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Phytochemical, Pharmacognostic and Pharmacological Studies on Zingiber Officinale

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Abstract

Rhizomes of *Zingiber officinale* Roscoe. belonging to the family Zingiberaceae is used for bronchitis, as a carminative, for treating cough, cataracts and as a stimulant. The rhizome is cooked with salt and water and used as an expectorant. Extract of the juice of rhizome is used aseye-drops. In Yemen, it is mixed with other plants used for constipation, as a purgative, against colds, catarrh and acidity of the stomach. Root ginger is widely used for culinary purposes and asa spice. The rhizomes (imported from India) are used with cinnamon and cloves and made into atea for treating colds and as a general tonic. The drink is also used as an aphrodisiac (Gazanfar, 1994).

Ginger is useful in piles, rheumatism, headache, lumbago, pains, bleeding, chest congestion, cholera, cold, diarrhea, dropsy, nausea, stomachache, gastrointestinal disorders, vomiting, and diarrhea. The fresh juice of ginger acts as a strong diuretic. The juice of the leaves is effective against helminthiasis and marasmus and related conditions of diarrhea and dysentery (Monograph of Unani Medicine, 2003).

Keywords: phytochemical; pharmacognostic ;pharmacological; zingiber officinale

Introduction

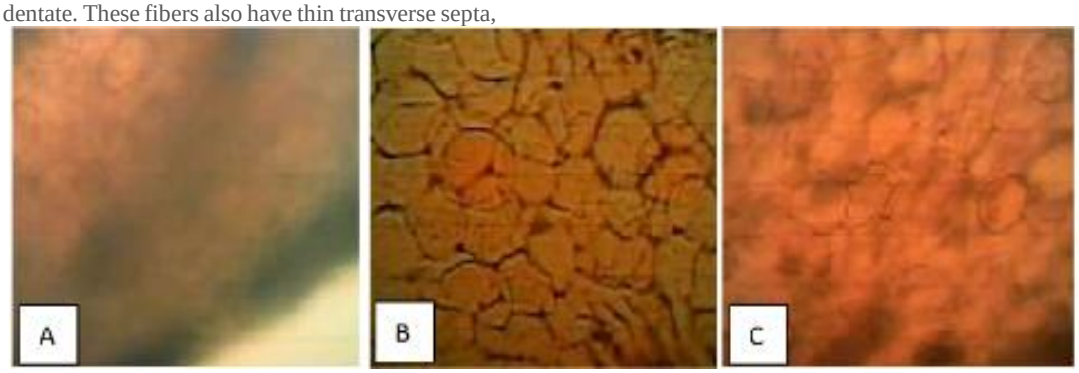
Ginger is extremely valuable in dyspepsia, flatulence, colic, vomiting, spasms and other painful affections of the stomach, and the bowls unattended by fevers for cold, cough, asthma, dyspepsiaand indigestion. Aromatic, carminative, stimulant to gastrointestinal tract, and stomachic; also digestive. Externally a local stimulant and rubefacient (Kapoor, 2001).

It is a pale yellowish branched rhizome and it is laterally compressed with longitudinally striated surfaces giving a coarse feeling when touched between fingers. When a branch is cut, it shows fibrous structures.

A transverse section of a branch of the rhizome is oblong in outline. As the sample is composed of an unpeeled rhizome, the outermost layers are composed of brown cork cells underlain by layers of collapsed parenchyma cells. which are brownish-yellow in color. These are surrounding the cortex, which occupies a large zone, and it consists of rounded and polygonal parenchyma cells and they are almost light yellow in color. Many of the cortical parenchyma cells contain oblong or pear-shaped starch granules. Scattered between these cells are many yellow-colored rounded or oval cells that contain

droplets of yellow oil. The cortex is underlain by a clear endoclermis layer with collapsed cells. The numerous vascular bundles, which are light gray in color, are scattered in both cortex and the yellow-colored stele. The xylem vessels are annularly, spirally, or reticulately thickened. The vascular bundles are almost surrounded by a group of fibers, which are long and they have thick walls that are pitted and one side of the walls is dentate. These fibers also have thin transverse septa, which are observed at intervals. The central zone is occupied by the pith, which consists of polygonal or rounded cells among which are scattered rounded or oval cells that contain droplets of a yellowish volatile oil.

Parts Studied: Rhizome



Chemical Constituents:

The rhizome contains 1–4% essential oil and an oleoresin. The chief constituents of essential oil are sesquiterpenes (1%-3%) which include (-)-zingiberene, (+)-ar-curcumene, (-) β-sesquiphellandrene, β-bisabolene,citral and citronellyl acetate (Wagner,H. ,1996). Heptane, octane, isovaleraldehyde, nonanol, ethyl pinene, camphene, β-pinene, sabinene, myrecene, limonene, β-phellandrene and 1,8-cineole, sequithujene, cis- sesquisabinene hydrate and zingiberenol (2-methyl-6(trans-4´-methyl-4- hydroxycylohex-2-enyl)-hept-2-ene), car-3-ene, terpineol, nerol, neral, geranial, geraniol and geranyl acetate, α-farnesene, β-farnesene, linalool, , gingerol, shogaol, dihydrogingerol, hexahydrocurcumin are also reported in the essential oil of rhizomes. Monoterpene aldehydes and alcohols are also present. Gingerols and shogaols (WHO, 1999).

Gingerdione: 1-dehydrogingerdione (Reena, 2000). Gingediol, methylgingediol and their diacetates. (6)-dehydroginerdione,(10)-dehydrogingerdione,(6)-gingerdione and (10)-gingerdione and (6)-gingerol from roots. Gingerdiones, hexahydrocurcumin and desmethylhexahydrocurcumin. Gingerols I, II and II from rhizomes. Asparticacid, threonine, serine, glycine, cysteine, valine, isoleucine, leucine and arginine from aerial parts and tuber.

(6)-shogaol,(6)-dehydrogingerdione,(8)-and (10)-gingerols are active constituents. Zingiberene, α-curcumene, α-copaene, undecan-2-one, neral and geranial from root essential oil. Zerumbone, zerumbodienone, humulene epoxide I and humulene epoxide II from roots. Galanolactone and (E)8□,17-epoxylabd-12-en-15,16-dial along with (6)- shogaol,(6)-,(8)- and (10)-gingerols from roots. Diarylheptenones: gingerenone A, B, and C and isogingerenone B from rhizomes (Rastogi, 1991, 1993, 1995, 1998).

The following chemical studies have been carried out (Quality Control Methods, 1998; Evans, 1996) on the rhizome of Zingiber officinale (ZCHRTM unpublished work):

Physicochemical Constants (%)

Loss of weight in drying at 105 oC: 10.90 Absolute alcohol solubility : 4.00 Water solubility : 16.00

Successive Extractives (%)

Petroleum ether (60-80 ^{O}C) : 3.05
Chloroform : 1.05
Absolute alcohol : 1.90

Ash Values (%)

Total ash : 8.50
Water soluble ash : 1.30Acid insoluble ash (10% HCl) : 0.20

pH Values (aqueous solution)

pH of 1% solution : 4.58-4.62
pH of 10% solution : 4.31-4.32

Elemental Analyses:

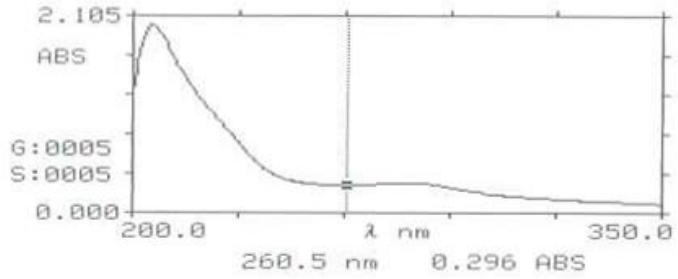
Ash values (British Herbal Pharmacopeia- Reference)					
Assay and identification of element (AOAC International- Reference)					
Apparatus	**(AA-6800 Shimadzu-Flame method)**				
Element	**Std. conc. µg/ml (ppm)**	**Sample conc. mg/ml**	**Sample absorbance**	**Actual conc. mg/ml**	**Actual conc.(%)**
Cr	1, 2, 4	9.995	0.0000	<0.0001	<0.001
Zn	0.25, 0.5, 1	9.995	0.1388	0.04169	0.004169
Cu	1, 2, 4	9.995	0.006	0.00722	0.00072

Fe	1, 2, 4	0.9086	0.0274	0.05051	0.005051
K	1, 2, 4	0.9086	1.4268	10.88296	1.088296
Pb	1, 2, 4	9.995	0.0000	<0.0001	<0.00001
Cd	0.125,0.25,0.5	9.995	0.0000	<0.00001	<0.000001
Ca	5, 10, 20	0.826	0.0193	5.529864	0.552986
Mg	0.25, 0.5, 1	0.0826	0.2825	2.90884	0.290884
Na	1,2,4	0.9086	0.09992	2.2693	0.22693

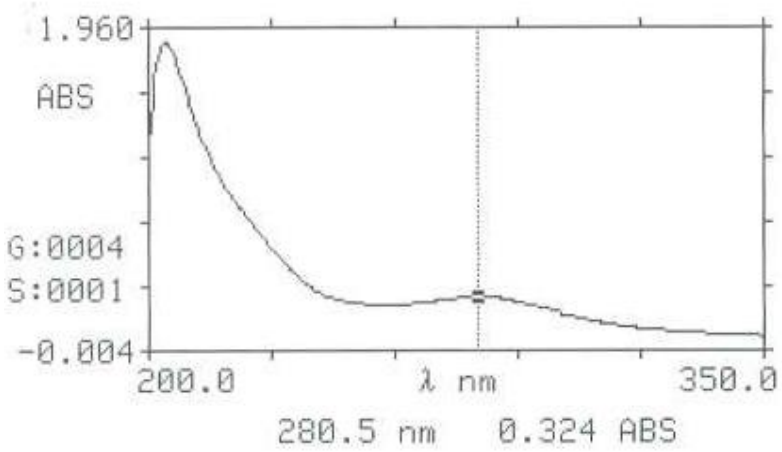
1ppm conc. = 1µg/ml; Actual conc. (%) =Actual conc. (ppm) x 0.0001 [1ppm=0.0001%]

UV Spectral Studies:

Ultraviolet Spectrum (USP reference)				
Apparatus	**Beckman DU 520 general purpose UV/VIS spectrophotometer.**			
Sample conc. (mg / ml)	**Solvent**	**λ max (nm)**	**λ min (nm)**	**Abs.(λ max - λ min)**
0.60636	Intestinal Fluid simulated without pancreatic pH=7.5±0.1	205.5 277.5	 260.5	2.007 0.323-0.296
0.83666	Gastric Fluid simulated without pepsin pH =1.2±0.1	204 280.5	257.5	1.857 0.324- 0.276

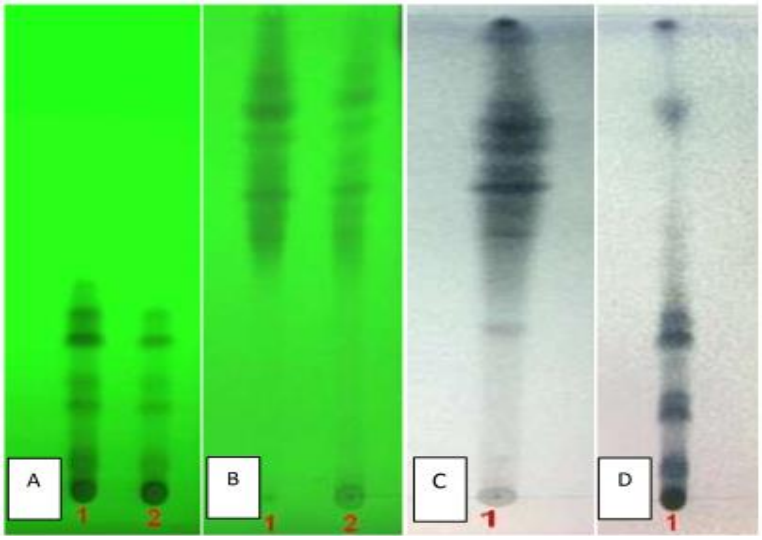


Intestinal Fluid simulated without pancreatic pH=7.5±0.1



Gastric Fluid simulated without pepsin pH=1.2±0.1

Thin layer chromatography (TLC): (Wagner, 1996)



TLC fingerprint of Petroleum ether -60-80 ^{O}C extract (track 1) and MeOH extract (track 2)Mobile phase Fig. A & D: Toluene, ethyl acetate (93:7) B & C: Toluene, ethyl formate, formic acid (5:4:1)Detection A & B: UV 254nm Derivatization C & D: Vanillin-Sulphuric acid under normal light

Pharmacological & Toxicological Studies:

Literature and reported information about the plant: General pharmacological studies were performed on ginger and shogaol, which are the pungent constituents of ginger (Zingiber officinale Roscoe). Intravenous (IV) administration of gingerol at (1.75-3.5 mg/kg) or shogaol (at 1.75-3.5 mg/kg) and oral administration of them (at 70-140 mg/kg) produced an inhibition of spontaneous motor activity, antipyretic and analgesic effects, prolonged hexobarbital-induced sleeping time. These effects of shogaol were mostly more intensive than that of gingerol.

Shogaol showed an intense antitussive effect in comparison with dihydrocodeine phosphate. In the electro-encephalogram of cortex, the low amplitude fast wave pattern was observed for 5 min after IV administration of shogaol, and then changed to the drowsy pattern, which was restored after 60 min. In the gastro-intestinal system, shogaol intensively inhibited the traverse of charcoal meal through the intestine in contrast with gingerol after IV administration of 3.5 mg/kg, but shogaol facilitated such an intestinal function after oral administration of 35 mg/kg. Both shogaol and gingerol suppressed gastric contraction in situ, and the suppression by the former was more intensive than that by the latter. In the cardiovascular system, both shogaol and gingerol produced depressor response at lower doses on the blood pressure. At high doses, both drugs produced three phase pattern (Suekawa, 1984). Ethanolic decoction of Zingiber officinale (200 mg/kg) fed orally for 20 days produced significant antihyperglycaemic effect (P=<0.01) in diabetic rats (Bhandari, 2005). The cytoprotective and gastric anti-ulcer studies of ginger that have been carried out in albino rats indicates the cytoprotective and anti-ulcerogenic effects of the ginger (Al-Yahiya, 1989).

In humans, ginger is thought to act directly on the gastrointestinal system to reduce nausea (Holtmann, 1989). Ginger has been shown to reduce the symptoms of motion sickness associated with travel by boat and, to a lesser extent (Grontved, 1988), (Ribenfeld, 1999), (Careddu, 1999). Two double-blind clinical trials have found that ginger may reduce nausea due to anesthesia following surgery (Bone, 1990); (Phillips, 1993). However, one trial could not confirm this benefit (Arfeen, 1995). A preliminary trial has suggested ginger may be helpful for preventing chemotherapy-induced nausea (Meyer, 1995). While ginger is a popular remedy for nausea of pregnancy, it has only been clinically studied for very severe nausea and vomiting known as hyperemesis gravidarum (Langner, 1998). Ginger can be life threatening. Ginger contains some compounds that cause chromosomal mutation in the test tube. However, the available clinical research, combined with the fact that ginger is widely used in the diet of certain cultures, suggests that prudent use of ginger for morning sickness is safe in amounts up to 1 gram per day.

Ginger is considered a tonic for the digestive tract, stimulating digestion and toning the intestinal muscles (Bradley, 1992). Ginger may protect the stomach from the damaging effect of alcohol and non-steroidal anti-inflammatory drugs (NSAIDs, such as ibuprofen) and may help prevent ulcers (Al-Yahya,1989).

Ginger also supports cardiovascular health. Ginger may make blood platelets less sticky and less likely to aggregate (Bordia, 1997), (Verma, 1993). However, not all human research has confirmed this (Lumb, 1994), (Janssen, 1996).

The efficacy of ginger for the prevention of postoperative nausea and vomiting was studied in a double-blind, randomized, controlled trial in 108 ASA 1 or 2 patients undergoing gynecological laparoscopic surgery under general anesthesia. These studies concluded that ginger BP in doses of 0.5 or 1.0 gram is ineffective in reducing the incidence of postoperative nausea and vomiting (Arfeen, 1995).

The effectiveness of ginger (Zingiber officinale) as an antiemetic agent was compared with

placebo and metoclopramide in 60 women who had major gynecological surgery in a double-blind, randomized study. The administration of antiemetic after operation was significantly greater in the placebo group compared to the other two groups (p=< 0.05) (Bone, 1990).

In a placebo-controlled study, the effect of ginger and fenugreek was examined on blood lipids, blood sugar, platelet aggregation, fibrinogen and fibrinolytic activity. Ginger did not affect the blood lipids and blood sugar (Bordia, 1997). Ginger on thromboxane synthetase activity was found dose dependent, or only occurs with fresh ginger, and that up to 2 g of dried ginger is unlikely to cause platelet dysfunction when used

therapeutically (Lumb, 1994). In a double-blind randomized placebo trial, the effect of the powdered rhizome of ginger Zingiber officinale was tested on seasickness.

Ginger root reduced the tendency of vomiting and cold sweating significantly better than placebo did ($p < 0.05$) (Grontved, 1988). The effect of powdered ginger root (Zingiber officinale) upon vertigo and nystagmus following caloric stimulation of the vestibular system was studied in eight healthy volunteers in a double-blind crossover placebo trial (Grontved, 1986.). The effect of ginger root (Zingiber isrhizoma) on gastrointestinal motility was examined based on its ability to enhance charcoal meal transport in mice. The plant and its active constituents have gastrointestinal motility enhancing effect (Yamahara, 1990).

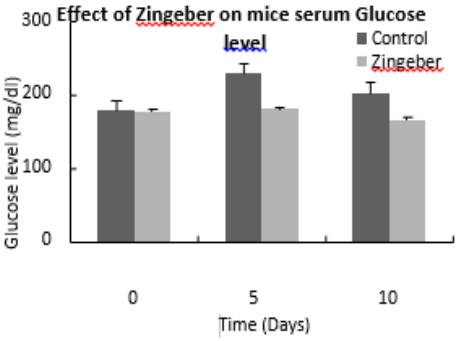
The effects of these substances were similar to or slightly weaker than those of metoclopramide and donperidone. Dietary supplementation ginger in 20 healthy male volunteers for 7 days was found to enhance platelet aggregation to a significant extent (Varma, 1993).

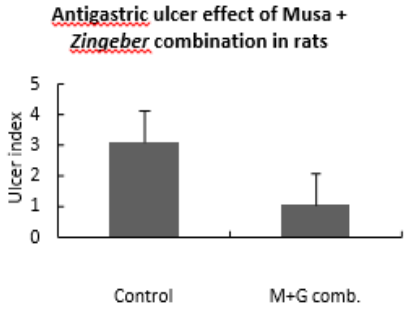
The following pharmacological and safety evaluation studies (Derelanko 2002, Han, 2003) were carried out on the plant decoction of Zingiber officinalis.

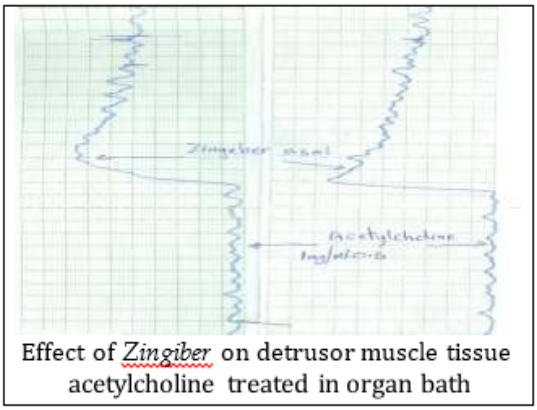
ACTIVITY	**RESULTS**			
	Strong	**Moderate**	**Mild**	**Negative**
Analgesic (hot plate)				√
Anti-diabetic activity		√		
Antidepressant (TST)				√
Anti-stress activity (swimming test)	√			
Anti-gastric ulcer effect (NaOH rat model)	√			
Antithrombotic effect		√		
Effect on guinea pig tracheal chain				√
Effect on rabbit jejunum		√		
Effect on guinea pig ileum			√	
Effect on rat fundus		√		
Effect on detrusor muscle		√		
Effect on right rat atria (HR) ↓			√	
Acute toxicity on mice				√
Locomotor activity test			√	
Motor co-ordination (grip strength & motor activity				√
Rectal temperature				√
Body weight				√
Ld50 = > 10 g/kg p.o. in mice				
Mortality				√

Conclusion:

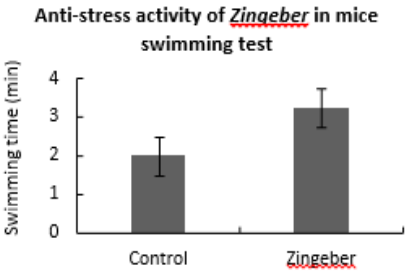
The plant decoction showed moderate anti-diabetic activity; the combination of Zingiber + Musa exhibited anti-gastric ulcer effect in rats and moderate contraction effect on acetylcholine treated detrusor muscle. The decoction was evaluated for its safety in mice, following acute toxicity test. Acute administration of the plant decoction did not produce any noticeable toxic effects in the mice at the doses tested.







Effect of *Zingiber* on detrusor muscle tissue acetylcholine treated in organ bath



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