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Review Article

A brief study on *zingiber officinale*-A review

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ABSTRACT

Ginger is one of the important medicinal plants which naturally occur in various countries. Ginger; Zingiber officinale belongs to family Zingiberaceae. Young ginger rhizomes are juicy and fleshy with a very mild taste. They are often pickled in vinegar or sherry as a snack or just cooked as an ingredient in many dishes. They can also be steeped in boiling water to make ginger tea, to which honey is often added; sliced orange or lemon fruit may also be added. Ginger can also be made into candy, or ginger wine which has been made commercially since 1740. Mature ginger rhizomes are fibrous and nearly dry. The juice from old ginger roots is extremely potent and is often used as a spice in Indian recipes, and is a quintessential ingredient of Chinese, Korean, Japanese and many South Asian cuisines for flavoring dishes such as seafood or goat meat and vegetarian cuisine. Ginger acts as a useful food preservative. Fresh ginger can be substituted for ground ginger at a ratio of 6 to 1, although the flavors of fresh and dried ginger are somewhat different. Powdered dry ginger root is typically used as a flavoring for recipes such as gingerbread, cookies, crackers, cakes, and ginger beer. Ginger produces a hot, fragrant kitchen spice.

Keywords; Ginger, Zingiber officinale,Medicinal plant, ginger rhizomes

INTRODUCTION

Ginger(Zingiber officinale)or ginger root is the rhizome of the plant Zingiber officinale, consumed as a delicacy, medicine, or spice. It lends its name to its genus and family (Zingiberaceae). Other notable members of this plant family are turmeric, cardamom, and galangal. The distantly related dicots in the Asarum genus have the common name wild ginger because of their similar taste[1]. Ginger is indigenous to southern China, from whence it is spread to the Spice Islands and other parts of Asia, and subsequently to West Africa and to the Caribbean. [2]Ginger (Zingiber officinale Rosc.) is a creeping perennial on a thick tuberous rhizome, which spreads underground. In the first year, a green, erect reed like stem about 60 cm high grows from this rhizome. The plant has narrow; lanceolate to linear-lanceolate, 15-30 cm long leaves which die of each year. The odor and taste are characteristic, aromatic and pungent. Ginger, valued as a spice has been used through ages in almost all systems of medicine against many maladies. The plant is indigenous to Southeast Asia and is cultivated in a number of countries including India. The smell and taste of the drug are typical and aromatic. The medicinal part of the herb is dried roots. It is now recognized as a drug of choice for nausea and vomiting. It has also been found useful in pregnancy related morning sickness. In rheumatoid arthritis and osteoarthritis it is used as a natural pain reliever and an anti- inflammatory agent. It is also useful in curing ulcer and preventing heart attack and stroke. A number of active constituents and medicinal properties have been reported during the last decade. The present article provides a comprehensive account of important medicinal properties of this versatile herb. Ginger (Zingiberofficinale)is known as Sunthi in Ayurveda and description of the plant appears in the old text like Charaka, Sushruta, Vagbhatta and Chakra-dutta [3]. The use of drug is mentioned in form of Trikatu, a famous Ayurvedic remedy for the treatment of digestive disorders. In Ashtanga Hridaya, the plant has been used in Rasna Saptak Quath (a decoction based on seven medicinal herbs), and a traditional remedy for arthritis [4]. Pharmacologically, the drug in Ayurveda has been described as appetizer. It is also indicated in ointment form for local application in pains.

Table 1: Classification

Kingdom:	**Plantae**
Clade:	Angiosperms
Clade:	Monocots
Clade:	Commelinids
Order:	Zingiberales
Family:	Zingiberaceae
Genus:	*Zingiber*
Species:	*Z. officinale*

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Figure 1: Ginger Plant (Copied from google.co.in)

Figure 2: Ginger Rhizome (Copied from google.co.in)

CHEMICAL AND NUTRITIONAL COMPONENT

Various types of chemicals have been isolated from Zingiber officinale and extensively studied for their chemical structure by using advanced analytical techniques such as gas chromatography-mass spectroscopy (GC-MS) and high performance liquid chromatography (HPLC). The fresh and dried *Z. officinale* extracts have been reported to possess gingerols, 1,7-bis-(40-Hydroxy-30-methoxyphenyl)-3,5-heptadione, adenine, 1- Dehydro-3-dihydro-gingerdione, Acetoxy-6-dihydroparadol, Isogingerol, 5-Methoxy-gingerol, Methyl diacetoxy-gingerdiol, Methyl diacetoxy-gingerdiol, 1-Dehydro-gingerdione, Acetoxy-gingerol, Shogaol, Paradol, 1-(40 Hydroxy-30-methoxyphenyl)- 7-octen-3-one, 1-(40- Hydroxy-30-methoxyphenyl)-7-decen-3-one, 1-(40-Hydroxy-30- methoxyphenyl)-7-dodecen-3-one, beta-sitosterol palmitate, isovanillin, glycol monopalmitate, hexacosanoic acid 2,3-dihydroxypropyl ester, maleimide-5- oxime, p-hydroxybenzaldehyde and 1-(omega-ferulyloxyceratyl) glycerol's [5-7]. 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 Ginger is used widely in a variety of food because of its nutritional composition and flavouring compounds. Fresh ginger is reported to contains protein, fat, minerals, fibers, carbohydrates, lipids (including glycerides, phosphatidic acid, lecithins, and fatty acids), protease, iron, calcium, magnesium, potassium, and phosphorous. It also contains vitamins such as thiamine, riboflavin, niacin and vitamin C [8,9].

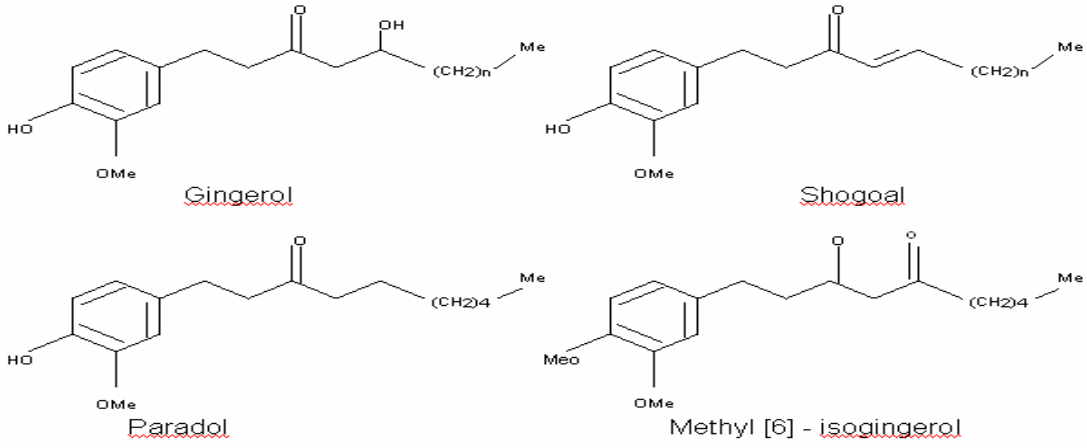

Figure 3:

PHARMACOLOGICAL EFFECT

Anti-cancer effects:

Anticancer effects of ginger are thought to be attributed to various constituents including vallinoids, viz. (6)-gingerol and (6)-paradol, shogaols, zingerone, and Galanals A and B.[10-12]Galanals A and B have been found to be potent apoptosis inducers of human T lymphoma Jurkat cells.[10]

Anticoagulant Effects

Ginger (Zingiber off*icinale)* has been shown to inhibit platelet aggregation7,8,13 and to decrease platelet thromboxane production *in vitro* [13-15]. (8)- Gingerol, (8)-shogaol, (8)-paradol, and gingerol analogues (1 and 5) exhibited antiplatelet activities. However, its effects *in-vivo* has not been well studied. Although Verma et al. found ginger to decrease platelet aggregation [16], Lumb found no effect of ginger on platelet count, bleeding time, or platelet aggregation[17]. Similarly, Bordia et al. found ginger to have no effect on platelet aggregation, fibrinolytic activity, or fibrinogen levels [18]. Janssen et al. showed no effect of oral ginger on platelet thromboxane B2 production [19], while Srivastava found thromboxane levels to be decreased by ginger ingestion in a small study [20].

Antiemetic Effects

The mechanism of action of ginger's effect on nausea and vomiting remains uncertain. However, there are several proposed mechanisms. The components in ginger that are responsible for the antiemetic effect are thought to be the gingerols, shogaols, and galanolactone, a diterpenoid of ginger [21-23]. Recent animal models and *invitro* studies have demonstrated that ginger extract possesses antiserotoninergic and 5- HT3 receptor antagonism effects, which play an important role in the etiology of postoperative nausea and vomiting [24,25]. In a randomized, placebo-controlled, crossover trial of 16 healthy volunteers, ginger (1g orally) had no effect on gastric emptying [26]. It appears unlikely that ginger's anti-emetic or antinausea effects are mediated through increased gastro duodenal motility or through increased gastric emptying. Using gastro duodenal manometry, Micklefield et al. demonstrated that oral ginger increases antral motility during phase III of the migrating motor complex (MMC) and increases motor response to a test meal in the corpus [27]. However, ginger had no significant effect in the antrum or corpus during other phases, except for a significant decrease in the amplitude of antral contractions during phase II of the MMC. Additionally, there was no effect of ginger on duodenal contractions or on the "motility index."

Anti-Inflammatory Effects

Ginger (Zingiber officinale)has a long history of use as an anti-inflammatory and many of its constituents have been identified as having anti-inflammatory properties [28]. Ginger has been found to inhibit prostaglandin biosynthesis [29] and interfere with the inflammatory cascade and the vanilloidnociceptor [30]. Ginger has been shown to share pharmacological properties with non-steroidal anti-inflammatory drugs (NSAIDs) because it suppresses prostaglandin synthesis through the inhibition of cyclooxygenase-1 and cyclooxygenase-2. However, ginger can be distinguished from NSAIDs based on its ability to suppress leukotriene biosynthesis by inhibiting 5-lipoxygenase. This discovery preceded the observation that dual inhibitors of cyclooxygenase and 5-lipoxygenase may have a better therapeutic profile and have fewer side effects than NSAIDs. It was also discovered that a ginger extract (EV.EXT.77) derived from *Zingiber officinale* (and *Alpinagalanga*) inhibits the induction of several genes involved in the inflammatory response, including genes encoding cytokines, chemokines, and the inducible enzyme cyclooxygenase-2. This discovery provided the first evidence that ginger modulates biochemical pathways activated in chronic inflammation. Identification of the molecular targets of individual ginger constituents provides an opportunity to optimize and standardize ginger products with respect to their effects on specific biomarkers of inflammation.

Antinociceptive Effects

(6)-shogaol has produced anti-nociception and inhibited the release of substance P in rats, seemingly via the same receptor to which capsaicin binds. However, it was observed to be 100 times less potent and to elicit half the maximal effect of capsaicin. [31]

Antioxidant Effects

In vitro, ginger (Zingiber officinale)has been shown to exhibit antioxidant effects. [32] (6)-gingerol appears to be the antioxidant constituent present in ginger, as it was shown to protect HL-60 cells from oxidative stress [33]. Ginger oil has dominative protective effects on DNA damage induced by H2O2. Ginger oil might act as a scavenger of oxygen radical and might be used as an antioxidant.[31]

Gastrointestinal Effects

The active components of ginger are reported to stimulate digestion, absorption, relieve constipation and flatulence by increasing muscular activity in the digestive tract. The effectiveness of ginger (940 mg) in motion sickness was compared to that of dimenhydrinate (100 mg) in 18 male and 18 female college students, who were

selfrated as having extreme or very high susceptibility to motion sickness. The study concluded that ginger was superior to dimenhydrinate in preventing motion sickness. Ginger administration (1g) prior to elective gynaecologic laparoscopy was also found to be effective in preventing postoperative nausea and vomiting. The effect of ginger was similar to that observed with 100 mg metoclopramide. In addition, a double blind study in 27 pregnant women suffering from morning sickness demonstrated that oral administration of 250 mg of powdered ginger 4 times daily over 4 days significantly reduced symptoms of nausea and vomiting. There is evidence that ginger rhizome (root) increases stomach acid production. If so, it may interfere with antacids, sucralfate (Carafate), H2 antagonists, or proton pump inhibitors. In contrast, other *in vitro* and animal studies have revealed gastro protective properties [34, 35].in addition, (6) shogaol, generally more potent than (6)-gingerol, has inhibited intestinal motility in intravenous preparations and facilitated gastrointestinal motility in oral preparations. Ginger extract has also been reported to inhibit the growth of *Helicobacter pylori in vitro*.5 However, Desai et al. observed a significant increase in the exfoliation of gastric surface epithelial cells following the consumption of 6g or more of ginger (after examining gastric aspirates in 10 healthy volunteers).[36]

Antitussive Effects

(6)-shogaol, generally more potent than (6)- gingerol, has exhibited antitussive effects.[37]

Immunomodulatory Effects

In vitro evidence indicates that ginger has Immuno-modulatory effects and is an effective antimicrobial and antiviral agent [38].

Lipid Effects

Buccal ingestion of ginger extract has been shown to have hypocholesterolemic, hypolipidemic, and antiatherosclerotic effects in cholesterol-fed rabbits and in rats. Inhibition of LDL oxidation and attenuated development of atherosclerosis has also been observed in Apo lipoprotein E-deficient mice [39].

Weight Loss Effects

Spiced foods or herbal drinks, such as those that contain ginger, have the potential to produce significant effects on metabolic targets, such as satiety, thermogenesis, and fat oxidation [40]. A significant clinical outcome sometime may appear straight forwardly but also depends too strongly on full compliance of subjects. Thermogenic ingredients, such as ginger, may be considered as functional agents that could help restore a "positive energy balance" and prevent obesity.

Antiarthritic Effect

A study investigated the antiarthritic effects of ginger and its bioactive constituents. A well characterized crude ginger extract was compared with a fraction containing [6]- gingerol and their derivatives to inhibit joint swelling in an animal model of rheumatoid arthritis, streptococcal cell wall-induced arthritis. Both extracts demonstrated anti-inflammatory activity. The crude dichloromethane extract, containing essential oils and more polar compounds, was more efficacious, when normalized to [6]-gingerol content, in preventing, both joint inflammation and destruction. Non-gingerol components enhance the antiarthritic effects of the more widely studied [6]-gingerol [36].

Antimicrobial Effect

Ginger has strong antibacterial and to some extent antifungal properties. In vitro studies have shown that active constituents of ginger inhibit multiplication of colon bacteria. These bacteria ferment undigested carbohydrates causing flatulence. This can be counteracted with ginger. It inhibits the growth of Escherichia coli, Proteus sp, Staphylococci, Streptococci and Salmonella. The ginger extract has antimicrobial action at levels equivalent to 2000 mg/ ml of the spice. Ginger inhibits aspergillus, a fungus known for production of aflatoxin, a carcinogen. Fresh ginger juice showed inhibitory action against A.niger, S.cerevisiae, Mycoderma SPP. And L. acidophilus at 4, 10, 12 and 14% respectively at ambient temperatures. Ingenol and [6]–shogaol, isolated from ginger rhizome, demonstrated antiviral activity.*[18]*32 [10]-gingerol has been reported as active inhibitor of *M. avium*and *M. tuberculosis invitro.* Gingerol and related compounds have been investigated for antimicrobial activities. [6]- gingerol and [12]-gingerol, isolated from ginger rhizome, demonstrated antibacterial activity against periodontal bacteria [38].

Radio Protective Effect

In vitro, pre-treatment with [6]-gingerol reduced UVB-induced intracellular reactive oxygen species levels, activation of caspase- 3, -8, -9, and Fas expression. It also reduced UVB-induced expression and transactivation of COX-2. Translocation of NF-κB from cytosol to nucleus in HaCaT cells was inhibited by [6]- gingerol via suppression of IκBα phosphorylation (ser-32). Examination by EMSAs and immunohistochemistry showed that topical application of [6]-gingerol (30 μM) prior to UVB irradiation (5 kJ/m2) of hairless mice, also inhibited the induction of COX-2 mRNA and protein, as well as NF-κB translocation.[41]

Antigenotoxic Effect

Norethandrolone and oxandrolone were investigated for their genotoxic effect on human lymphocyte chromosomes using chromosomal aberrations and sister chromatid exchanges as parameters and subsequently Genistein and [6]-gingerol were used as antigenotoxic agents to ameliorate the genotoxicity induced by the steroids. Norethandrolone and oxandrolone were studied at 5, 10, 20, 30 and 40 µM, respectively and were found to be significantly genotoxic at 30 and 40 µM. Genistein and [6]- gingerol proved to be equally effective in reducing genotoxic damage at appropriate doses.[42]

Mutagenicity Effect

A study was performed to discover the active part in mutagenesis of [6]-gingerol and [6]- shogaol. [6]-Shogoal was much less mutagenic (1 × 103 revertants/108 viable cells/700 µM) than [6]-gingerol (1 × 107 of the same units). Mutation frequencies of their related compounds were 4 × 101 for zingerone, 1 × 107 for 3-hydroxymyristic acid and 3 × 102 for 12-hydroxystearic acid [43, 44].

Cardiovascular Effects

In vitro research indicates that gingerols and the related shogaols exhibit cardio depressant activity at low doses and cardiotonic properties at higher doses [33].Both (6)-shogaol and (6)-gingerol, and the ginger diones, are reportedly potent enzymatic inhibitors of prostaglandin, thromboxane, and leukotriene biosynthesis.

Effect on blood pressure

Several pieces of evidence, mainly from rat studies, have suggested that ginger exerts many direct and indirect effects on blood pressure and heart rate [45]. More recently, Ghayur and Gilani [46] reported 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. In rabbit thoracic aorta preparation, the crude extract relaxed the phenylephrine induced vascular contraction at a dose 10 times higher than that required against K-induced contraction. Ca2+ channel- blocking activity was confirmed when the crude extract shifted the Ca2+ dose–response curves to the right, similar to the effect of verapamil. It also inhibited the phenylephrine control peaks in normal Ca2+-plus and Ca2+-free solutions, indicating that it acts at both the membrane-bound and the intracellular Ca2+ channels. When tested in endothelium contraction at a dose 14 times less than that required for relaxing the PE-induced contraction. The vasodilator effect of the crude extract was endothelium-independent because it was not blocked by either L-NAME (a non-selective inhibitor of nitric oxide synthase used experimentally to induce hypertension) or atropine and also was reproduced in the endothelium-denuded preparations in the same dose range. These data indicate that the blood pressure lowering effect of ginger is mediated through blockade of voltage dependent calcium channels. In another paper, the same group concluded that the blood pressure lowering action of aqueous ginger extract was through a dual inhibitory effect mediated via stimulation of both muscarinic receptors and blockade of Ca2+ channels. Interestingly, they also noted that the different constituents of ginger might have opposing actions on the reactivity of blood vessels.

Effect on blood clotting

The effect of an aqueous extract of ginger on platelet thromboxane-B2 (TBX2) and prostaglandin-E2 (PGE2) production was examined after giving rats a raw aqueous extract of ginger daily for a period of 4 weeks, either orally or intraperitoneally (IP). A low dose of ginger (50 mg/kg) administered either orally or IP did not produce any significant reduction in the serum TBX2 levels. However, ginger administered orally caused significant changes inthe serum PGE2 at this dose. 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 IP. These results suggest that ginger could be used as an anti-thrombotic and anti-inflammatory agent [47].

Requirements for organic spices and products

To be sold as "organic", a product must be certified by an accredited certification body. There are slight differences in standards between countries. IFOAM, the International Federation ofOrganic Agriculture Movement, has established organic production, processing and trading standards, and tried to harmonize certification systems worldwide.[48] National and regional governments are also trying to work under a compatible minimum set of standards. The European Union (EU) has established basic regulations for organic products in 1991 (Council Regulation 2092/91), which apply to all products marketed as "organic", "biologic", "ecologic", "biodynamic", or similar terms. Imports may be accepted through procedures conforming to the exporting country's regulations, or by review of the certification documents, which accompany each shipment. The EU regulation sets a minimum standard, and member states or private certification bodies may certify to standards that meet or exceed EU regulation 2092/91. In the United States, the Organic Food Production Act (OFPA) was

passed into law in 1990, and since October 2002 has made organic production and processing uniformly regulated across all of the United States. The Agricultural Marketing Service (AMS) branch of the U.S. Department of Agriculture is administering the National Organic Program [49].

To be labeled "organic", a product must be grown following organic agricultural practices. Postharvest handling and processing must be done in certified facilities, whether on the farm or in food packing or processing facilities. Only mechanical, thermal or biological methods can be used in organic processing. The use of genetically modified organisms (GMO) (plants, animals or bacteria) and products of GMO are prohibited in organic production. Likewise, ionizing radiation and sewage sludge are prohibited from organic agricultural practices. Labels of organic products must identify the certification body. In general, the Japanese organic standards (Japan Agricultural Standards, JAS) follow the U.S. NOP standards. However, JAS does not allow organic labeling on products that contain less than 95% organic ingredients (the EU and NOP allow labeling "made with organic ingredients" for products that contain between 70% and 95% organic ingredients). In addition to standards pertaining to the production of organic products, IFOAM basic standards include environmental and social justice requirements. For example, IFOAM basic standards[50] include "2.1.1: operators shall take measures to maintain and improve landscape and enhance biodiversity quality"; "8.1: operators shall have a policy on social justice"; "8.5: operators shall provide their employees and contractors equal opportunity and treatment, and shall not act in a discriminatory way"; and "8.6: children employed by organic operators shall be provided with educational opportunities". IFOAM, EU and U.S. organic standards include lists that allow the use of specific synthetic, non-agricultural or non-organic agricultural substances. If a substance does not appear on those lists, it must not be used on an organic product, in the process or as an ingredient. Those lists differ slightly, and operators producing for export markets to Europe, United States and Japan should consult and compare those lists carefully to assure compliance in each country [50, 51]. To comply with organic standards and practices, the operator must document all farming and post-harvest activities. The following records must be maintained: farm field map, field history, activity register, input records including purchases, output records including sales, harvest records, storage records, pest control records, movement records, equipment cleaning and labeling. All such documentation must meet specific standards that are enumerated in directives issued by the certification agencies. In the processing plant, the operator must present an "organic handling plan" that will show how contamination from prohibited materials and commingling with non-organic products will be prevented. This includes a detailed description of the process, receiving and storage ofingredients and finished products, cleaning and sanitation of the processing equipment, facilities pest management, and a documentary "paper trail" that must permanently record all of the above.For the spice and oleoresins production, ionizing radiation and the use of volatile synthetic solvents are prohibited for use in the processing of organic products.

CONCLUSION

Gingiber officinale (rhizome) is used as a medicine and also used in various types of Ayurvedic formulations.It shows various types of pharmacological activities such as anticancer, antiemetic, anticoagulant, antitussive, cardiovascular etc.It is easily available and more beneficial for human health. Commonly it is used in tea for the treatment of throat infection in villages and cities.It is used daily in spices and its nutritional value also the important properties of this plant.

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REFERENCES

1. "Zingiber officinale information from NPGS/GRIN". ars-grin.gov. Retrieved 3 March 2008.
2. "Spices: Exotic Flavors & Medicines: Ginger". Retrieved 2 May 2014.
3. Hridayam of Srimadvagbhata edited with `Nirmala' Hindi commentary along with special deliberation etc. by Dr. Brahmanand Tripathi Pratishtan, Delhi, 1999 (Sutrasthan 6/163-164).
4. Sushruta Samhita of Sushruta edited and translated by Kaviraja P V Sharma, Chaukhamaba Visvabharti, Varanasi, 1999 (Sutrasthan 37/ 3,38/22-23)
5. Jolad SD, Lantz RC, Solyom AM, Chen GJ, Bates RB, Timmermann BN, Fresh organically grown ginger (*Zingiber officinale*): composition and effects on LPSinduce PGE2 production, Phytochemistry, 2004, 65, 1937-1954.
6. Bao L, Deng A, Li Z, Du G, Qin H, Chemical constituents of rhizomes of *Zingiber officinale*, ZhongguoZhong Yao ZaZhi, 2010, 35(5), 598-601.

7. Singh G, Kapoor IPS, Singh P, De-Heluani CS, De-Lampasona MP, Catalan CAN, Chemistry, antioxidant and antimicrobial investigations on essential oil and oleoresins of *Zingiber officinale*, Food and Chemical Toxicology, 2008, 46, 3295-3302.
8. ICMR Bulletin, Ginger: Its role in xenobiotic metabolism, 2003, 33(6), 57-63.
9. Ibrahim TA, Dada IBO, Adejare RA, Comparative phytochemical properties of crude ethanolic extracts and physicochemical characteristics of essential oils of *Myristicalfragrans*(nutmeg) seeds and *Zingiber officinale* (ginger) roots. EJEAFChe, 9 (6), 2010, 1110-1116.
10. Miyoshi N, Nakamura Y, Ueda Y, Abe M, Ozawa Y, Uchida K and Osawa T. Dietary ginger constituents, galanals A and B, are potent apoptosis inducers in Human T lymphoma Jurkat cells. Cancer Lett. 9-25-2003;199(2):113-119.
11. Aggarwal BB and Shishodia S. Molecular targets of dietary agents for prevention and therapy of cancer. BiochemPharmacol. 5-14- 2006;71(10):1397-1421.
12. Shukla, Y and Singh M. Cancer preventive properties of ginger: a brief review. Food ChemToxicol. 2007;45(5):683-690.
13. Desai HG, Kalro RH and Choksi AP. Effect of ginger & garlic on DNA content of gastric aspirate. Indian J Med Res. 1990;92:139-141.
14. Ma J, Jin X, Yang L and Liu ZL. Diarylheptanoids from the rhizomes of Zingiber officinale. Phytochemistry. 2004;65(8): 1137-1143.
15. Wang WH and Wang ZM. Studies of commonly used traditional medicineginger. ZhongguoZhong.YaoZaZhi. 2005;30(20):1569-1573.
16. Surh Y, Park K and Chun K. Antitumor- promoting activities of selected pungent phenolic substances present in ginger. Journal of Environmental Pathology, Toxicology and Oncology. 1999;18(2):131-139.
17. Guh JH, KO FN, Jong TT and Teng CM. Antiplatelet effect of gingerol isolated from Zingiber officinale. J Pharm. Pharmacol. 1995;47(4):329- 332.
18. Srivastava KC. Isolation and effects of some ginger components on platelet aggregation and eicosanoid biosynthesis. Prostaglandins Leukot Med. 1986;25(2-3):187-198.
19. Nurtjahja-Tjendraputra E, Ammit AJ, Roufogalis BD, Tran VH and Duke CC. Effective anti-platelet and COX-1 enzyme inhibitors from pungent constituents of ginger. Thromb Res. 2003;111(4-5):259-265.
20. Verma SK, Singh J, Khamesra R and Bordia A. Effect of ginger on platelet aggregation in man. Indian J Med Res. 1993;98:240-242
21. Lumb AB. Effect of dried ginger on human platelet function. Thromb Haemost.1994; 71(1):110-111.
22. Bordia A, Verma SK and Srivastava KC. Effect of ginger (Zingiber officinale Rosc.) and fenugreek (Trigonellafoenumgraecum L.) on blood lipids, blood sugar and platelet aggregation in patients with coronary artery disease. Prostaglandins LeukotEssent Fatty Acids.1997;56(5):379-384.
23. Janssen PL, Meyboom S, van Staveren WA, De Vegt F and Katan MB. Consumption of ginger (Zingiber officinale roscoe) does not affect ex vivo platelet thromboxane production in humans. Eur J Clin Nutr.1996;50(11):772-774.
24. Srivastava KC. Effect of onion and ginger consumption on platelet thromboxane production in humans. Prostaglandins LeukotEssent Fatty Acids. 1989;35(3):183-185.
25. Bhattarai S, Tran VH and Duke CC. The stability of gingerol and shogaol in aqueous solutions. J Pharm Sci. 2001;90(10):1658-1664.
26. Yamahara J, Rong HQ and Iwamoto M. Active components of ginger exhibiting anti-serotonergic action. Phytotherapy Res.1989;3(2):70-71.
27. Huang Q, Iwamoto M and Aoki S. Anti-5-hydroxytryptamine3, effect of galanolactone, diterpenoid isolated from ginger. Chem Pharm Bull. 1991;39(2):397-399.
28. Lumb AB. Mechanism of antiemetic effect of ginger. Anaesthesia. 1993;48(12):1118.
29. Russell D and Kenny GN. 5-HT3 antagonists in postoperative nauseaand vomiting. Br J Anaesth. 1992;69(7 Suppl 1):63S-68S.
30. Phillips S, Hutchinson S and Ruggier R. Zingiber officinale does not affect gastric emptying rate. A randomised, placebo-controlled, crossover trial. Anaesthesia. 1993; 48(5):393-395.
31. Micklefield GH, Redeker Y, Meister V, Jung O, Greving I and May B. Effects of ginger on gastroduodenal motility. Int J ClinPharmacol Ther. 1999;37(7):341-346.
32. Yamahara J, Miki K, Chisaka T, Sawada T, Fujimura H, Tomimatsu T, Nakano K, and Nohara T. Cholagogic effect of ginger and its active constituents. J Ethnopharmacol. 1985;13(2):217-225.
33. Srivastava KC and Mustafa T. Ginger (Zingiber officinale) and rheumatic disorders. Med Hypotheses. 1989; 29(1):25-28.

34. Chrubasik S, Pittler MH and Roufogalis BD. Zingiberisrhizoma: a comprehensive review on the ginger effect and efficacy profiles. Phytomedicine. 2005;12(9):684-701.
35. Onogi T, Minami M, Kuraishi Y and Satoh M. Capsaicin-like effect of (6)- shogaol on substance P-containing primary afferents of rats: a possible mechanism of its analgesic action. Neuropharmacology.1992;31(11):1165-1169.
36. Fuhrman B, Rosenblat M, Hayek T, Coleman R and Aviram M. Ginger extract consumption reduces plasma cholesterol, inhibits LDL oxidation and attenuates development of atherosclerosis in atherosclerotic, apolipoprotein E-deficient mice. J Nutr. 2000; 130(5):1124-1131.
37. Wang CC, Chen LG, Lee LT and Yang LL. Effects of 6-gingerol, an antioxidant from ginger, on inducing apoptosis in human leukemic HL-60 cells. In Vivo. 2003; 17(6):641-645.
38. Funk JL, Frye JB, Oyarzo JN, Timmermann BN. Comparative Effects of Two Gingerol-Containing Zingiber officinale Extracts on Experimental Rheumatoid Arthritis. J Nat Prod. 2009; 72:403-407.
39. Suekawa M, Ishige A, Yuasa K, Sudo K, Aburada M and Hosoya E. Pharmacological studies on ginger. I. Pharmacological actions of pungent constitutents, (6)-gingerol and (6)- shogaol. J Pharmacobiodyn. 1984;7(11):836-848.
40. Miri P, Bae J and Lee DS. Antibacterial activity of [10]-gingerol and [12]-gingerol isolated from ginger rhizome against periodontal bacteria. Phytothery Res. 2008; 22:1446-1449.
41. Westerterp-Plantenga M, Diepvens K, Joosen AM, Berube-Parent S and Tremblay A. Metabolic effects of spices, teas, and caffeine. PhysiolBehav. 8-30-2006;89(1):85-91.
42. Kim J-K, Kim Y, Na, K-M, Surh Y-J and Kim T-Y. [6]-Gingerol prevents UVB-induced ROS production and COX-2 expression in vitro and in vivo Free Rad Res. 2007;41:603-614.
43. Beg T, Siddiqe Y S, Ara G, Gupta J and Afzal M; Antigenotoxic Effect of Genistein and gingerol on genotoxicity induced by norethandrolone and oxandrolone in cultured human lymphocytes. Int J Pharmacol. 2008;4:177-183.
44. Nakamura H and Yamamoto T; The active part of the [6]-gingerol molecule in mutagenesis. Mutation Research Letters. 1983;122:87-94.
45. A, James, M.E., Nannapaneni, R. and Johnson, M.G. *J Food Prot*. 1999, 62: 899.
46. Ghayur, M.N., Gilani, A.H., Afridi, M.B., Houghton, P.J., *Vascul. Pharmacol*. 2005, 43, 234–241
47. Castleman, M. Emmaus, Pennsylvania: Rodale Press, 2001.
48. Riddle, J.A., and Ford, J.E. 2000. IFOAM/IOIA International Organic Inspection Manual.
49. Die Deutsche Bibliothek. Indian Ministry of Food Processing Industry: (http://mofpi.nic.in/technologies/rural/spices&plantation/spi_dehydraginger.htm)
50. International Federation of Organic Movements (http://www.ifoam.org)
51. Organic Trade Association (http://www.ota.com)