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)
Kathi J. Kemper, MD, MPH

<table>
<thead>
<tr>
<th>Principal Proposed Use:</th>
<th>Nausea due to motion sickness, morning sickness, general anesthesia or chemotherapy</th>
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<td>Other Proposed Uses:</td>
<td>Headaches and arthritis, chills associated with viral infections, high cholesterol</td>
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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. 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.

Some Africans believe that eating ginger regularly will help repel mosquitoes.

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. 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. The German Commission E approves the use of ginger root as a treatment for dyspepsia and prophylactic against motion sickness.
**Botany**

*Medicinal species:* Zingiber officinale Roscoe

*Common names:* Ginger, African ginger, Black ginger, Cochin ginger, Gan jiang, Gegibre, Ingwer, Jamaican ginger, Race ginger

*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.

**Biochemistry**

<table>
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<th>Ginger: Potentially Active Chemical Constituents</th>
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<tr>
<td>• Phenolic compounds: shogaols and gingerols</td>
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<tr>
<td>• Sesquiterpenes: bisapolene, zingiberene, zingiberol, sesquiphellandrene, curcurmene</td>
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<tr>
<td>• Other: 6-dehydrogingerdione, galanolactone, gingesulfonic acid, zingerone, geraniol, neral, monoacyl digalactosylglycerols, gingerglycolipids</td>
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The active ingredients in ginger are thought to reside in its volatile oils, which comprise approximately 1-3% of its weight. The major active ingredients in ginger oil are the sesquiterpenes: bisapolene, zingiberene, and zingiberol. 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.

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

#### Ginger: Potential Clinical Benefits

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

- **Cardiotonic**
  - **In vitro data:** In isolated guinea pig atrial muscles, gingerol enhanced contractility\(^{16}\).
  - **Animal data:** In animals, gingerol had inotropic and chronotropic effects\(^{16,17}\).
  - **Human data:** There are no reports of ginger’s effects on cardiac function in humans.

- **Antilipemic**
  - **In vitro data:** In homogenated liver from mice and rats, ginger extracts interfered with cholesterol biosynthesis\(^{18}\).
  - **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 concentrations18.

iii. Human data: A single dose (10 grams) of ginger had no impact on serum lipids in one study22. 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’s23. In shrews, dogs and rats, ginger extracts effectively reduced chemotherapy-associated vomiting24,25. Ginger also protected frogs against experimentally induced emesis26. An herbal combination including ginger and ginkgo was as effective as metoclopramide in another animal study of experimentally-induced nausea27. 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 gut28,29.

   iii. Human data: Both during fasting and after a standard test meal, ginger extracts significantly enhanced gastroduodenal motility in 12 normal volunteers30. 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 nausea31.

      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\textsuperscript{32}. Another case series also supported ginger’s use as an antiemetic in patients undergoing chemotherapy\textsuperscript{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\textsuperscript{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\textsuperscript{36,37}.

Several studies have evaluated ginger’s effectiveness in preventing motion sickness or sea sickness and the potential mechanisms for this effect\textsuperscript{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\textsuperscript{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\textsuperscript{40}. In a randomized controlled trial of naval cadets, ginger was significantly more effective than placebo in preventing sea sickness, both vomiting and vertigo\textsuperscript{41}. In an early trial involving 36 college students prone to motion sickness, ginger was as effective as dimenhydrinate in preventing nausea\textsuperscript{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\textsuperscript{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\textsuperscript{43}. In one NASA-sponsored study in healthy volunteers, ginger (500 – 1000 mg) had no apparent effect
on gastric emptying. However, other studies have reported enhanced intestinal motility following oral administration of ginger.

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. These results were confirmed in several subsequent studies in which several of ginger’s constituents, 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.

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

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

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


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.

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.

i. In vitro data: Ginger extracts inhibited platelet cyclooxygenase production, thromboxane generation and platelet aggregation in a dose-dependent fashion; gingerol also inhibited thromboxane-mediated platelet aggregation.

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\textsuperscript{56}. In human volunteers who took a huge (10 gram) one-time dose of dried ginger, there was a marked inhibition of platelet aggregability\textsuperscript{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\textsuperscript{57}.

There are no reports of bleeding problems in persons consuming up to 5 grams daily of dried ginger\textsuperscript{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\textsuperscript{59}.

i. In vitro data: Ginger extracts block the formation of inflammatory compounds such as thromboxane, leukotrienes and prostaglandins\textsuperscript{60,61}.

ii. Animal data: In the rat model of chronic severe inflammatory arthritis, ginger oil effectively reduced swelling and inflammation\textsuperscript{62}. Ginger compounds also had antipyretic effects comparable to aspirin in rats\textsuperscript{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\textsuperscript{59}.

Adult volunteers who ate 5 grams of raw ginger daily had a 25% reduction in thromboxane concentrations\textsuperscript{64}. A case series of seven patients with rheumatoid arthritis reported improved symptoms following supplemental ginger\textsuperscript{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, gingenones 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

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

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. In human erythrocyte membranes, ginger extracts inhibited lipid peroxidation by 72%. In human chondrocytes, ginger’s volatile oil effectively prevented the production of hydrogen peroxide usually induced by fulvic acid.

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 glutathione.

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.

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

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.

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. Very large doses of 6 grams or more of ginger may lead to gastric irritation and loss of protective gastric mucosa. At normal doses (up to 2 grams daily), ginger does not interfere with blood clotting or any individual coagulation parameter.

The acute LD50 of ginger in rats is greater than 5 grams of ginger oil per kilogram of body weight.

Chronic toxicity: None reported; no significant mutagenic or carcinogenic activity.

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; 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. 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. Some German herbalists recommend up to four times this amount. 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

Candied ginger: A 1 inch square piece is presumably equivalent to 500 – 1000 of dried ginger.

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


