

Journal of Biological and Chemical Research



An International Journal of Life Sciences and Chemistry
EISSN 2319-3077 (Online) | ISSN 0970-4973 (Print)

www.jbcr.co.in | jbiolchemres@gmail.com



Journal Impact Factor: **4.275**, | Global Impact Factor: **0.876**, | InfoBase Impact Factor: **3.66**
Scientific Journal Impact Factor: **3.285**, | IC Value: **82.43**

Scope

Life Sciences (Botany and Zoology), Medical Sciences, Chemical Sciences, Agricultural Sciences, Biochemical Sciences, Environmental Sciences, Biotechnology, Molecular Biology and Tissue Culture



Volume 43 (1), January-June, 2026



Indexed, Abstracted and Cited

Index Copernicus International (Europe), Research Bible (Japan), Scientific Journals Impact Factor Master List, Directory of Research Journals Indexing (DRJI), Indian Science. In, Database Electronic Journals Library (Germany), Open J-Gate, J Gate e-Journal Portal, Info Base Index, International Impact Factor Services (IIFS) (Singapore), Scientific Indexing Services (USA), International Institute of Organized Research (I2OR), World Cat, International Innovative Journal Impact Factor, Swedish Scientific Publishing, Eye Source and cifactor.org Journals Indexing Directory, Cosmos Science Foundation South-East Asia, Indexing of International Research Journals and ImpactFactor.pl - Compendium wiedzy o czasopismach naukowych, Philadelphia.



Dr. M. Zahid Rizvi

REVIEW ARTICLE

Received: 31/03/2026

Revised: 15/05/2026

Accepted: 16/05/2026

A Review of *Zingiber officinale* Roscoe and its Medical Significance in Indigenous Cultures

Mohd. Zahid Rizvi and Arshad H. Rizvi

Department of Botany, Shia P.G. College, Lucknow, U.P., India

ABSTRACT

Zingiber officinale Roscoe, a member of the Zingiberaceae family commonly known as ginger (or 'Adarak'), has been utilized globally since prehistoric times for both culinary and therapeutic purposes. Distributed across tropical Asia, it is extensively cultivated in Indian states such as Kerala, Andhra Pradesh, Uttar Pradesh, West Bengal, and Maharashtra. The plant is characterized by its distinctive, thick, branched perennial underground rhizome, which serves as the commercial source of ginger. In traditional Indian Systems of Medicine (ISM)—including Ayurveda, Unani, and Siddha—*Z. officinale* is well-documented for its exceptional therapeutic efficacy against gastrointestinal issues, respiratory ailments, inflammation, diabetes, and neurological disorders like migraines. These diverse medicinal properties are driven by key bioactive constituents, including gingerols, shogaols, zerumbone, sesquiterpenes, flavonoids, alkaloids, and essential oils. Given its profound phytochemical profile and pharmacological potential, this review aims to highlight the clinical and commercial significance of *Z. officinale* in human healthcare management.

Keywords: *Zingiber officinale*, Zingiberaceae, Pharmacology and Phytochemistry.

INTRODUCTION

Zingiber officinale (Ginger, Zingiberaceae) (ZO) is a rhizomatous perennial plant used worldwide as a spice in foods, beverages, flavoring agent and is attributed to have many medicinal properties. Zingiberaceae is cultivated commercially in India, China, South East Asia, West Indies, Mexico and other parts of the world. In particular, it has been an important plant for the traditional medicine especially in India dates back to the times of Rig Veda (3500 to 1800 B.C.). Later, the monumental Ayurvedic works like Charaksamhita and Sushrutasamhita as well as Unani have incorporated nearly 700 plant drugs entering into several medicinal preparations used in the management of health care (Harsha et al., 2013). In this review we have explore the traditional applications, phytochemistry and current pharmacological applications of *Zingiber officinale*.

Geographical distribution and habitat

Zingiber officinale is widely distributed to tropical Asia (Kritikar and Basu, 2007); In India, it is cultivated mainly in Kerala, Andhra Pradesh, Uttar Pradesh, West Bengal and Maharashtra (Khare, 2007). In India, different types of Indian ginger are available like Cochin ginger (light brown or yellowish grey); Calicut ginger from Malabar (orange or reddish brown, resembling African ginger) and Kolkata ginger (greyish brown to greyish blue) (Khare, 2007).

Botanical description of *Zingiber officinale*

Zingiber officinale (Roscoe) belongs to the family Zingiberaceae. It is commonly known as "Adarak" in Hindi and "Ginger" in English. *Z. officinale* is cultivated commercially in India, China, South East Asia, West Indies and other part of the world.

Ginger has a distinctive thickened, branched perennial rhizome or stem (underground stem) which sometimes looks somewhat like a swollen hand. The rhizome has a brown corky outer layer and a pale yellow centre with a spicy lemon-like scent. The underground rhizome is the source of commercial "ginger root". Roots grow from the bottom of the rhizome and shoots from the upper surface. Shoots (pseudostems), up to 1.2 m tall, arise annually from buds on the rhizome. These pseudostems are formed from a series of leaf bases (sheaths) wrapped tightly around one another with the long (up to 7 cm), narrow (up to 1.9 cm wide), mid-green leaf blades arranged alternately. The leaves die back after the growing season. The flowering stalk rises directly from the rhizome with the leaves and consists of an oblong spike with scalloped green bracts. From each bract one or more white or yellowish-green flowers is produced, blooming for several days. The flowering heads, borne on separate shorter stems, are cone-shaped spikes and composed of a series of greenish to yellowish leaf-like bracts. Protruding just beyond the outer edge of the bracts, the flowers are pale yellow in colour with a purplish lip that has yellowish dots and striations. Flowering stems are rarely, if ever, produced in cultivated plants (Ross, 2003).

Taxonomical description

Kingdom	:	Plantae
Order	:	Zingiberales
Genus	:	Zingiber
Family	:	Zingiberaceae
Species	:	<i>Zingiber officinale</i>
Common name:		Ginger, Adarak

Vernacular names

Hindi: Adrak
Manipuri: Shing
Marathi: Alha, Aale
Tamil: Ingee
Urdu: Adarak
Assamese: Ada
Gujarati: Adu, Sunth
Sanskrit: Adraka
Nepali: Aduwa

Tangkhul: Hui
Malayalam: Inchi
Telugu: Allam, Allamu, Allamu chetu,
Kannada: Alla, Shunthi
Bengali: Ada



Figure 1. *Zingiber officinale* (A) whole plant (B) Rhizome (C) Leaves (D) Flowers.

Traditional applications

Ginger has been commonly used throughout the world as a spice for dietary as well as medicinal purpose since prehistoric time. Since ancient times, it has been an important ingredient in Ayurvedic, Tibb-Unani, Sidhha and Chinese herbal medicines. These medicinal properties have often been exploited through the use of ginger-based drinks. For example, tea made with ginger root is a common, traditional remedy for a cold, while ginger beer and ginger ale are still drunk to help ease indigestion. In India the fresh and dried rhizomes 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 (Deng et al., 2022). It is a popular preparation for cough and asthma consisted of the juice of fresh ginger with a little juice of fresh garlic, mixed with honey. Powdered dried ginger was applied to the temples to mitigate headache. Fresh ginger was mixed with a little honey used for nausea. Ginger is common home remedy in India. 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.

People in India make a paste out of ginger and apply it to their temples to treat a headache. They also eat it to treat a common cold, and mix it with salt and lemon to use against nausea (Awang, 1992; Bisset and Wichtl, 1994; Banerjee et al., 2011; Ansari et al., 2016).

Modern scientific reports

Anti-diabetic and Hypolipidemic activity

Ginger has been shown to a potent antidiabetic and hypolipidemic agent in various clinical and pre-clinical studies Bao et al. (2024). Akhani et al., 2004, have shown anti-diabetic activity of *Zingiber officinale* in streptozotocin-induced type I diabetic rats. They suggested, a potential antidiabetic activity of the juice of *Z. officinale* in type I diabetic rats, possibly involving 5-HT receptors (Akhani et al., 2004). Zainab and co-workers, 2006, have shown that a dose of 500 mg/kg, raw ginger was significantly effective in lowering serum glucose, cholesterol and triacylglycerol levels in the ginger-treated diabetic rats compared with the control diabetic rats. The ginger treatment also resulted in a significant reduction in urine protein levels (Zainab et al., 2006). The administration of an ethanolic extract of ginger 300 mg/kg to normal rabbits showed potential hypoglycaemic activity (51 % decrease in serum glucose) 2 h after administration (Mascolo et al., 1989).

Hepatoprotective activity

Ginger has been reported to have significant hepatoprotective activity. *In vivo* study carried out by Atta et al., 2010, methanol extract of ginger (250 and 500 mg/kg) and chicory (250 and 500 mg/kg) given alone or mixed (1:1 wt/wt) significantly restored the carbon tetrachloride-induced alterations in the biochemical and cellular constituents of blood. No toxic symptoms were reported in doses up to 5 g/kg (Atta et al., 2010). Poorrostami et al., 2014, have shown the Effect of hydroalcoholic extract of *ginger* on the liver of epileptic female rats treated with lamotrigine (Poorrostami et al., 2014). Sakr et. al., 2011, the effect of ginger on hepatotoxicity induced in albino rats by the anticancer drug, adriamycin (ADR) (Sakr et al., 2011).

Anti-parasitic activity

Several *in vitro* and *in vivo* studies have shown that the *Z. officinale* and its constituents exhibited significant nematocidal, cestocidal, trematocidal, anti-protozoal, insecticidal, molluscicidal and anti-leech effects. Gilani and Ghayur, reported that ginger exhibits gastrointestinal pro-kinetic activity via activation of cholinergic receptors (Gilani and Ghayur, 2005). Quian and Liu, 1992 speculated that the mechanism of action of ginger may be both central and peripheral, i.e., anticholinergic and antihistaminic (Quian and Liu, 1992).

Antidepressant activity

Pratap et al., 2012, have studied antidepressant activity of hydroalcoholic activity of *Zingiber officinale*. The oral administration of *Zingiber officinale* extract at 150 mg/ kg and 300 mg/kg respectively as compared to the control treated group showed an antidepressant activity comparable to that of standard drug. The antidepressant effects of *Zingiber officinale* extract seem to be mainly associated with the activation of dopamineergic system and possess potential anxiolytic and antidepressant activities (Pratap et al., 2012).

Antibacterial activity

Islam et al., 2014, investigated antimicrobial activity of ginger extracts against food-borne pathogenic bacteria. The study has shown the potent antimicrobial activity of the ginger extract against the all tested bacterial pathogens. Soybean oil extract of ginger showed highest zone of inhibition (11.67 ± 1.53 mm) against *Salmonella* spp. and lowest zone of inhibition (8.0 ± 1.73 mm) against *Escherichia coli*. Ginger extract also showed lower zone of inhibition (8.67 ± 2.52 mm) against *Staphylococcus aureus* compared to the Gram-negative bacteria. Soybean oil extract of ginger at boiling temperature has potential antimicrobial activity and could be used in food preparation to get the synergistic effect of soybean and ginger. Karteek et al. (2012) evaluated the antibacterial activity *Zingiber officinale* against five important bacterial strains viz., *E. coli*, *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Proteus vulgaris*. The researchers showed that the extract of these herbs has great potential against different microorganisms tested and has inhibitory effect (Karteek et al., 2012).

Antioxidant activity

Various *in vitro* and *in vivo* experiments have showed that *Z. officinale* (ZO) and its constituents exhibited potent antioxidant activity. According Ayustaningwarno et al., (2024) ZO was found to be showing the significant antiradical activity against DPPH and ABTS free radical suggesting the potent antioxidant capacity of ZO (Ansari et al., 2016). ZO essential oil and oleoresin exhibited significant antioxidant and antimicrobial activities (Bellik, 2014). ZO isolated compound, 6-shogaol has potent antioxidant properties which can be credited to the occurrence of unsaturated ketone moiety (Khader M et al., 2010). Stoilova et al ., 2007 demonstrated that ZO extract inhibited the the hydroxyl radicals 79.6% at 37 °C and 74.8% at 80 °C, showing higher antioxidant activity than standard quercetin.(Stoilova et al ., 2007). The antioxidant potential of different extracts of ZO was determined by three different methods. The order of activity was as follows, 80% methanolic > 80% ethanolic > methanolic > ethanolic > 30°C water > 100°C water > acetonic extract. Proving that ZO is a potent source of antioxidant components demonstrating higher effects in alcoholic media as determined by different assays (Shirin and Jamuna, 2010).

Effect on male reproductive functions

Hosseini et al., 2016, evaluated the effect of ZO on sperm DNA fragmentation (SDF) in infertile men. Results demonstrated that ZO in a controlled study of efficacy was effective in decreasing SDF in infertile men (Hosseini et al., 2016). In an another study the aqueous extract of *Z. officinale* had positive effect on testosterone level at the dose of 200mg/kg for 4 weeks and 8 weeks respectively. Results showed that it stimulates secretion from the testes (and other male accessory sex organs) that influences semen. (Memudu et al., 2012). It has also been evidenced that ZO stimulate male reproductive system in induce busulfan infertility. In this experiment ZO increased the volumes of seminiferous tubule and elevated the level of seminiferous tubule and Sperm count (706×10^5 and 682×10^5) of the treated groups compared to control group ($p=0.00$) (Hossein et al ., 2013). Hozayen et al. (2012) evaluated the chemoprotective effect of *Z. officinale* roots against aspartame-induced rat testicular toxicity.

Results revealed that aqueous extract of ginger root increase serum testosterone level in rats (Hozayen et al., 2012). Morakinyo et al., 2008, evaluated the effect of ZO aqueous extract on male reproductive functions and studied the mechanisms underlying these effects. Results showed the pro-fertility properties in male rats which might be a product of both its potent antioxidant properties and androgenic activities (Crichton et al., 2023).

Larvicidal activity

Larvicidal activity of isolated phytochemicals from the ZO was reported against *Culex quinquefasciatus* and *Aedes aegypti* by Rahuman et al., 2008. The results showed the significant larvicidal activity of (6)- dehydrogingerdione, (4) gingerol and (6)-dihydrogingerdione against fourth instar larvae of *C. quinquefasciatus* (LC50 5.52, 7.66, 27.24 ppm), and *A. aegypti* (LC50 4.25, 9.80, 18.20 ppm) respectively. In the same way, larvicidal activity of ZO was reported against *Angiostrongylus cantonensis*, a roundworm (Rahuman et al., 2008). Lin et al., 2010, investigated the anthelmintic activity of [6]-gingerol, [10]-gingerol, [6]-shogaol and [10]-shogaol of ZO phytoconstituents for the parasite *Angiostrongylus cantonensis*. The results revealed that these compounds killed *A. cantonensis* larvae and reduced their impulsive actions in a dose-time dependent manner. (Lin et al., 2010).

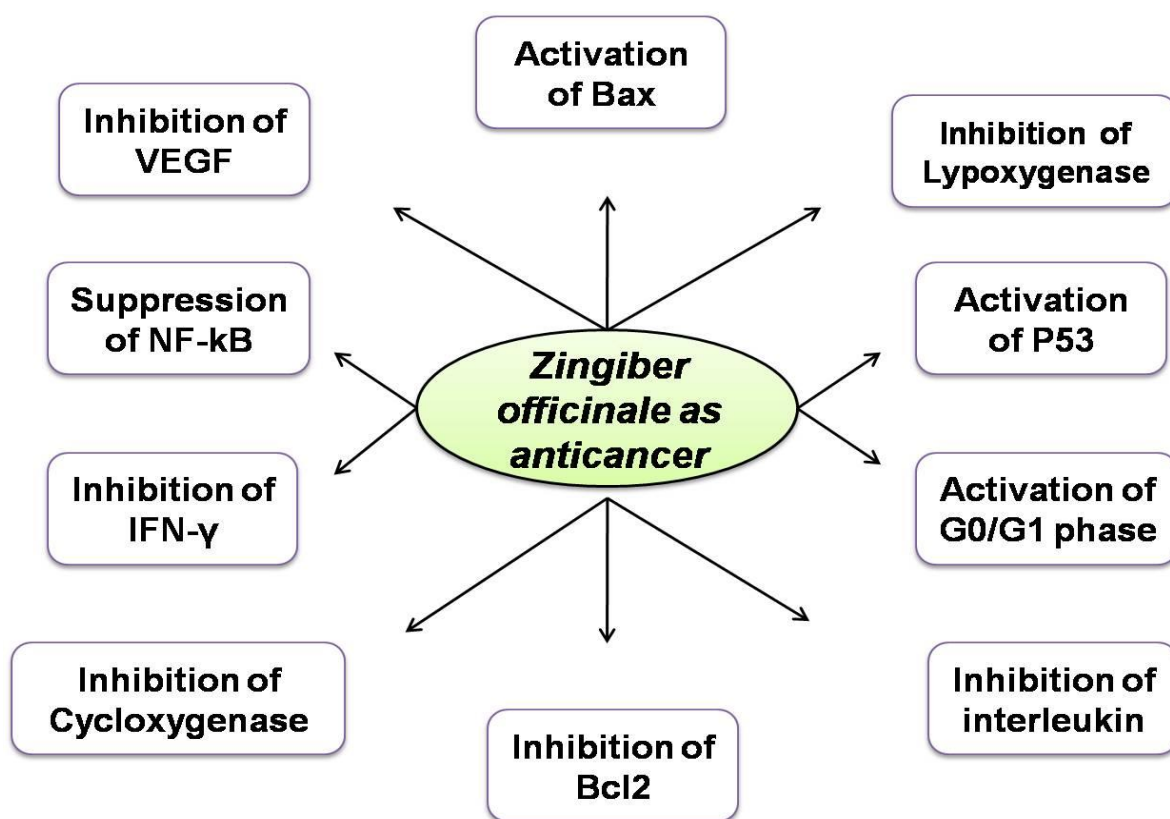


Figure 1. *Zingiber officinale* as a potent anticancer agent.

Migraine

Ginger is well documented in Ayurvedic system of medicine for the treatment of several neurological disorders. Oral administration of ginger may exerts prophylactic and abortive effects in migraine headache without any severe side-effects. The study showed that administration of ginger powder at dose of 500-600 mg for 3-4 days with gap of 4 hours, showed relief from migraine attack (Mustafa and Srivastava, 1990). Gingerols are potent inhibitors of prostaglandin synthetase and also efficient at inhibiting leukotriene biosynthesis. It is evidenced that by restraining these inflammatory neurotransmitters, ZO may play an important role in migraine prevention (Kiuchi et al., 1992).

Anti-diarrhoeal activity

In an experimental study *Zingiber officinale* exhibited antidiarrheal activity by affecting bacterial and host cell metabolism. The results indicate that in the absence of antimicrobial action, *Z. officinale* exhibits its antidiarrhoeal activity by affecting bacterial and host cell metabolism. This study reports a novel mechanism of action by *Z. officinale* in infectious diarrhoea (Daswani et al., 2010).

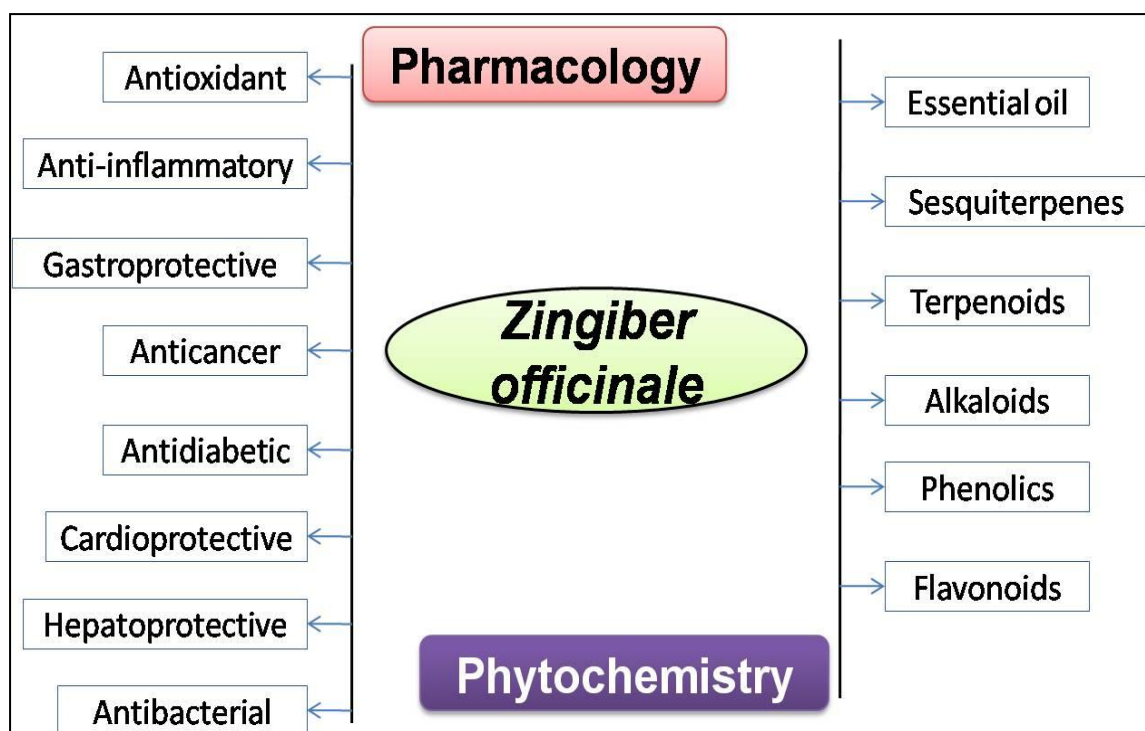


Figure 2. Pharmacological and phytochemical potential of *Zingiber officinale*.

Gastroprotective effect

ZO has been widely used as a potential lead against gastric disorders (Stewart et al., 1991; Mowrey and Clayson, 1982). Nanjundaiah et al., 2008, evaluated the gastroprotective effect of ZO rhizome extract. Results demonstrated that aqueous extract of ginger was proficient to protect the gastric mucosa from stress-induced mucosal lesions and reduce gastric acid

secretion probably by blocking H⁺, K⁺-ATPase action, restraining growth of *H. pylori* and offer anti-oxidant defence against oxidative stress-induced gastric damage (Nanjundaiah et al., 2008). The gastroprotective potential of ZO was also evaluated by using gastric ulcers induced by acidified ethanol, indomethacin, and restraint water immersion stress. The results demonstrated that by oral administration by intragastric gavage, 7.5, 15, and 30 mg/kg or cimetidine 100 mg/kg significantly inhibited the formation of gastric ulcer in all gastric ulcer models showing the gastroprotective efficiency of ZO (Pareeya et al., 2016).

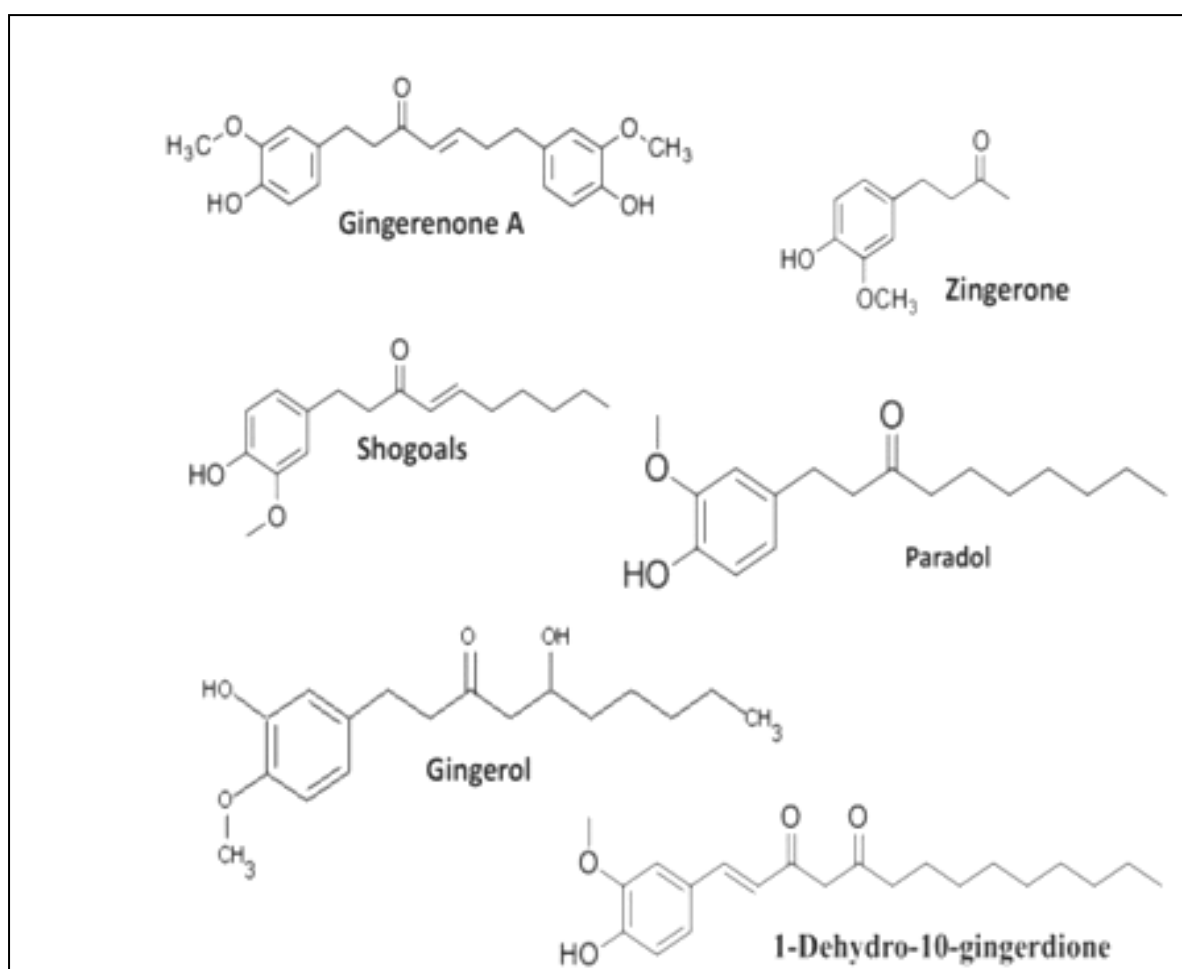


Figure 3. Major active compounds of *Zingiber officinale*.

Cardioprotective activity

ZO stimulates the cardiac muscles and blood circulation all over the body. Due to this increased blood circulation by ZO it is believed to motivate cellular metabolic activity which facilitates to relief the tension and cramps (Ghosh et al., 2012). There are several reports showed that ZO phytochemicals to have significant cardioprotective activity. Two isolated phytochemicals of ZO, gingerols and the related shogaols exhibited cardio depressant activity. It is also reported that (6)- gingerol, (6)-shogaol and gingerdiones are potent enzymatic inhibitors of prostaglandin, thromboxane, and leukotriene biosynthesis (Wang et al., 2003).

Table 1. Comprehensive pharmacological properties of phytochemicals in Ginger.

Phytochemicals	Pharmacological properties	References
6-Gingerols and related compounds	Anticancer via apoptosis in cancer cells, , Antioxidant Anti-inflammatory Immunomodulatory Hepatoprotective activity Antibacterial activity	Masuda et al., 2004; Park et al., 2006; Plengsuriyakarn et al., 2012; Kim et al., 2011; Young et al., 2005. Park et al., 2008; Sabina et al., 2011.
Zerumbone	Antioxidant Antimicrobial Antitumor activity	Kirana et al., 2003; Abdul et al., 2008
Curcumene	Antioxidant Anticancer Anti-inflammatory activity	Shin and Lee, 2013; Singh et al., 2010
Shagoal	Antioxidant and anti-inflammatory activity, [6]-shogaol showed anticancer activity through the inhibition of cell invasion reduction of matrix metalloproteinase-9 expression, anti-proliferation activity and anti-invasion	Hu et al., 2012; Alqasoumi et al., 2011

Chemical constituents

Numerous different classes of active compounds have been identified including terpenes and oleoresin which commonly known as ginger oil. Ginger also constitutes volatile oils approximately 1% to 3% and non-volatile pungent components oleoresin (Zick et. al., 2008). The major identified components from terpene are sesquiterpene hydrocarbons and phenolic compounds which are gingerols and shogaols (Hasan et. al., 2012). Gingerols and its derivatives have been identified as major compounds from *Z. officinale* rhizome. [4]-gingerol, [6]-gingerol, [8]-gingerol, [10]-gingerol, [6]-paradol, [14]-shogaol, [6]-shogaol, 1-dehydro-[10]-gingerdione, [10]-gingerdione, hexahydrocurcumin, tetrahydrocurcumin, gingerenone A, 1,7-bis-(4' hydroxyl-3' methoxyphenyl)-5-methoxyheptan-3-one, and methoxy-[10]-gingerol (Koh et. al., 2009). However, the proportion of compounds vary depends on country of origin, commercial processor, and whether the ginger is fresh, dried, or processed (Schwertner & Pascoe, 2006). Although phylogenetic analysis has showed that all ginger samples from widely different geographical origins are genetically indistinguishable, metabolic profiling showed some quantitative differences in the contents of [6]-, [8]-, and [10]-gingerols (Jiang et. al., 2006). An examination of the concentrations of [6]-, [8]-, and [10]-gingerols and [6]-shogaol in 10 different ginger-root dietary supplements purchased randomly from a variety of pharmacies and health food stores yielded some disconcerting results (Schwertner & Pascoe, 2006).

The essential oil of ginger contains heptane, octane, isovaleraldehyde, nonanol, ethyl pinene, camphene, b-pinene, sabinene, myrcene, limonene, b-phellandrene, 1,8-cineole with presence of gingediol, methylgingediol and their diacetates by GC-MS. (Kami et al., 1972). D³-carene, a-terpinene, a-terpineol, nerol, 1,8-cineole, zingiberene, neral, geranial, geraniol and geranyl acetate were identified in essential oil from rhizomes of ginger (Sakamura and Fukiko, 1978).

CONCLUSION AND FUTURE OUTLOOK

We have discussed the traditional and modern applications of *Zingiber officinale* in human health management with respect to pharmacology, phytochemistry and other importance. The ginger bears an enormous number of pharmacological activities such as anticancer, cardioprotective activity, anti-inflammatory activity, anti-diabetic activity, anti-microbial activity, antioxidant property, anti-proliferative activity, hypolipidemic, neuroprotective activity and hepatoprotective, which have been clinically proved. Presence of diverse group of bioactive compounds such as gingerols, shogaols, curcumene, sesquiterpenes, alkaloids and flavonoids made ginger conspicuous among plant kingdom. We hope this article will facilitate all about the traditional and modern scientific research related to enormous pharmacological activities of ginger to researchers for advanced clinical based research to manage human beings from several types of ailments.

ACKNOWLEDGEMENTS

Suggestions and help provided by friends and colleagues are duly acknowledged and to all the researchers who worked on Ginger (*Zingiber officinale*), without whom this review article would not have been possible.

REFERENCES

- Abdul, A.B. Abdelwahab, S.I. Al-Zubairi, A.S. Elhassan, M.M. and Murali, S.M. (2009). Anticancer and Anti-microbial Activities of Zerumbone from the Rhizomes of Zingiber zerumbut. *Int J Phar-macol.* 4: 301-304.
- Akhani, S.P., Vishwakarma, S.L. and Goyal, R.K. (2004). Anti-diabetic activity of Zingiber officinale in streptozotocin-induced type I diabetic rats. *J of Pharm and Pharmacology.* 56(1): 101-105.
- Al-Amin, Z.M. Thomson, M. Al-Qattan, K.K. Peltonen-Shalaby, R. and Ali, M. (2006). Anti-diabetic and hypolipidaemic properties of ginger (*Zingiber officinale*) in streptozotocin-induced diabetic rats. *British J of Nutri.* 96: 660–666.
- Alqasoumi, S. Yusufoglu, H. Farraj, A. and Alam, A. (2011). Effect of 6-shogaol and 6-gingerol on Diclofenac Sodium Induced Liver Injury. *Int J Pharmacol.* 7: 868-873.
- Ansari, J. A. Ahmad, M.K. Khan, A.H. Fatima, N. Khan, H.J. Rastogi, N. Mishra, D.P. and Mahdi, A. A. (2016). Antiproliferative and antioxidant activity of Zingiber officinale Roscoe rhizome. *Indian of Exp Biology.* 54: 767-773.
- Atta, A.H. Elkoly, T.A. Mounair, S.M. Kamel, G. Alwabel, N.A. and Zaher, S. (2010). [Hepatoprotective effect of methanol extracts of Zingiber officinale and Cichorium intybus](#). *Indian J Pharm Sci.* 72 (5): 564-570.
- Awang, D.V.C., (1992). Ginger. *Can Pharm J:* 309
- Ayustaningwarno, F. Anjani, G. Ayu, A.M. and Fogliano, V. (2024). A critical review of ginger's (*Zingiber officinale*) antioxidant, anti-inflammatory and immunomodulatory activities. *Frontiers in Nutrition.* 11: 1364836. DOI: 10.3389/fnut.2024.1364836.
- Bao, V. Abdalla, A.N. Algarni, A.S. et al. (2024). *Zingiber officinale* Roscoe (Ginger) and its bioactive compounds in diabetes: A systematic review of clinical studies and insight of mechanism of action. *Current Pharmaceutical Design.* 30(7): 887–903. DOI: 10.2174/0929867330666230524122318.

- Bellik, Y. (2014).** Total antioxidant activity and antimicrobial potency of the essential oil and oleoresin of *Zingiber officinale* Roscoe. *Asian Pac J Trop Dis.* 4: 40-44.
- Bisset, N.G. and Wichtl, M. (1994).** Herbal Drugs and Phytopharmaceuticals, Medpharm Scientific Publishers
- Bordbar, H. Esmaeilpour, T. Dehghani, F. and Panjehshahin, M.R. (2013).** Stereological study of the effect of ginger's alcoholic extract on the testis in busulfan-induced infertility in rats. *Iran J Reprod Med.* 11(6): 467–472.
- Brijesh, D.P.G.S. Tetali, P. Antia, N.H. and Birdi, T.J. (2010).** Antidiarrhoeal activity of *Zingiber officinale* (Rosc.). *Current science.* 98(Suppl 2):222-229.
- Crichton, M. Marshall, S. Marx, W. Isenring, E. and Lohning, A. (2023).** Therapeutic Health Effects of Ginger (*Zingiber officinale*): Updated Narrative Review Exploring the Mechanisms of Action. *Nutrition Reviews.* 81(9): 1213–1224. DOI: 10.1093/nutrit/nuac115.
- Deng, M. Yun, X. Ren, S. Qing, Z. and Luo, F. (2022).** Plants of the Genus *Zingiber*: A Review of Their Ethnomedicine, Phytochemistry and Pharmacology. *Molecules.* 27(9): 2826. DOI: 10.3390/molecules27092826.
- Ghosh, A.K. Banerjee, S. Mullick H.I. and Banerjee, J. (2011).** *Zingiber officinale*: a natural gold. *Int J of Pharma and Bio Sciences* 2: 283-294.
- Ghosh, A.K. Banerjee, S. Mullick, H.I. and Banerjee, J. (2011).** *Zingiber officinale*: a natural gold. *Int J of Pharma and Bio Sciences.* 2(1): 283-294.
- Gilani, A.H. and Ghayur, M.N. (2005).** Ginger: from myths to reality. In: Gottschalk-Batschkus, C.E., Green, J.C. (Eds.), *Ethnotherapies in the Cycle of Life*, BOD-Books on Demand. Ethnomed Institut für Ethnomedizin e.V., Munchen, pp. 307– 315.
- Handbook of African Medicinal Plants**, CRS Press: 116 – 118.
- Hasan, H.A. Rasheed, Raauf, A.M. Razik, A.B.M. and Hassan, R.B.A. (2012).** ‘Pharmaceut Chemical Composition and Antimicrobial Activity of the Crude Extracts Isolated from *Zingiber Officinale* by Different Solvents’. *Pharmaceute Anat Acta.* 3 184.
- Hosseini, J. Mamaghani, A.M. Hosseinifar, H. Gilani, M.A.S. Dadkhah, F. and Sepidarkish, M. (2016).** The influence of ginger (*Zingiber officinale*) on human sperm quality and DNA fragmentation: A double-blind randomized clinical trial. *Int J Reprod Biomed.* 14(8):533-40.
- Hozayen, W.G. Soliman, H.A. and Abou-Seif, H.S. (2014).** Study of the chemopreventive effects of *Zingiber officinale* roots against aspartame induced testicular toxicity in rat model. *J Phys Pharm Adv.* 4:360-367.
<http://dx.doi.org/10.1093/ecam/nep060>
- Hu, R. Zhou, P. Peng, Y.B. Xu, X. Ma, J. Liu, Q. Zhang, L. Wen, X.D. Qi, L.W. Gao, N. and Li. P. (2012).** 6-Shogaol induces apoptosis in human hepatocellular carcinoma cells and exhibits anti-tumor activity in vivo through endoplasmic reticulum stress. *PLoS One.* 7: e39664.
- Ishiguro, K, Ando, T. Maeda, O. Ohmiya, N. Niwa, Y. Kadomatsu, K. and Goto, H. (2007).** Ginger ingredients reduce viability of gastric cancer cells via distinct mechanisms. *Biochem Biophys Res Commun.* 362(1):218-23.
- Islam, K. Rowsni, A.A. Khan, M.M. and Kabir M.S. (2014).** Antimicrobial activity of ginger (*zingiber officinale*) extracts against food-borne pathogenic bacteria. *Int J of Sci, Environ and Tech.* 3 (3): 867 – 871.

- Karteek, P. Jahnavi, V. Keerthi, D.V. and Chaitanya, S. K. (2012). Evaluation of antibacterial activity of herbs. *Int J of pharm.* 3:230-232.
- Keum, Y. S. Kim, J. and Lee, K. H. (2002). Induction of apoptosis and caspase-3 activation by chemopreventive [6]-paradol and structurally related compounds in KB cells. *Cancer Lett.* 177(1): 41–7.
- Khader, M. Bresgen, N. and Eckl, P.M. (2010). Antimutagenic effects of ethanolic extracts from three Palestinian medicinal plants. *J Ethnopharmacol.* 127: 319-24.
- Khare, C.P. (2008). Indian Medicinal Plants: An Illustrated Dictionary. June 2008. DOI: 10.1007/978-3-540-37418-34, Publisher: Springer Verlag, New York,
- Kim, H.W. Oh, D.H. Jung, C. Kwon, D.D. and Lim, Y.C. (2011). Apoptotic Effects of 6-Gingerol in LNCaP Human Prostate Cancer Cells Soonchunhyang. *Med Sci.* 17: 75-79.
- Kirana, C. McIntosh, G.H. Record, I.R. and Jones, G.P. (2003). Antitumor activity of extract of Zingiber aromaticum and its bioactive sesquiterpenoid zerumbone. *Nutr Cancer.* 45: 218-25.
- Kiuchi, F. Iwakami, S. Shibuya, M. Hanaoka, F. and Sankawa, U. (1992). Inhibition of prostaglandin and leukotriene biosynthesis by gingerols and diarylheptanoids. *Chem. Pharm. Bull.* 40: 387–391
- Ko, J.K. and Leung, C.C. (2010). Ginger extract and polaprezinc exert gastroprotective actions by anti-oxidant and growth factor modulating effects in rats. *J of Gastroenterology and Hepatology* 25(12): 1861–1869.
- Koh, E.M. Kim, H.J. and Kim, S. Editors. (2009). ‘Modulation of macrophage functions by compounds isolated from Zingiber officinale’. *Planta Med.* 75(2): 148-51.
- Kritikar, K.R. and Basu, B.D. (2007). Indian Medicinal Plants. Vol. 4. 2nd ed. (Dehradun, India: International Book Distributors).
- Lee, E. and Surh, Y.J. (1998). Induction of apoptosis in HL-60 cells by pungent vanilloids, [6]-gingerol and [6]-paradol. *Cancer Lett.* 134 (2): 163-8.
- Lin, R.J. Chen, C.Y. Chung, L.Y. and Yen, C.M. (2009). Larvicidal activities of ginger (Zingiber officinale) against *Angiostrongylus cantonensis*. *Acta Trop.* 115(1-2): 69-76
- Mascolo, N. Jain, R. Jain, S.C. and Capasso, F. (1989). Ethnopharmacologic investigation of ginger (Zingiber officinale). *J Ethnopharmacol.* 27: 129 –140.
- Masuda, Y. Kikuzaki, H. Hisamoto, M. and Nakatani, N. (2004). Antioxidant properties of gingerol related compounds from ginger. *Biofactors* . 21: 293-6.
- Memudu, A.E. Akinrinade, I.D. Ogundele, O.M. and Duru, F. (2012). Investigation of the androgenic activity of ginger (Zingiber officinale) on the histology of the testis of adult sprague dawley rats . *J of Med and Medical Sci.* 3(11): 697-702.
- Morakinyo, A. O. Adeniyi, O. S. and Arikawe, A. P. (2008). Effects of Zingiber Officinale on Reproductive Functions in the Male Rat. *African JI of Biomed Res.* 11: 329 – 334
- Mowrey, D.E. and Clayson (1982). Motion sickness, ginger and psychophysics. *Lancet.* 655-657
- Mustafa, T. and Srivastava, K.C. (1990). Ginger (Zingiber officinale) in migraine headache. *J Ethnophar.* 29: 267–73.
- Nakayama, T. K. M. and Hayashi, S. (1972). Volatile constituents of Zingiber officinale. *Phytochemistry.* 11(11): 3377–3381

- Nanjundaiah, S.M. Annaiah, H. N. M. and Dharmesh, S. M. (2011).** Gastroprotective Effect of Ginger Rhizome (*Zingiber officinale*) Extract: Role of Gallic Acid and Cinnamic Acid in H⁺, K⁺-ATPase/H. pylori Inhibition and Anti-Oxidative Mechanism. Evidence-Based Complementary and Alternative Medicine Article ID 249487, 13 pages.
- Park, M. Bae, J. and Lee, D.S. (2008).** Antibacterial activity of [10]-gingerol and [12]-gingerol isolated from ginger rhizome against periodontal bacteria. *Phytother Res.* 22: 1446-1449.
- Park, Y.J. Wen, J. Bang, S. Park, S.W. and Song, S.Y. (2006).** Gingerol induces cell cycle arrest and cell death of mutant p53-expressing pancreatic cancer cells. *Yonsei Med J.* 47: 688-97.
- Plengsuriyakarn, T. Viyanant, V. Eursitthichai, V. Tesana, S. Chaijaroenkul, W. and Itharat, A. (2012).** Na-Bangchang K. Cytotoxicity, toxicity, and anticancer activity of *Zingiber officinale* Roscoe against cholangiocarcinoma. *Asian Pac J Cancer Prev.* 13: 4597-606.
- Poorrostami, A. Farokhi, F. Heidari, R. (2014).** Effect of hydroalcoholic extract of ginger on the liver of epileptic female rats treated with lamotrigine. *Avicenna J Phytomed.* 4(4): 276–286.
- Pratap, S.R. Ritesh, J. Rahul and M. Prashant, T. (2012).** Antidepressant activity of hydroalcoholic extract of *zingiber officinale*. *Int Res J Of Pharmacy.* 3 (2).
- Qian, D.S. and Liu, Z.S. (1992).** Pharmacologic studies of antimotion sickness actions of ginger. *Zhongguo Zhong Xi Yi Jie He Za Zhi.* 12(2): 95-8, 70.
- Qing-Yi, Wei. Jian-Ping, Ma. Yu, Jun and Zhong-Li, Liu (2005).** Cytotoxic and apoptotic activities of diarylheptanoids and gingerol-related compounds from the rhizome of Chinese ginger. *Journal of Ethnopharmacology.* 102(2): 177-84.
- Ross, I. A. (2003).** Medicinal Plants of the World. January 2003. DOI: 10.1007/978-1-59259-365-1_19. pp.337-365
- Ryan, J.L. Heckler, C.E. Roscoe, J.A. Dakhil, S.R. Kirshner, J. Flynn, P.J. Hickok, J.T. and Morrow, R. (2012).** Ginger (*Zingiber officinale*) reduces acute chemotherapy-induced nausea: a URCC CCOP study of 576 patients. *Support Care Cancer.* 20(7):1479-89.
- Sabina, E.P. Pragasam, S.J. Kumar, S. and Rasool, M. (2011).** 6-gingerol, an active ingredient of ginger, protects acetaminophen-induced hepatotoxicity in mice. *Zhong Xi Yi Jie He Xue Bao.* 9: 1264-9.
- Sakamura, F. (1987).** Changes in volatile constituents of *Zingiber officinale* rhizomes during storage and cultivation. *Phytochemistry.* 26(8): 2207–2212
- Sakr, S.A. Mahran, H.A. and Lamfon, H.A. (2011).** Protective effect of ginger (*Zingiber officinale*) on adriamycin - induced hepatotoxicity in albino rats. *J Med Plant Res.* 5:133-140.
- Schwertner, H.A. Rios, D.C. Pascoe, J.E. (2006).** ‘Variation in concentration and labeling of ginger root dietary supplements’. *Obstet Gynecol.*107(6): 1337-43.
- Shin, Y. and Lee, Y. (2013).** Cytotoxic Activity from *Curcuma zedoaria* Through Mitochondrial Activation on Ovarian Cancer Cells. *Toxicol Res.* 29(4): 257–261.
- Shirin, A. P. R. and Prakash, J. (2010).** Chemical composition and antioxidant properties of ginger root (*Zingiber officinale*). *J of Med Plants Res.* 4(24): 2674-2679

- Singh, G. Kapoor, I.P.S. Singh, P. Carola, S. Heluanib, Marina, P. Lampasona, Cesar and A.N. Catalan (2010).** Comparative study of chemical composition and antioxidant activity of fresh and dry rhizomes of turmeric (*Curcuma longa* Linn.). *Food and Chemical Toxicology*. 48(4): 1026–1031.
- Sontakke, S. Thawani, V. and Naik, M.S. (2003).** Ginger as an antiemetic in nausea and vomiting induced by chemotherapy: a randomized, cross-over, double blind study. *Indian j of pharma*. 35: 32-36.
- Stewart, J. Wood, M.J. Wood, C.D. and Mims, M.E. (1991).** Effects of ginger on motion sickness susceptibility and gastric function. *Pharmacology*. 42(2): 111-120.
- Stoilova, I. Krastanov, A. and Stoyanova, A. (2007).** Antioxidant activity of a ginger extract (*Zingiber officinale*). *Food Chem*. 102: 764—770.
- Vani, N. (2013).** Phytochemical Analysis of Some Selected Spices. *Int J of Innovative Res in Sci, Eng and Tech*. 11 (2): 6618-6621.
- Wang, C.C. Chen, L.G. Lee, L.T. and Yang, L.L. (2003).** Effects of 6-gingerol, an antioxidant from ginger, on inducing apoptosis in human leukemic HL-60 cells. *In Vivo*. 17(6): 641-645.
- Wang, G. Li. X. Huang, F. Zhao, J. Ding, H. Cunningham, C. Coad, J.E. Flynn, D.C. Reed, E. and Li. Q.Q. (2005).** Antitumor effect of beta-elemene in non-small-cell lung cancer cells is mediated via induction of cell cycle arrest and apoptotic cell death. *Cell Mol Life Sci*. 62(7-8): 881-93.
- Young, H.Y. Luo, Y.L. Cheng, H.Y. Hsieh, W.C. Liao, J.C. and Peng, W.H. (2005).** Analgesic and anti-inflammatory activities of [6]-gingerol. *J Ethnopharmacol*. 96: 207-310.
- Zick, S.M. Djuric, Z. Ruffin, M.T. Litzinger, A.J. Normolle, D.P. Alrawi, S. Feng, M.R. and Brenner, D.E. (2008).** Pharmacokinetics of 6-gingerol, 8-gingerol, 10-gingerol, and 6-shogaol and conjugate metabolites in healthy human subjects. *Cancer Epidemiol Biomarkers Prev*. 17: 1930–1936.

Corresponding author: Dr. Mohd. Zahid Rizvi, Associate Professor of Botany, Department of Botany, Shia P.G. College, Lucknow, U.P., India
Email: zahid682001@gmail.com