity in vitro[71].
        ii. *Animal data:* none
        iii. *Human data:* none
12. **Antineoplastic:** Antineoplastic
    i. *In vitro data:* Ginger inhibited Epstein-Barr virus activation[72,73]. Ginger compounds (6-gingerol and 6-paradol) had inhibitory effects on the viability and DNA synthesis of human promyelocytic leukemia cells[74,75]. Ginger's essential oil significantly suppressed formation of DNA adducts by aflatoxin B1 in a microsomal enzyme-mediated reaction[76].

ii. *Animal data:* Pre-treatment with an alcoholic extract of ginger provided significant protection against experimentally-induced skin tumors in mice[77-78]. Other ginger family plants, *Alpinia oxyphylla, Zingiber zerumbet* and *Curcuma longa*, also displayed potent anti-tumor effects in mice[79,80].

iii. *Human data:* none

13. **Antioxidant:** Antioxidant

i. *In vitro data:* In human aortic endothelial cells, zingerone demonstrated significant antioxidant effects on low density lipoproteins[81,82]. In human erythrocyte membranes, ginger extracts inhibited lipid peroxidation by 72%[83]. In human chondrocytes, ginger's volatile oil effectively prevented the production of hydrogen peroxide usually induced by fulvic acid[84].

ii. *Animal data:* In rats fed a high fat diet, supplementation with ginger provided significant antioxidant effects, raising tissue concentrations of superoxide dismutase and catalase and reducing gluatathione[85].

iii. *Human data:* none

14. **Skin and mucus membranes:** none

15. **Other/miscellaneous:** Warming/diaphoretic: Ginger has traditionally been used in Asia as a warming remedy to treat chills associated with colds and flu.

i. *In vitro data:* Ginger and its extracts induce significant thermogenesis in the isolated rat hind limb model[86].

ii. *Animal data:* In rats, ginger significantly inhibited serotonin (5-HT) induced hypothermia; shogaol compounds appeared to be responsible for this effect[87]. Within 30 minutes of oral administration, ginger raised the body temperature of rats by 0.5 degrees Centigrade[88]. Gingerol increased body temperature and oxygen consumption in rats, indicating an increased metabolic rate[86].

iii. *Human data:* none

Toxicity and Contraindications

All herbal products carry the potential for contamination with other herbal products, pesticides, herbicides, heavy metals, and pharmaceuticals.

This is particularly concerning for imports from developing countries.

Allergic reactions can occur to any natural product in sensitive persons

Allergic reactions to ginger have been reported, but only as contact dermatitis in those with occupational exposure to spices[89].

Potentially toxic compounds in ginger: None

Acute toxicity: Aside from mild stomach upset in persons unaccustomed to spicy foods, ginger has no known acute toxicity at the usual doses consumed for dietary or medicinal purposes[90]. Very large doses of 6 grams or more of ginger may lead to gastric irritation and loss of protective gastric mucosa[90]. At normal doses (up to 2 grams daily), ginger does not interfere with blood clotting or any individual coagulation parameter[58,22,57]. The acute LD50 of ginger in rats is greater than 5 grams of ginger oil per kilogram of body weight[13].

Chronic toxicity: None reported; no significant mutagenic or carcinogenic activity[91-92]

Limitations during other illnesses or in patients with specific organ dysfunction: Unknown; none reported. Some herbalists advise against ginger for patients with cardiac conditions, gallstones or other biliary disease or patient with diabetes or hypoglycemia[10,93,94]; however, there are no reports of adverse effects of ginger in patients eating it as part of their diet or as a dietary supplement.

Interactions with other herbs or pharmaceuticals: Unknown; none reported. Some herbalists recommend avoiding use by patients taking anticoagulant medications; no adverse interactions have been reported.

Safety during pregnancy, lactation and/or childhood: Unknown. Presumed safe based on its long history of use as food. Because of the reported uterotonic activity of a related species, *Zingiber cassumunar*, some herbalists recommend avoiding ginger during pregnancy[10,93,95]. No adverse effects in pregnancy have been reported.

Typical dosages

Provision of dosage information does NOT constitute a recommendation or endorsement, but rather indicates the range of doses commonly used in herbal practice.

Doses are given for single herb use and must be adjusted when using herbs in combinations.

Doses may also vary according to the type and severity of the condition treated and individual patient conditions.

Adult doses: There is disagreement on the optimal form and dose of ginger. Reputable physicians and herbalists recommend a range of doses:

Dried ginger: 250 milligrams four times daily by mouth [10]. Some German herbalists recommend up to four times this amount [6]. Chinese herbalists may use up to 10 times this amount.

Tea: 1 tsp of fresh ginger root boiled in 1 –2 cups of water for 10 –20 minutes. Cool for 5 minutes and sweeten as desired. May be mixed with peppermint or chamomile.

Ginger tincture: 1.5 – 3.0 mL per dose [10]

Candied ginger: A 1 inch square piece is presumably equivalent to 500 – 1000 of dried ginger [96,8]

Pediatric dosages: Unknown

Availability of standardized preparations: No

Dosages used in herbal combinations: Variable

Proprietary names: Travel Sickness, Travellers, Zintona

Multi-ingredient preparations containing ginger: Adenas, Adrenas, Cura, Digestive Aide, Donalg, Ginger syrup, Ginkgo plus herbal formula, Herbal Booster, Herbal Cleansee, Herbal digestive aide, Strong ginger tincture, Unex amarum, Vitaglow Herbal Laxative, Weak Ginger Tincture

See Also:

Ginger Clinician Information Summary: http://www.mcp.edu/herbal/ginger/ginger.cis.pdf

Ginger Patient Fact Sheet: http://www.mcp.edu/herbal/ginger/ginger.ph.pdf

REFERENCES

1. Duke JA, Ayensu ES. Medicinal Plants of China. Medicinal Plants of the World. Vol. 1. Algonac, MI: Reference Publications, Inc, 1985:362.
2. Qureshi S, Shah AH, Tariq M, Ageel AM. Studies on herbal aphrodisiacs used in Arab system of medicine. Am J Chin Med 1989; 17:57-63.
3. Kapil U, Sood AK, Gaur DR. Maternal beliefs regarding diet during common childhood illnesses. Indian Pediatr 1990; 27:595-9.
4. Johri RK, Zutshi U. An Ayurvedic formulation 'Trikatu' and its constituents. J Ethnopharmacol 1992; 37:85-91.
5. Murray MT. The healing power of herbs : the enlightened person's guide to the wonders of medicinal plants. Rocklin, CA: Prima Pub., 1995:xiv, 410.
6. Blumenthal M. The complete German Commission E monographs : therapeutic guide to herbal medicines. Austin: American Botanical Council, 1998.
7. Tyler VE. The honest herbal : a sensible guide to the use of herbs and related remedies. New York: Pharmaceutical Products Press, 1992:xviii, 375.
8. Peirce A. The American Pharmaceutical Association practical guide to natural medicines. New York: William Morrow and Company, Inc., 1999.
9. Evans WC. Trease and Evans' pharmacognosy. London ; Philadelphia: Baillière Tindall, 1989.
10. Newall CA, Anderson LA, Phillipson JD. Herbal medicines : a guide for health-care professionals. London: Pharmaceutical Press, 1996:ix, 296.
11. Connell D, Sutherland M. A re-examination of gingerol, shogaol and zingerone, the pungent principles of Ginger (Zingiber officinale Roscoe). Aust J Chem 1969; 22:1033-43.
12. Yoshikawa M, Hatakeyama S, Chatani N, Nishino Y, Yamahara J. Qualitative and quantitative analysis of bioactive principles in Zingiberis Rhizoma by means of high performance liquid chromatography and gas liquid chromatography. On the evaluation of Zingiberis Rhizoma and chemical change of constituents during Zingiberis Rhizoma processing. Yakugaku Zasshi 1993; 113:307-15.
13. Mascolo N, Jain R, Jain SC, Capasso F. Ethnopharmacologic investigation of ginger (Zingiber officinale). J Ethnopharmacol 1989; 27:129-40.
14. Connell D. The chemistry of the essential oil and oleoresin of ginger (Zingiber officinale Roscoe). Flavour Industry 1970; 1:677-93.
15. Ding GH, Naora K, Hayashibara M, Katagiri Y, Kano Y, Iwamoto K. Pharmacokinetics of [6]-gingerol after intravenous administration in rats. Chem Pharm Bull (Tokyo) 1991; 39:1612-4.
16. Kobayashi M, Ishida Y, Shoji N, Ohizumi Y. Cardiotonic action of [8]-gingerol, an activator of the Ca++-pumping adenosine triphosphatase of sarcoplasmic reticulum, in guinea pig atrial muscle. J Pharmacol Exp Ther 1988; 246:667-73.

17. Shoji N, Iwasa A, Takemoto T, Ishida Y, Ohizumi Y. Cardiotonic principles of ginger (Zingiber officinale Roscoe). J Pharm Sci 1982; 71:1174-5.
18. Tanabe M, Chen YD, Saito K, Kano Y. Cholesterol biosynthesis inhibitory component from Zingiber officinale Roscoe. Chem Pharm Bull (Tokyo) 1993; 41:710-3.
19. Bhandari U, Sharma JN, Zafar R. The protective action of ethanolic ginger (Zingiber officinale) extract in cholesterol fed rabbits. J Ethnopharmacol 1998; 61:167-71.
20. Sambaiah K, Srinivasan K. Effect of cumin, cinnamon, ginger, mustard and tamarind in induced hypercholesterolemic rats. Nahrung 1991; 35:47-51.
21. Srinivasan K, Sambaiah K. The effect of spices on cholesterol 7 alpha hydroxylase activity and on serum and hepatic cholesterol levels in the rat. Internat J Vit Nutr Res 1991; 61:364-69.
22. Bordia A, Verma SK, Srivastava KC. Effect of ginger (Zingiber officinale Rosc.) and fenugreek (Trigonella foenumgraecum L.) on blood lipids, blood sugar and platelet aggregation in patients with coronary artery disease. Prostaglandins Leukot Essent Fatty Acids 1997; 56:379-84.
23. Yamahara J, Huang QR, Li YH, Xu L, Fujimura H. Gastrointestinal motility enhancing effect of ginger and its active constituents. Chem Pharm Bull (Tokyo) 1990; 38:430-1.
24. Yamahara J, Rong HQ, Naitoh Y, Kitani T, Fujimura H. Inhibition of cytotoxic drug-induced vomiting in suncus by a ginger constituent. J Ethnopharmacol 1989; 27:353-5.
25. Sharma SS, Kochupillai V, Gupta SK, Seth SD, Gupta YK. Antiemetic efficacy of ginger (Zingiber officinale) against cisplatin- induced emesis in dogs. J Ethnopharmacol 1997; 57:93-6.
26. Kawai T, Kinoshita K, Koyama K, Takahashi K. Anti-emetic principles of Magnolia obovata bark and Zingiber officinale rhizome. Planta Med 1994; 60:17-20.
27. Frisch C, Hasenohrl RU, Mattern CM, Hacker R, Huston JP. Blockade of lithium chloride-induced conditioned place aversion as a test for antiemetic agents: comparison of metoclopramide with combined extracts of Zingiber officinale and Ginkgo biloba. Pharmacol Biochem Behav 1995; 52:321-7.
28. Qian DS, Liu ZS. Pharmacologic studies of antimotion sickness actions of ginger. Chung Kuo Chung Hsi I Chieh Ho Tsa Chih 1992; 12:95-8, 70.
29. Huang Q, Iwamoto M, Aoki S, Tanaka N, Tajima K, Yamahara J. Anti-5-hydroxytryptamine effect of galanolactone, diterpenoid isolated from ginger. Chem Pharm Bull 1991; 39:397-9.
30. Micklefield GH, Redeker Y, Meister V, Jung O, Greving I, May B. Effects of ginger on gastroduodenal motility. Int J Clin Pharmacol Ther 1999; 37:341-6.
31. Fischer-Rasmussen W, Kjaer SK, Dahl C, Asping U. Ginger treatment of hyperemesis gravidarum. Eur J Obstet Gynecol Reprod Biol 1991; 38:19-24.
32. Meyer K, Schwartz J, Crater D, Keyes B. Zingiber officinale (ginger) used to prevent 8-Mop associated nausea. Dermatol Nurs 1995; 7:242-4.
33. Pecoraro A, Patel J, Guthrie T, Ndubisi B. Efficacy of ginger as an adjunctive anti-emetic in acute chemotherapy-induced nausea and vomiting. ASHP Midyear Clinical Meeting 1998; 33:P-429E.

34. Bone ME, Wilkinson DJ, Young JR, McNeil J, Charlton S. Ginger root--a new antiemetic. The effect of ginger root on postoperative nausea and vomiting after major gynaecological surgery. Anaesthesia 1990; 45:669-71.
35. Phillips S, Hutchinson S, Ruggier R. Zingiber officinale does not affect gastric emptying rate. A randomised, placebo-controlled, crossover trial. Anaesthesia 1993; 48:393-5.
36. Arfeen Z, Owen H, Plummer JL, Ilsley AH, Sorby-Adams RA, Doecke CJ. A double-blind randomized controlled trial of ginger for the prevention of postoperative nausea and vomiting. Anaesth Intensive Care 1995; 23:449-52.
37. Visalyaputra S, Petchpaisit N, Somcharoen K, Choavaratana R. The efficacy of ginger root in the prevention of postoperative nausea and vomiting after outpatient gynaecological laparoscopy. Anaesthesia 1998; 53:506-10.
38. Anonymous. Monographs on the medicinal uses of plants. Exeter: European Scientific Cooperative on Phytotherapy, 1997.
39. Schmid R, Schick T, Steffen R, Tschopp A, Wilk T. Comparison of Seven Commonly Used Agents for Prophylaxis of Seasickness. J Travel Med 1994; 1:203-206.
40. Grontved A, Hentzer E. Vertigo-reducing effect of ginger root. A controlled clinical study. ORL J Otorhinolaryngol Relat Spec 1986; 48:282-6.
41. Grontved A, Brask T, Kambskard J, Hentzer E. Ginger root against seasickness. A controlled trial on the open sea. Acta Otolaryngol (Stockh) 1988; 105:45-9.
42. Mowrey DB, Clayson DE. Motion sickness, ginger, and psychophysics. Lancet 1982; 1:655-7.
43. Holtmann S, Clarke AH, Scherer H, Hohn M. The anti-motion sickness mechanism of ginger. A comparative study with placebo and dimenhydrinate. Acta Otolaryngol (Stockh) 1989; 108:168-74.
44. Stewart JJ, Wood MJ, Wood CD, Mims ME. Effects of ginger on motion sickness susceptibility and gastric function. Pharmacology 1991; 42:111-20.
45. Yamahara J, Mochizuki M, Rong HQ, Matsuda H, Fujimura H. The anti-ulcer effect in rats of ginger constituents. J Ethnopharmacol 1988; 23:299-304.
46. Yamahara J, Hatakeyama S, Taniguchi K, Kawamura M, Yoshikawa M. Stomachic principles in ginger. II. Pungent and anti-ulcer effects of low polar constituents isolated from ginger, the dried rhizoma of Zingiber officinale Roscoe cultivated in Taiwan. The absolute stereostructure of a new diarylheptanoid. Yakugaku Zasshi 1992; 112:645-55.
47. al-Yahya MA, Rafatullah S, Mossa JS, Ageel AM, Parmar NS, Tariq M. Gastroprotective activity of ginger zingiber officinale rosc., in albino rats. Am J Chin Med 1989; 17:51-6.
48. Yamahara J, Miki K, Chisaka T, et al. Cholagogic effect of ginger and its active constituents. J Ethnopharmacol 1985; 13:217-25.
49. Gong QM, Wang SL, Gan C. A clinical study on the treatment of acute upper digestive tract hemorrhage with wen-she decoction. Chung Hsi I Chieh Ho Tsa Chih 1989; 9:272-3, 260.
50. Sharma M, Shukla S. Hypoglycemic effect of ginger. J Res Ind Med Yoga Homeopath 1977; 12:127-30.

51. Miller LG. Herbal medicinals: selected clinical considerations focusing on known or potential drug-herb interactions. Arch Intern Med 1998; 158:2200-11.
52. Srivastava KC. Aqueous extracts of onion, garlic and ginger inhibit platelet aggregation and alter arachidonic acid metabolism. Biomed Biochim Acta 1984; 43:S335-46.
53. Backon J. Ginger: inhibition of thromboxane synthetase and stimulation of prostacyclin: relevance for medicine and psychiatry. Med Hypotheses 1986; 20:271-8.
54. Srivastava KC. Isolation and effects of some ginger components of platelet aggregation and eicosanoid biosynthesis. Prostaglandins Leukot Med 1986; 25:187-98.
55. Guh J-H, Ko F-N, Jong T-T, Ting C-M. Antiplatelet effect of gingerol isolated from Zingiber officinale. J Pharmacy Pharmacology 1995; 47:329-32.
56. Verma SK, Singh J, Khamesra R, Bordia A. Effect of ginger on platelet aggregation in man. Indian J Med Res 1993; 98:240-2.
57. Janssen PL, Meyboom S, van Staveren WA, de Vegt F, Katan MB. Consumption of ginger (Zingiber officinale roscoe) does not affect ex vivo platelet thromboxane production in humans. Eur J Clin Nutr 1996; 50:772-4.
58. Lumb AB. Effect of dried ginger on human platelet function. Thromb Haemost 1994; 71:110-1.
59. Mustafa T, Srivastava KC. Ginger (Zingiber officinale) in migraine headache. J Ethnopharmacol 1990; 29:267-73.
60. Kiuchi F, Shibuya M, Sankawa U. Inhibitors of prostaglandin biosynthesis from ginger. Chem Pharm Bull (Tokyo) 1982; 30:754-7.
61. Flynn D, Rafferty M, Boctor A. Inhibition of human neutrophil 5-liopxygenase activity by gingerdione, shogaol, capsaicin and related pungent compounds. Prostaglandins Leukotrienes Med 1986; 24:195-8.
62. Sharma JN, Srivastava KC, Gan EK. Suppressive effects of eugenol and ginger oil on arthritic rats. Pharmacology 1994; 49:314-8.
63. Suekawa M, Ishige A, Yuasa K, Sudo K, Aburada M, Hosoya E. Pharmacological studies on ginger. I. Pharmacological actions of pungent constitutents, (6)-gingerol and (6)-shogaol. J Pharmacobiodyn 1984; 7:836-48.
64. Srivastava KC. Effect of onion and ginger consumption on platelet thromboxane production in humans. Prostaglandins Leukot Essent Fatty Acids 1989; 35:183-5.
65. Srivastava KC, Mustafa T. Ginger (Zingiber officinale) and rheumatic disorders. Med Hypotheses 1989; 29:25-8.
66. Srivastava KC, Mustafa T. Ginger (Zingiber officinale) in rheumatism and musculoskeletal disorders. Med Hypotheses 1992; 39:342-8.
67. Chen HC, Chang MD, Chang TJ. Antibacterial properties of some spice plants before and after heat treatment. Chung Hua Min Kuo Wei Sheng Wu Chi Mien I Hsueh Tsa Chih 1985; 18:190-5.

68. Ejechi BO, Souzey JA, Akpomedaye DE. Microbial stability of mango (Mangifera indica L.) juice preserved by combined application of mild heat and extracts of two tropical spices. J Food Prot 1998; 61:725-7.
69. Denyer CV, Jackson P, Loakes DM, Ellis MR, Young DA. Isolation of antirhinoviral sesquiterpenes from ginger (Zingiber officinale). J Nat Prod 1994; 57:658-62.
70. Janes ME, Nannapaneni R, Johnson MG. Identification and characterization of two bacteriocin-producing bacteria isolated from garlic and ginger root. J Food Prot 1999; 62:899-904.
71. Endo K, Kanno E, Oshima Y. Structures of antifungal diarylheptenones, gingerenones A, B, C and isogingerenone B, isolated from the rhizomes of Zingiber officinale. Phytochemistry 1990; 29:797-9.
72. Vimala S, Norhanom AW, Yadav M. Anti-tumour promoter activity in Malaysian ginger rhizobia used in traditional medicine. Br J Cancer 1999; 80:110-6.
73. Murakami A, Morita H, Safitri R, Ramlan A, Koshimizu K, Ohigashi H. Screening for in vitro anti-tumor-promoting activities of edible plants from Indonesia. Cancer Detect Prev 1998; 22:516-25.
74. Lee E, Surh Y. Induction of apoptosis in HL-60 cells by pungent vanilloids, 6-gingerol and 6-paradol. Cancer Letters 1998; 134:163-8.
75. Surh YJ, Lee E, Lee JM. Chemoprotective properties of some pungent ingredients present in red pepper and ginger. Mutat Res 1998; 402:259-67.
76. Hashim S, Aboobaker V, Madhubala R, Bhattacharya R, Rao A. Modulatory effects of essential oils from spices on the formation of DNA adduct by an aflatoxin B1 in vitro. Nutr Cancer 1994; 21:169-75.
77. Katiyar SK, Agarwal R, Mukhtar H. Inhibition of tumor promotion in SENCAR mouse skin by ethanol extract of Zingiber officinale rhizome. Cancer Res 1996; 56:1023-30.
78. Surh Y-J, park K-K, Chun K-S, Lee J-M, Lee E, Lee S. Anti-trumo promoting activities of selected pungent phenolic substances present in ginger. J Environ Path Tox Onc 1999; 18:131-9.
79. Lee E, Park KK, Lee JM, et al. Suppression of mouse skin tumor promotion and induction of apoptosis in HL-60 cells by Alpinia oxyphylla Miquel (Zingiberaceae). Carcinogenesis 1998; 19:1377-81.
80. Matthes H, Luu B, Ourisson G. Cytotoxic components of Zingiber zerumbet, curcuma deoaria and C. domestica. Phytochemistry 1980; 19:2643-50.
81. Pearson D, Frankel E, Aeschbach R, JB G. Inhibition of endothelial cell-mediated oxidation of low-density lipoprotein by rosemary and plant phenolics. J Agric Food Chem 1997; 45:578-82.
82. Zhou Y, Xu R. Antioxidative effect of Chinese drugs. Chung Kuo Chung Yao Tsa Chih 1992; 17:368-9, 373 inside backcover.
83. Sujatha R, Srinivas L. Modulation of lipid peroxidation by dietary componenets. Toxicology in vitro 1995; 9:231-36.
84. Guo P, Xu J, Xu S, Wang K. Inhibition of hydrogen peroxide production in chondrocytes induced by fulvic acid by ginger volatile oil. China J Chinese Materia Medica 1997; 22:559-61.
85. Jeyakumar S, Nalini N, Venugopal M. Antioxidant activity of ginger in rats fed a high fat diet. Med Sci Res 1999; 27:341-44.

86. Eldershaw TP, Colquhoun EQ, Dora KA, Peng ZC, Clark MG. Pungent principles of ginger (Zingiber officinale) are thermogenic in the perfused rat hindlimb. Int J Obes Relat Metab Disord 1992; 16:755-63.
87. Huang Q, Matsuda H, Sakai K, Yamahara J, Tamai Y. The effect of ginger on serotonin induced hypothermia and diarrhea. Yakugaku Zasshi 1990; 110:936-42.
88. Kano Y, Zong QN, Komatsu K. Pharmacological properties of galenical preparation. XIV. Body temperature retaining effect of the Chinese traditional medicine, "goshuyu-to" and component crude drugs. Chem Pharm Bull (Tokyo) 1991; 39:690-2.
89. Kanerva L, Estlander T, Jolanki R. Occupational allergic contact dermatitis from spices. Contact Derm 1996; 35:157-62.
90. Desai HG, Kalro RH, Choksi AP. Effect of ginger & garlic on DNA content of gastric aspirate. Indian J Med Res 1990; 92:139-41.
91. Nakamura H, Yamamoto T. Mutagen and anti-mutagen in ginger, Zingiber officinale. Mutat Res 1982; 103:119-26.
92. Nagabhushan M, Amonkar AJ, Bhide SV. Mutagenicity of gingerol and shogaol and antimutagenicity of zingerone in Salmonella/microsome assay. Cancer Lett 1987; 36:221-33.
93. Brinker FJ. Herb contraindications and drug interactions : with appendices addressing specific conditions and medicines. Sandy, Or.: Eclectic Institute, 1997:146.
94. McGuffin M, Hobbs C, Upton R, Goldberg A. American Herbal Products Association's Botanical Safety Handbook. Boca Raton. New York: CRC Press, 1997:231.
95. Kanjanapothi D. A uterine relaxant compound from Zingiber cassumunar. Planta Med 1987; 53:329-32.
96. Robbers JE, Tyler VE. Tyler's Herbs of choice : the therapeutic use of phytomedicinals. New York: Haworth Herbal Press, 1999:x, 287.