Rhizoma Zingiberis

Definition

Rhizoma Zingiberis is the dried rhizome of *Zingiber officinale* Roscoe (*Zingiberaceae*) (*1–5*)

Synonyms

Amomum zingiber L. (*1, 6*), *Zingiber blancoi* Massk. (*6*).

Selected vernacular names

Ada, adrak, adu, African ginger, ajenjibre, ale, alea, allam, allamu, ardak, ardraka, ardrakam, ardrakamu, asunglasemtong, ata-le jinja, baojiang, beuing, chiang, citaraho, cochin ginger, common ginger, djae, gember, gengibre, gingembre, ginger, ginger root, gnji, gung, halia bara, halia, halija, hli, inchi, Ingberwurgel, inguere, inguru, Ingwer, jahe, Jamaica ginger, janzabeil, kallamu, kan chiang, kanga, kerati, khenseing, khiang, khing, khing-daeng, khing klaeng, khing phueak, khuong, kintoki, jion, konga, lahja, lei, luya, mangawizi, ngesnges, niamaku, oshoga, palana, palu, rimpang jahe, sa-e, sakanjabir, sge u-gser, shengiang, shenjing, shoga, shonkyoh, shokyo, shouhkyoh, tangawizi, wai, zanjabeel, zangabil ee-e-tar, zingabil urratab, zingibil, zingiberis rhizoma, zinjabil, zingiber, zinam (*1, 4, 6–13*).

Description

A perennial herb with a subterranean, digitately branched rhizome producing stems up to 1.50 m in height with linear lanceolate sheathing leaves (5–30 cm long and 8–20 mm wide) that are alternate, smooth and pale green. Flower stems shorter than leaf stems and bearing a few flowers, each surrounded by a thin bract and situated in axils of large, greenish yellow obtuse bracts, which are closely arranged at end of flower stem forming collectively an ovate-oblong spike. Each flower shows a superior tubular calyx, split part way down one side; an orange yellow corolla composed of a tube divided above into 3 linear-oblong, blunt lobes; 6 staminodes in 2 rows, the outer row of 3 inserted at mouth of corolla; the posterior 2, small, horn-like; the anterior petaloid, purple and spotted and divided into 3 rounded lobes; an inferior, 3-celled ovary with tufted stigma. Fruit a capsule with small arillate seeds (*1, 7, 8*).

Plant material of interest: dried rhizome

General appearance

Ginger occurs in horizontal, laterally flattened, irregularly branching pieces; 3–16 cm long, 3–4 cm wide, up to 2 cm thick; sometimes split longitudinally; pale yellowish buff or light brown externally, longitudinally striated, somewhat fibrous; branches known as "fingers" arise obliquely from the rhizomes, are flattish, obovate, short, about 1–3 cm long; fracture, short and starchy with projecting fibres. Internally, yellowish brown, showing a yellow endodermis separating the narrow cortex from the wide stele, and numerous scattered fibrovascular bundles, abundant scattered oleoresin cells with yellow contents and numerous larger greyish points, vascular bundles, scattered on the whole surface (*1–5*).

Organoleptic properties

Odour, characteristic aromatic; taste, pungent and aromatic (*1–5*); colour, internally pale yellow to brown (*1, 4*).

Microscopic characteristics

Cortex of isodiametric, thin-walled parenchyma cells contains abundant starch granules, each with a pointed hilum up to 50 μm long and 25 μm wide and 7 μm thick, and showing scattered secretion cells with suberized walls and yellowish brown oleoresinous content, and scattered bundles of the leaf-traces accompanied by fibres; endodermis, of pale brown, thin-walled cells with suberized radial walls; stele, with parenchymatous ground tissue, numerous yellow oleoresin secretion cells and numerous scattered, closed collateral vascular bundles with nonlignified, reticulate, scalariform, and spiral vessels, often accompanied by narrow cells; containing a dark brown pigment, and supported by thin-walled fibres with wide lumen, small oblique slit-like pits, and lignified middle lamella; some of the fibres are septate (*1, 3, 4*).

Powdered plant material

Powdered ginger is yellowish white to yellowish brown; characterized by numerous fragments of thin-walled parenchyma cells containing starch granules; fragments of thin-walled septate fibres with oblique slit-like pits; fragments of nonlignified scalariform, reticulate, and spiral vessels, often accompanied by dark pigment cells; oleoresin in fragments or droplets with oil cells and resin cells scattered in parenchyma; numerous starch granules, simple, flat, oval, oblong with terminal protuberance, in which the hilum is pointed, 5–60 μm usually 15–30 μm long, 5–40 μm (usually 18–25 μm) wide, 6–12 μm (usually 8–10 μm) thick with somewhat marked fine transverse striations (*1–4*).

Geographical distribution

The plant is probably native to south-east Asia and is cultivated in the tropical regions in both the eastern and western hemispheres. It is commercially grown

in Africa, China, India, and Jamaica; India is the world's largest producer (*1*, *4*, *6*, *7*, *10*, *14*).

General identity tests

Rhizoma Zingiberis is identified by its macroscopic and organoleptic characteristics, including its characteristic form, colour, pungent taste, and volatile oil content; and by microchemical tests *(1–5)*.

Purity tests

Microbiology

The test for *Salmonella* spp. in Rhizoma Zingiberis products should be negative. The maximum acceptable limits of other microorganisms are as follows (*15–17*). For preparation of decoction: aerobic bacteria—not more than 10^7/g; fungi—not more than 10^5/g; *Escherichia coli*—not more than 10^2/g. Preparations for internal use: aerobic bacteria—not more than 10^5/g or ml; fungi—not more than 10^4/g or ml; enterobacteria and certain Gram-negative bacteria—not more than 10^3/g or ml; *Escherichia coli*—0/g or ml.

Foreign organic matter

Not more than 2.0% (*1*). Powdered ginger is frequently adulterated with exhausted ginger (*8*).

Total ash

Not more than 6.0% (*2*, *3*).

Acid-insoluble ash

Not more than 2.0% (*5*).

Water-soluble extractive

Not less than 10% (*3*, *4*).

Alcohol-soluble extractive

Not less than 4.5% (*3*).

Pesticide residues

To be established in accordance with national requirements. Normally, the maximum residue limit of aldrin and dieldrin in Rhizoma Zingiberis is not more than 0.05 mg/kg (*17*). For other pesticides, see WHO guidelines on quality control methods for medicinal plants (*15*) and guidelines for predicting dietary intake of pesticide residue (*18*).

Heavy metals

Recommended lead and cadmium levels are not more than 10 and 0.3 mg/kg, respectively, in the final dosage form of the plant material (*15*).

Radioactive residues

For analysis of strontium-90, iodine-131, caesium-134, caesium-137, and plutonium-239, see WHO guidelines on quality control methods for medicinal plants (*15*).

Other purity tests

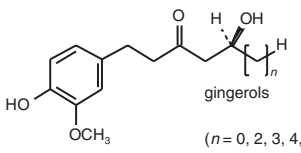
Chemical and moisture tests to be established in accordance with national requirements.

Chemical assays

Contains not less than 2% v/w of volatile oil (*1*), as determined by the method described in WHO guidelines (*15*). Qualitative analysis by thin-layer chromatography (*1*); qualitative and quantitative gas chromatography and high-performance liquid chromatography analyses of ginger oils for gingerols, shogaols, α-zingiberene, β-bisabolene, β-sesquiphellandrene, and *ar*-curcumene (*19*).

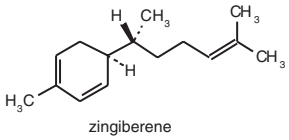
Major chemical constituents

The rhizome contains 1–4% essential oil and an oleoresin. The composition of the essential oil varies as a function of geographical origin, but the chief constituent sesquiterpene hydrocarbons (responsible for the aroma) seem to remain constant. These compounds include (−)-zingiberene, (+)-*ar*-curcumene, (−)-β-sesquiphellandrene, and β-bisabolene. Monoterpene aldehydes and alcohols are also present. The constituents responsible for the pungent taste of the drug and possibly part of its anti-emetic properties have been identified as 1-(3′-methoxy-4′-hydroxyphenyl)-5-hydroxyalkan-3-ones, known as [3–6]-, [8]-, [10]-, and [12]-gingerols (having a side-chain with 7–10, 12, 14, or 16 carbon atoms, respectively) and their corresponding dehydration products, which are known as shogaols (*1, 4, 6, 14, 19*). Representative structures of zingiberene, gingerols and shogaols are presented below.

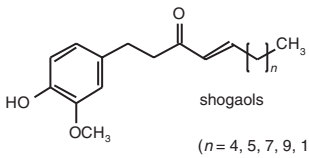


gingerols

(*n* = 0, 2, 3, 4, 5, 7, 9)



zingiberene



shogaols

(*n* = 4, 5, 7, 9, 10)

Dosage forms

Dried root powder, extract, tablets and tincture (*2*, *14*). Powdered ginger should be stored in well-closed containers (not plastic) which prevent access of moisture. Store protected from light in a cool, dry place (*4*, *5*).

Medicinal uses

Uses supported by clinical data

The prophylaxis of nausea and vomiting associated with motion sickness (*20*–*23*), postoperative nausea (*24*), pernicious vomiting in pregnancy (*25*), and seasickness (*26*, *27*).

Uses described in pharmacopoeias and in traditional systems of medicine

The treatment of dyspepsia, flatulence, colic, vomiting, diarrhoea, spasms, and other stomach complaints (*1*, *2*, *4*, *9*, *21*). Powdered ginger is further employed in the treatment of colds and flu, to stimulate the appetite, as a narcotic antagonist (*1*, *2*, *4*, *6*, *11*, *12*, *21*), and as an anti-inflammatory agent in the treatment of migraine headache and rheumatic and muscular disorders (*9*, *11*, *12*, *28*).

Uses described in folk medicine, not supported by experimental or clinical data

To treat cataracts, toothache, insomnia, baldness, and haemorrhoids, and to increase longevity (*9*, *10*, *12*).

Pharmacology

Experimental pharmacology

Cholagogic activity

Intraduodenal administration of an acetone extract (mainly essential oils) of ginger root to rats increased bile secretion for 3 hours after dosing, while the aqueous extract was not active (*29*). The active constituents of the essential oil were identified as [6]- and [10]-gingerol (*29*).

Oral administration of an acetone extract of ginger (75 mg/kg), [6]-shogaol (2.5 mg/kg), or [6]-, [8]-, or [10]-gingerol enhanced gastrointestinal motility in mice (*30*), and the activity was comparable to or slightly weaker than that of metoclopramide (10 mg/kg) and domperidone (*30*). The [6]-, [8]-, or [10]-gingerols are reported to have antiserotoninergic activity, and it has been suggested that the effects of ginger on gastrointestinal motility may be due to this activity (*30*, *31*). The mode of administration appears to play a critical role in studies on gastrointestinal motility. For example, both [6]-gingerol and [6]-shogaol inhibited intestinal motility when administered intravenously but accentuated gastrointestinal motility after oral administration (*6*, *12*, *32*).

Antiemetic activity

The emetic action of the peripherally acting agent copper sulfate was inhibited in dogs given an intragastric dose of ginger extract (*33*), but emesis in pigeons treated with centrally acting emetics such as apomorphine and digitalis could not be inhibited by a ginger extract (*34*). These results suggest that ginger's antiemetic activity is peripheral and does not involve the central nervous system (*11*). The antiemetic action of ginger has been attributed to the combined action of zingerones and shogaols (*11*).

Anti-inflammatory activity

One of the mechanisms of inflammation is increased oxygenation of arachidonic acid, which is metabolized by cyclooxygenase and 5-lipoxygenase, leading to prostaglandin E_2 and leukotriene B_4, two potent mediators of inflammation (*28*). *In vitro* studies have demonstrated that a hot-water extract of ginger inhibited the activities of cyclooxygenase and lipoxygenase in the arachidonic acid cascade; thus its anti-inflammatory effects may be due to a decrease in the formation of prostaglandins and leukotrienes (*35*). The drug was also a potent inhibitor of thromboxane synthase, and raised prostacyclin levels without a concomitant rise in prostaglandins E_2 or $F_{2\alpha}$ (*36*). *In vivo* studies have shown that oral administration of ginger extracts decreased rat paw oedema (*37*, *38*). The potency of the extracts was comparable to that of acetylsalicylic acid. [6]-Shogaol inhibited carrageenin-induced paw oedema in rats by inhibiting cyclooxygenase activity (*39*). Recently, two labdane-type diterpene dialdehydes isolated from ginger extracts have been shown to be inhibitors of human 5-lipoxygenase *in vitro* (*40*).

Clinical pharmacology

Antinausea and antiemetic activities

Clinical studies have demonstrated that oral administration of powdered ginger root (940 mg) was more effective than dimenhydrinate (100 mg) in preventing the gastrointestinal symptoms of kinetosis (motion sickness) (*22*). The results of this study further suggested that ginger did not act centrally on the vomiting centre, but had a direct effect on the gastrointestinal tract through its aromatic, carminative, and absorbent properties, by increasing gastric motility and adsorption of toxins and acids (*22*).

In clinical double-blind randomized studies, the effect of powdered ginger root was tested as a prophylactic treatment for seasickness (*26*, *27*). The results of one study demonstrated that orally administered ginger was statistically better than a placebo in decreasing the incidence of vomiting and cold sweating 4 hours after ingestion (*27*). The other investigation compared the effects of seven over-the-counter and prescription antiemetic drugs on prevention of seasickness in 1489 subjects. This study concluded that ginger was as effective as the other antiemetic drugs tested (*26*).

At least eight clinical studies have assessed the effects of ginger root on the symptoms of motion sickness. Four of these investigations showed that orally administered ginger root was effective for prophylactic therapy of nausea and vomiting. The other three studies showed that ginger was no more effective than a placebo in treating motion sickness (*23*, *41*, *42*). The conflicting results appear to be a function of the focus of these studies. Clinical studies that focused on the gastrointestinal reactions involved in motion sickness recorded better responses than those studies that concentrated primarily on responses involving the central nervous system.

The hypothesis that an increase in gastric emptying may be involved in the antiemetic effects of ginger has recently come under scrutiny. Two clinical studies demonstrated that oral doses of ginger did not affect the gastric emptying rate, as measured by sequential gastric scintigraphy (*43*) or the paracetamol absorption technique (*44*).

In a double-blind, randomized, cross-over trial, oral administration of powdered ginger (250 mg, 4 times daily) effectively treated pernicious vomiting in pregnancy (*25*). Both the degree of nausea and the number of vomiting attacks were significantly reduced (*25*). Furthermore, in a prospective, randomized, double-blind study, there were statistically significantly fewer cases of postoperative nausea and vomiting in 60 patients receiving ginger compared to a placebo (*24*). The effect of ginger on postoperative nausea and vomiting was reported to be as good as or better than that of metoclopramide (*24*, *45*). In contrast, another double-blind randomized study concluded that orally administered ginger BP (prepared according to the British Pharmacopoeia) was ineffective in reducing the incidence of postoperative nausea and vomiting (*46*).

Anti-inflammatory activity

One study in China reported that 113 patients with rheumatic pain and chronic lower back pain, injected with a 5–10% ginger extract into the painful points or reaction nodules, experienced full or partial relief of pain, decrease in joint swelling, and improvement or recovery in joint function (*11*). Oral administration of powdered ginger to patients with rheumatism and musculoskeletal disorders has been reported to provide varying degrees of relief from pain and swelling (*28*).

Contraindications

No information available.

Warnings

No information available.

Precautions

General

Patients taking anticoagulant drugs or those with blood coagulation disorders should consult their physician prior to self-medication with ginger. Patients with gallstones should consult their physician before using ginger preparations (*21*).

Drug interactions

Ginger may affect bleeding times and immunological parameters owing to its ability to inhibit thromboxane synthase and to act as a prostacyclin agonist (*47, 48*). However, a randomized, double-blind study of the effects of dried ginger (2 g daily, orally for 14 days) on platelet function showed no differences in bleeding times in patients receiving ginger or a placebo (*49, 50*). Large doses (12–14 g) of ginger may enhance the hypothrombinaemic effects of anticoagulant therapy, but the clinical significance has yet to be evaluated.

Carcinogenesis, mutagenesis, impairment of fertility

The mutagenicity of ginger extracts is a controversial subject. A hot-water extract of ginger was reported to be mutagenic in B291I cells and *Salmonella typhimurium* strain TA 100, but not in strain TA 98 (*51*). A number of constituents of fresh ginger have been identified as mutagens. Both [6]-gingerol and shogaols have been determined to be mutagenic in a *Salmonella*/microsome assay (*52*), and increased mutagenesis was observed in an Hs30 strain of *Escherichia coli* treated with [6]-gingerol (*53*). However, the mutagenicity of [6]-gingerol and shogaols was suppressed in the presence of various concentrations of zingerone, an antimutagenic constituent of ginger (*52*). Furthermore, ginger juice was reported to be antimutagenic and suppressed the spontaneous mutations induced by [6]-gingerol, except in cases where the mutagenic chemicals 2-(2-furyl)-3-(5-nitro-2-furyl)acryl amide and *N*-methyl-*N*′-nitro-*N*-nitrosoguanidine were added to [6]-gingerol (*54*). Other investigators have also reported that ginger juice is antimutagenic (*54, 55*).

Pregnancy: teratogenic effects

In a double-blind randomized cross-over clinical trial, ginger (250 mg by mouth, 4 times daily) effectively treated pernicious vomiting in pregnancy (*25*). No teratogenic aberrations were observed in infants born during this study, and all newborn babies had Apgar scores of 9 or 10 after 5 minutes (*25*).

Paediatric use

Not recommended for children less than 6 years of age.

Other precautions

No information available concerning drug and laboratory test interactions, or non-teratogenic effects on pregnancy or nursing mothers.

Adverse reactions

Contact dermatitis of the finger tips has been reported in sensitive patients (*56*).

Posology

For motion sickness in adults and children more than 6 years: 0.5 g, 2–4 times daily. Dyspepsia, 2–4 g daily, as powdered plant material or extracts (*21*).

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