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REVIEW ARTICLE

PHARMACOGNOSY

ZINGIBER OFFICINALE: A NATURAL GOLD

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ABSTRACT

Ginger, (*Zingiber officinale* Roscoe, Zingiberacae) is one of the important medicinal plant which naturally occurs in various country like India, China, South East Asia, West Indies, Mexico and other parts of the world. This natural gold has been consumed worldwide as a spice and flavoring agent from the ancient time. Ginger plants are generally 1-3 ft. in height and having different chemical constituents like Amaldehyde, Gingerol, Shogaol, and Paradol etc. It has some tremendous beneficial effect to human body to cure various types of diseases.

Ginger bears an enormous number of pharmacological activities among those, Neuro-protective activity and activity against colon cancer have facilitated the extent of further research for finding out less toxic and more potent drugs for the better treatment of those diseases. This review will facilitate to gain all about the past scientific research and the necessary information about the enormous pharmacological activities of ginger which will insist researchers for future research to protect human beings from several types of diseases and may serves as a natural gold for the promotion of mankind.

KEYWORDS

Zingiber officinale, Gingerol, Shogaol, Amaldehyde, Neuro-protective, colon cancer

INTRODUCTION

Man's acquaintance with the medicinal properties of plants is of great antiquity. Even the higher mammals are said to be aware of the curative aspects of plant kingdom. Plants have been used in a number of systems of medicines in our country as well as in other countries. India is well known as the 'Emporium of Medicinal Plants'. The use of plants to treat various diseases in India dates back to the times of Rig-Veda (3500 to 1800 B.C.). Later, the monumental Ayurvedic works like Charaksamhita and Sushrutasamhita followed by other Ayurveda and Siddha treatises have incorporated nearly 700 plant drugs entering into several medicinal preparations used in the management of health care. In fact these systems have been in practice even in remote areas of our country for centuries[1].

Ginger consists of the fresh or dried roots of *Zingiber officinale*. The English botanist William Roscoe (1753-1831) gave the plant the name *Zingiber officinale* in an 1807 publication. The ginger family is a tropical group especially abundant in Indo-Malaysia, consisting of more 1200 plant species in 53 genera. The genus *Zingiber* includes about 85 species of aromatic herbs from East Asia and tropical Australia. The name of the genus, *Zingiber*, derives from a Sanskrit word denoting "horn-shaped," in reference to the protrusions on the rhizome [2, 3].

Zingiber officinalis Roscoe, commonly known as ginger belongs to family Zingiberaceae is cultivated commercially in India, China, South East Asia, West Indies, Mexico and other parts of the world. It is consumed worldwide as a spice and flavoring agent and is attributed to have many medicinal properties. The British Herbal Compendium reported its action as carminative, anti- emetic, spasmolytic, peripheral circulatory stimulant and anti-inflammatory [4]. The oil of ginger is a mixture of constituents, consisting of monoterpenes (phellandrene, camphene, cineole, citral, and borneol) and sesquiterpenes (zingiberene, zingiberol, zingiberenol, ß-bisabolene, sesquiphellandrene, and others). Aldehydes and alcohols are also present [5, 6].

A numeral of commercial variety of ginger exists. Nigerian Ginger is darker in color, minute size and more pungent taste. Cochin Ginger is habitually larger, well scraped, contains more starch and breaks with a shorter fracture. African Ginger is darker in color, more pungent in taste and less flavor than Jamaica Ginger. Ginger plant is propagated by rhizome cuttings each bearing a bud. The pieces of rhizome are planted in holes during March and April in a well- drained clayey soil. In December or January rhizomes are unruffled. Ginger requires a warm and humid atmosphere. A well distributed rainfall is required for its cultivation. If the area is getting fewer rainfalls, the crop needs habitual irrigation[7].

Policegoudra RS, Rehna K, Rao LJ, Aradhya SM studied antibacterial activity-guided purification by repeated silica gel column chromatography to obtain a pure compound. The structure of the isolated compound was deduced by analyzing UV, IR, LC-MS and 2D-HMQCT NMR spectral data, and named it as amadaldehyde, a novel compound [8]. Whereas Altman RD, Marcussen KC was studied on ginger extract on knee pain

in patients with osteoarthritis [9]. Some work has been devoted to the anti tumor activity of ginger like Shailah Abdullah et.al. Studied antitumor effects of ginger extract by evaluating apoptosis rate and cell cycle progression status [10]. Asnani VM, Verma RJ was studied the ameliorative effects of ginger extract [11].

The main aim to write this review is to give insight on *Zingiber officinale* that might be a natural gold due to its invaluable pharmacological properties by which students and researchers will get the overall information about its published pharmacognostic and pharmacological properties for their further research.

MORPHOLOGY

The ginger plant is an erect perennial growing from one to three feet in height. The stem is surrounded by the sheathing bases of the two-ranked leaves. A club-like spike of yellowish, purple-lipped flowers have showy greenish yellow bracts beneath. Unfortunately, ginger rarely flowers in cultivation. The ginger of commerce consists of the thick scaly rhizomes (underground stems) of the plant. They branch with thick thumb-like protrusions, thus individual divisions of the rhizome are known as "hands."[2, 3]. Rhizomes are 7-15 cm long and 1-1.5 cm broad and laterally compressed. The branches arise obliquely from the rhizome are about 1-3 cm long and terminate in depress scars or in undeveloped buds. The outer surface is buff-colored and longitudinally striated or fibrous [12] .Fractured surface shows a narrow cortex, a well marked endodermis and a wide stele [7].

TRADITIONAL USE

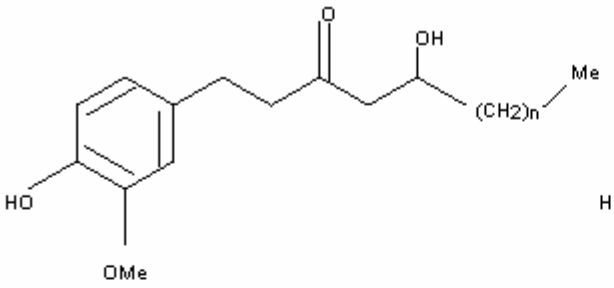
Ginger is extensively used around the world in foods as a spice. For centuries, it has been an important ingredient in Chinese, Ayurvedic and Tibb-Unani herbal medicines. In India the fresh and dried roots were measured distinct medicinal products. Fresh ginger has been used for cold-induced disease, nausea, asthma, cough, colic, heart palpitation, swellings, dyspepsia, loss of appetite, and rheumatism. In short, it is used for the same purposes as in ancient China. In nineteenth century India, one English writer observed that a popular preparation for cough and asthma consisted of the juice of fresh ginger with a little juice of fresh garlic, mixed with honey. A glue of powdered dried ginger was applied to the temples to mitigate headache. To dispel nausea, fresh ginger was mixed with a little honey, topped off with a nip of burnt peacock feathers. One modern government health guide in India suggests 1-2 teaspoons of ginger juice with honey as a cough suppressant. Ginger is as popular a home remedy in India today, as it was 2,000 years ago [2, 3]. The rhizomes of ginger are used as spice in food and beverages and in traditional medicine as carminative, antipyrexia and treatment of waist pain rheumatism and bronchitis. It is used for the treatment of gastrointestinal disorders and piles[13].

CHEMISTRY

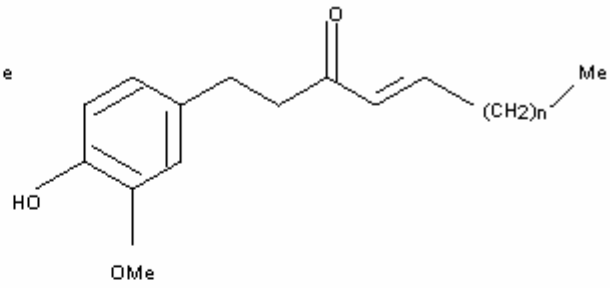
The pungency of ginger is due to gingerol, an oily liquid consisting of homologous phenols. It is formed in the plant from phenylalanine, malonate and hexonate [12]. In the fresh ginger rhizome, the gingerols were identified as the major active components and gingerol [5-hydroxy-1-(4-hydroxy-3-methoxy phenyl) decan-3-one] is the most abundant constituent in the gingerol series. The powdered rhizome contains 3-6% fatty oil, 9% protein, 60-70% carbohydrates, 3-8% crude fiber, about 8% ash, 9-12% water and 2-3% volatile oil. The volatile oil consists of mainly mono and sesquiterpenes; camphene, beta-phellandrene, curcumene, cineole, geranyl

acetate, terphineol, terpenes, borneol, geraniol, limonene, linalool, alpha-zingiberene (30-70%), beta-sesquiphellandrene (15-20%), beta-bisabolene (10-15%) and alpha-farmesene. In dried ginger powder, shogaol a dehydrated product of gingerol is a predominant pungent constituent up to biosynthesis [14, 15, 16]. It also contains acrid resinous substances (5-8%) [7]. Ginger contains up to three percent of a fragrant essential oil whose main constituents are sesquiterpenoids, with (-)-zingiberene as the main component. Smaller amounts of other sesquiterpenoids (β-sesquiphellandrene, bisabolene and farnesene) and a small monoterpenoid fraction (β-phelladrene, cineol, and citral) have also been identified[17].

Amadaldehyde is a novel compound has been isolated from the ginger extract[8]. Other pungent principles of the rhizomes are paradols, gingerdiols, gingerdiacetates, gingerdiones, 6-gingersulfonic acid, gingerenones etc. The rhizome also contains diterpenes and gingerglycolipids A, B and C[18].



Gingerol



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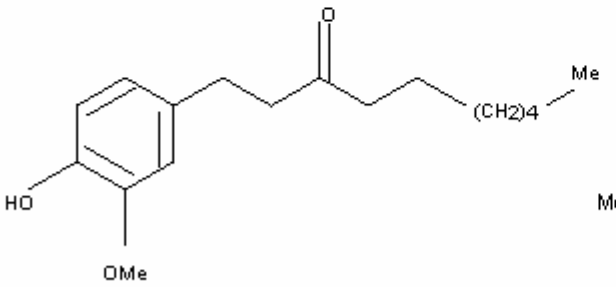
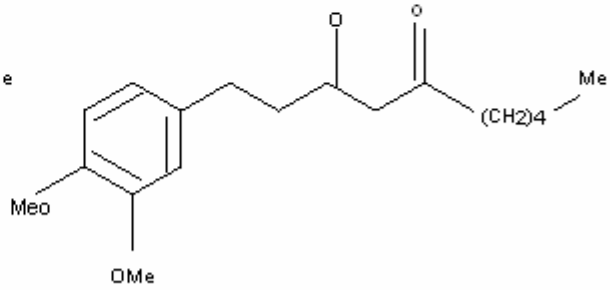


Paradol



Methyl [6] - isogingerol

A number of diaryleheptanones-gingerenones A, B, C and isogingerenone B have been investigated. Other minor compounds are methylegingediol, gingediacetates, methylegingediacetates and C_{20} – dialdehyde[12].

NUTRITIONAL IMPORTANCE

Fresh ginger contains 80.9% moisture, 2.3% protein, 0.9% fat, 1.2% minerals, 2.4% fibre and 12.3% Carbohydrates. The minerals present in ginger are iron, calcium and phosphorous. It also contains vitamins such as thiamine, riboflavin, niacin and vitamin C. The composition varies with the type, variety, agronomic conditions, curing methods, drying and storage conditions [19].

Ginger (Zingiber officinale Rosc.) has been used as a spice for over 2000 years. Its roots and the obtained extracts contain

polyphenol compounds ([6]-gingerol and its derivatives), which have a high antioxidant activity. Although the digestion stimulating effect of this spice became known a long time ago, the stimulating effect on peptic juices, such as gastric juice, bile, pancreatic and intestinal juices, was discovered later. Bile acids play a major role in the uptake of fats and each upset in the metabolism of fats would impede food digestion as a whole, because the fatty particles cover the other food elements and make them inaccessible for the action of the digestive enzymes. Lipase is the other key factor which plays a vital role in fat digestion. When ginger was included in animal diets, it was found that there was a considerable increase in the pancreatic and intestine lipase [20].

Table 1
Nutritional value of ginger [19].

Origin	Organoleptic Profile		Physicochemical Profile		
	Aroma	Color	Refractive Index	Density	Optical Rotation (°)
Malagasy 1	Less Characteristics	Yellow	1.4927	0.936	11.4
Malagasy 2	Floral Character	Pale Yellow	--	--	--
Commercial 1	Characteristics of Ginger	Pale Yellow	1.4884	0.8803	-33.9
Commercial 2	Characteristics of Ginger	Yellow Orange	1.4918	0.883	-39.3
Commercial 3	Characteristics of Ginger	Pale Yellow	1.4894	0.877	-39.3

Table 2
Appearance profile and physicochemical properties of ginger essential oils from different Origins [21, 22].

Constituents Present	% of amount
Moisture	80.9
Protein	2.3
Fat	0.9
Mineral	1.2
Fibre	2.5
Carbohydrate	12.3

STANDARDS & ADULTERATION

Ginger should contain minimum 10% of water soluble extractives, 4.5% Alcohol soluble extractives. It should offer maximum 6.0% of Total ash, 2.0% Acid insoluble ash and minimum 1.7% water soluble ash [23].

Adulteration can be detected by routine microscopical examination. Powdered ginger may have been prepared from 'wormy' drug, and so attention should be paid to the absence of insect fragments. Adulteration may also take the form of the addition of 'spent ginger' which has been exhausted in the preparations of essence. This may be detected by the official standards for alcohol-soluble extractive, water soluble extractives, total ash and water soluble ash [12].

PHARMACOLOGICAL CONSEQUENCES

Pharmacokinetic property:

The pharmacokinetic property of ginger has been estimated by many studies in both man and animals. Here is some information which reveals some pharmacokinetic properties of ginger. To investigate the pharmacokinetics of [6]-shogaol, a pungent ingredient of Zingiber officinale Roscoe., the pharmacokinetic parameters were determined by using (14) C-[6]-shogaol (labeled compound) and [6]-shogaol (non-labeled compound). The maximum plasma concentration [C (max)] and the area under the curve (AUC) of plasma radioactivity concentration increased in a dose-dependent manner for the labeled compound. When the labeled compound was orally administered at a dose of 10 mg/kg, 20.0 + or - 1.8% of the radioactivity administered was excreted into urine, 64.0 + or - 12.9% into feces, and 0.2 + or - 0.1% into breath. On the other hand, when the non-labeled compound [6]-shogaol was orally administered, the plasma concentration and biliary excretion of the unchanged form were extremely low. It would suggest that [6]-shogaol is mostly metabolized in the body and excreted as metabolites [24].

[6]-Gingerol was rapidly cleared by plasma with a terminal half life of 7.23 min and total body clearance of 16.8 ml/min/kg. Serum protein binding of [6]- gingerol was 92.4%. The renal excretion does not contribute at all to the disappearance of [6]-gingerol from plasma in rats [25]. The extent of [6]-gingerol bound to serum protein was more than 90% and was affected very slightly by the toxicity. This expects indicates that 6- gingerol is eliminated partly by the liver [26]. Nakazwa and Oshawa found that both the gut flora and the enzymes in the liver plays an important role in the metabolism of [6]-gingerol [27].

Effect on cardiovascular system:

Ginger is having stimulatory action on heart muscle results, stimulated blood circulation throughout the body [28]. The increased blood circulation is believed to stimulate cellular metabolic activity which helps to relief the cramps and tension [29]. It also helps to reduce blood pressure and cardiac workload [30]. Ginger is also known to possess antioxidant properties [31, 32, 33]. U. Bhandari et.al. has provided a clear idea about the anti-oxidant defense role against isoproterenol induced oxidative myocardial injury in rats [34].

Effect on migraine:

500-600mg of ginger powder administration at the onset of migraine for 3-4 days at interval of 4 hours, reported to provide relief from migraine attack [35].

Effect on gastrointestinal tract:

Some active components of ginger are reported to stimulate digestion, absorption, relieve constipation and flatulence by

increasing muscular activity in the digestive tract [36, 37]. It is also significantly reduced the nausea and vomiting [38, 39, 40].

Anti-inflammatory activity:

In Ayurveda, ginger is reported to be useful in treating inflammation and rheumatism. One of the mechanisms by which ginger exerts its ameliorative effects could be related to inhibition of prostaglandin and leukotriene biosynthesis [41].

Anti- microbial effect:

Some constituents of ginger inhibit the growth of some colon bacteria like Escherichia coli, Proteus species, Staphylococci, Streptococci and Salmonella. It has been found that out of 29 plant extracts, ginger extract had the broadest range of anti-fungal activity measured either by the fungi inhibited or as the average diameter of the zones of inhibition [42, 43, 44].

Effect on colon cancer:

The extract of ginger confined HCT 116 and HT 29 cells at G0/G1 and G2/M phases with consequent decreased in S-phase. This study suggests that ginger extract may bring to bear its antitumor effects on colon cancer cells by suppressing its growth, striking the G0/G1-phase, reducing DNA synthesis and inducing apoptosis [45].

Effect on lipid & glucose concentration in blood:

`A methanolic extract of dried rhizomes of ginger produced a significant reduction in fructose-induced elevation of lipid levels, be achieved with a dietary supplement of either ginger or its extract containing aldose reductase inhibitors [46].

Effect on blood clotting:

Thomson et. al., 2002 examined that ginger administered orally caused significant changes in the serum PGE2 significantly. High doses of ginger (500 mg/kg) were significantly effective in lowering serum PGE2 when given either orally or IP. However, TXB2 levels were significantly lower in rats given 500 mg/kg ginger orally, but not I.P. These results suggest that ginger could be used as an anti-thrombotic and anti-inflammatory agent [47].

Anti-oxidant action:

The antioxidant properties of [6]-gingerol which is very effective agent for anticipation of ultra violet B (UVB)-induced reactive oxygen species production and COX-2 idiom, and a promising therapeutic agent against UVB-induced skin disorders, has been studied both in-vitro & in-vivo. It also has a protective role to toxicity and lethality against some agent like carbon-tetra chloride, cisplatin etc [48, 49].

Analgesic effect:

Many studies have been evaluated for the analgesic effect of ginger and its constituents. It has a strong analgesic action which is many cases act by cyclo–oxygenase-1 (COX-1) inhibition. Gingerol and their derivatives, especially [8]-paradol, have been reported to be more potent anti-platelet and cyclo-oxygenase-1 (COX-1) inhibitors than aspirin [50].

Effect on blood pressure:

A number of pieces of evidence, mainly from rat studies, have suggested that ginger exerts many direct and indirect effects on blood pressure and heart rate [51]. It has been found that the crude extract of ginger induced a dose-dependent (0.3–3 mg/kg) fall in the arterial blood pressure of anesthetized rats. In Guinea pig paired atria, the crude extract exhibited a cardio depressant activity on the rate and force of spontaneous contractions [52].

Effect on Nephrotoxicity:

The nephroprotective effect of aqueous ethanol extract of *Zingiber officinale* (200 and 400 mg/kg) was evaluated against doxorubicin-induced (15 mg/kg) acute renal damage in rat. The nephroprotection of ginger is mediated by preventing the Doxorubicin-induced decline of renal antioxidant status, and also by increasing the activity by of Glutathione -S- transferse (GST) [53].

Anti-proliferative activity:

It has been found that the apoptosis of A549 cells by Ginger aqueous extract is mediated by up regulation of tumor suppressor gene p53 and alteration of the normal Bax/Bcl-2 ratio followed by down regulation of cellular pro-caspase 3. The morphological change of cells upon Ginger aqueous extract treatment has also been demonstrated. Both the structural and functional properties of tubulin and microtubule were lost, as confirmed by both ex vivo and in-vitro experiments [54].

Effect on Osteoarthritis:

A highly purified and standardized ginger extract had a statistically significant effect on reducing symptoms of Osteoarthritis of the knee. This effect was moderate. There was a good safety profile, with mostly mild GI adverse events in the ginger extract group [55].

Neuro protective activity:

The daily dose (4 mg kg [-1] b.w) i.p. injection of pure monosodium glutamate (MSG) for 30 days and subsequent withdrawal caused a significant decrease in epinephrine (E), norepinephrine (NE), dopamine (DA) and serotonin (5-HT) content all tested areas (cerebellum, brainstem, striatum, cerebral cortex, hypothalamus and hippocampus) at most of the time intervals studied. The neuroprotective effect is partly attributable to an antagonistic action of ginger root extracts on monosodium glutamate effect, so the monoamines content was increased. From these results, we can say that the ginger extract has a neuroprotective role against monosodium glutamate toxicity effect [56].

Hepatoprotective activity:

Ginger is also having significant Hepatoprotective activity. The bromobenzene (BB)-induced hepatotoxicity comes from its reactive metabolites. The efficacy of different doses of ginger (Zingiber officinale Rose.) extract in alleviating hepatotoxicity was investigated [57].

CONCLUSION

Phytoconstituents are rich of different pharmacological activity. Spices and condiments are common part of human diet obtained from plant kingdom. Because of its flavor, color, food preservation and enhance palatability, they have been extensively used in view of their health. Ginger has been used extensively in folklore medicine to treat common ailments. Ginger has a number of chemical constituents like [6]-Gingerol, [6] - Shagol, Methyl [6] – isogingerol, Paradol which are responsible to provide different pharmacological actions. Now scientific evidences in support of some of these beneficial properties are budding which would shore up their conservation. The ginger bears an enormous number of pharmacological activities such as Cardio protective activity, Anti-inflammatory activity, Anti-microbial activity, Antioxidant property, Anti-proliferative activity, Neuro-protective activity and Hepatoprotective activities which have been proved. Among those, Neuro-protective activity as well as effect of ginger in colon cancer has facilitated the extent of the further research with a positive outcome. Since there is no good

medicine till now for the treatment of these diseases, so researches may do a lot of research on ginger for finding out less toxic and more potent drugs for the better treatment of those diseases. We hope this review will facilitate all about the past scientific research and the necessary information about the enormous pharmacological activities of ginger to pharmaceutical's researchers which will insist them for advanced research to protect human beings from several types of diseases and by this way ginger may serves as a natural gold for the promotion of mankind.

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Dried rhizome of Zingiber officinale

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