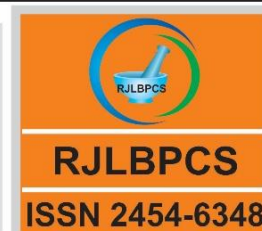




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Original Review Article**DOI: 10.26479/2019.0502.09*****ZINGIBER OFFICINALE: A SPICE WITH MULTIPLE ROLES*****Radha Singh*, Kusum Singh**

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ABSTRACT: Spice and medicinal plants added an important role because of their increased use as a raw material for the agronomy production, pharmacy pharmaceutical industry and in the everyday life. Ginger, the rhizome of *Zingiber officinale*, species of the ginger family (Zingiberaceae) has a long history of medicinal use for more than 2500 years as one of the most versatile medicinal plants having a wide spectrum of biological activity and a common flavour enhancer for various foods and beverages. The medicinal properties of ginger are due to the presence of gingerol and paradol, shogaols, etc. Currently, there is a renewed interest in ginger, and several scientific investigations aimed at isolation, identification of active constituents, scientific verification of its pharmacological actions for treatment of several diseases and conditions. This is use as anti-diabetic, antioxidant, anti-inflammatory, hepatoprotective, antimicrobial and various kind of disease. The aim of this review is to provide an overview about the main aspects related with pharmacology, phytochemistry and pharmacological activities of *Z. officinale* published in the literature done the last span.

KEYWORDS: *Zingiber officinale*, pharmacology, phytochemistry, pharmacological activities.

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1.INTRODUCTION

Nature has been a source of medicinal agents for thousands of years and a remarkable number of modern drugs have been isolated from natural sources that play a vital role in treatment of diseases [1]. Traditional knowledge of medicinal plants has always revealed the search for new cures. Traditional medicinal plants are often cheaper, locally available and easily consumable, raw or as simple medicinal preparations. These simple medicinal preparations often carry out beneficial responses due to their active chemical constituents [2]. Ginger scientifically known as *Zingiber*

officinale Roscoe, belonging to family Zingiberaceae is one of the most important plant with several medicinal, nutritional and ethnomedical values therefore, used extensively worldwide as a spice, flavouring agent and herbal remedy. Traditionally, *Z. officinale* is used in Ayurveda, Siddha, Chinese, Arabian, Africans, Caribbean and many other medicinal systems to cure a variety of diseases viz, nausea, vomiting, asthma, cough, palpitation, inflammation, dyspepsia, loss of appetite, constipation, indigestion and pain [3].

Description

The tuberous rhizome of ginger is a specific segmented stem structure that grows horizontally just under the soil surface. The plant has narrowed lanceolate to linear lanceolate, 15-30 cm long leaves which die of each year and produces clusters of white and pink flower buds that bloom into yellow flowers [4]. Ginger is originated in South-East Asia and is the most common spice commonly used all over the world [5]. It has been used as a spice and medicine in India and China since ancient times. Even though it is native to southern Asia, ginger is usually cultivated in most tropical countries such as Jamaica, China, Nigeria and Haiti. Over three quarters of the world population still depend on plants and plant extracts for health care [6].

Vernacular names

Language/ Country	Vernacular names (Fresh and dried ginger have different names)	Reference
Chinese	Jeung, Sang Keong, Chiang, Jiang, Keong, Shen Jiang	[7]
Hindi	Adi, Adrack (fresh), Sonth (dried)	
Sanskrit	Adraka (fresh), Shunthi (dried), Shringaveran, Nagara	
Indonesian	Jahe, Aliah, Jae, Lia	
Vietnamese	Gung, Sinh khuong	
European	Gingembre (French), Ingwar (German), Zenzero (Italian), Jengibre (Spanish)	
Turkish	Zencefil	
Bengali	Ada	
Gujarathi	Adhu (fresh), Sunth, Shuntia (dried)	
Malayalam	Inchi (fresh), Chukku (dried)	
Marathi	Alha, Aale (fresh), Sunth, Shuntia (dried)	
Oriya	Ada, Adraka	
Punjabi	Adrak	
Tamil	Ingee, ingiver, chukku (dried)	
Urdu	Adraka	

Classification

Kingdom – Plantae

Division – Angiospermae

Class – Monocotyledoneae

Order – Zingiberales

Family – Zingiberaceae

Genus – *Zingiber*Species - *Z. Officinale***Phytochemical composition**

Plant form	Compounds	Reference
Fresh ginger rhizome	Gingerols (6-, 8- and 10-gingerol), shogaols (6-, 8- and 10-shogaol), 3-dihydroshogaols, paradols, dihydroparadols, acetyl derivatives of gingerols, gingerdiols, mono- and di-acetyl derivatives of gingerdiols, 1- dehydrogingerdiones, diarylheptanoids, ingenol, and zingerone.	[6]
Dry ginger rhizome	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. Volatile oil- Monoterpenoids (β -phellandrene, camphene, cineole, geraniol, curcumene, citral, terphineol, borneol, cineole, geranyl acetate, limonene, linalool) and sesquiterpenoids [α -zingiberene (30–70%), β -sesquiphellandrene (15–20%), β -bisabolene (10–15%), α -farnesene, zingiberol].	[8]

Phytochemical screening of the aqueous Hydro-methanolic and Hydro-ethanolic extracts of *Z. officinale* [9]

S.No.	Phytochemicals	Aqueous extract	Hydro-Methanolic extract	Hydro-ethanolic extract
1.	Carbohydrates	-	-	-
2.	Proteins and amino acids	-	-	-
3.	Fats and Oil	-	++	+
4.	Alkaloids	-	-	-
5.	Flavonoids	+	+++	+++
6.	Terpenoids	+++	+	++
7.	Steroids	-	+	+

8.	Saponins	++	+++	+++
9.	Tannins	-	-	-
10.	Phenolics	++	+	++
11.	Phytosterol	+	+	+
12.	Ascorbic acid	+++	+++	+++
13.	Phlobotannins	+	-	-
14.	Cardiac glycosides	+	++	++

Phytochemical screening of the Acetone, Cyclohexane, Chloroform, Ethanolic and Methanolic extracts of *Z. officinale* [10]

S.No.	Phytochemicals	Acetone extract	Cyclohexane extract	Chloroform extract	Ethanolic extract	Methanolic extract
1.	Alkaloids	++++	+++	+++	+++	+++
2.	Tannins	++	++	++	++	++
3.	Glycosides	++	++	++	++	++
4.	Saponins	++	+++	+++	+++	+++
5.	Steroids	-	+	-	-	-
6.	Flavonoids	+++	++	++	++	++
7.	Terpenoids	+	+	+	+	+
8.	Phlobotannins	+	-	+	+	+

Where: - Absent (-), Weak (+), Moderate (++), Strong (+++)

Pharmacological properties

1. Lipid Effects

Oral eating of ginger extract has been revealed to have hypocholesterolemic, hypolipidemic, and antiatherosclerotic effects in cholesterol-fed in rats [11]. Concentration of 6-gingerol was found to be higher in the methanol extract and less in the ethyl acetate extract. So the ginger methanolic extract creates greater effects in comparison with the ethyl acetate extract in fructose- induced hyperlipidemia associated with insulin resistance [12]. Hypoglycaemic potentials of ginger in streptozotocin (STZ)-induced diabetic rats given an aqueous extract of raw ginger daily (500 mg/kg, i.p.) for a period of 7 weeks. The dose of 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 [13].

2. Antioxidant Effects

Antioxidants are the chemical substances that decrease oxidation stress and have the capacity to stabilize the damaging effects of free radicals in tissues. About 40 antioxidant compounds have been

exposed in ginger [14]. Gingerols are identified to affluence oxidative stress due to stimulation of superoxide dismutase, catalase, glutathione peroxidase and GSH actions [15]. They are thought to defend against cancer, arteriosclerosis, heart disease and some other diseases [6]. Because of these chemicals, ginger has shown a protective role to toxicity and lethality against some agent like carbon-tetra chloride [16]. Ginger oil can act as a scavenger of oxygen radical and might be used as an antioxidant [17].

3. Anti-Inflammatory Effects

Ginger root and its components can prevent NF- κ B activation induced by a variety of agents and down regulation of NF- κ B gene products involved in cellular rise and angiogenesis [18]. Dried *Z. officinale* also shows a role in conquering the expression of LPS-induced IFN- γ and IL-6, which are raised in LPS-induced inflammation [19]. Ginger suppresses prostaglandin production through inhibition of cyclooxygenase-1 and cyclooxygenase-2. It also suppresses leukotriene biosynthesis by inhibiting 5-lipoxygenase. This pharmacological property differentiates ginger from NSAID (Non-Steroidal Anti-Inflammatory Drugs). Dual inhibitors of cyclooxygenase and 5-lipoxygenase may have a better therapeutic profile and have fewer side effects than NSAID [17].

4. Hepato-protective effects

Administration of single dose of aqueous extract of ginger (200, 400 mg/kg) was effective in inhibiting the acetaminophen-induced hepatotoxicity and also reduced ALT, AST and ALP levels and increased the activities of antioxidant enzymes levels in the liver [20]. Ginger is also useful in inhibiting the mancozeb-induced and fungicide induced hepatotoxicity [21]. Several recent studies reported the protective effects of ginger extracts against alcohol induced toxicity [22] bromobenzene induced hepatotoxicity [23], and ethionine-induced toxicity [24]. Ginger is also effective in reversing lead induced hepatotoxicity [25].

5. Immunomodulatory Effects

Ginger is one of the most effective natural immunomodulator. *In vitro* study found that ginger inhibited lymphocyte proliferation; this was mediated by reductions in IL-2 and IL-10 production [26]. Aqueous ginger extract significantly increased the production of IL-1 β , IL-6 and TNF- α in activated peritoneal mouse macrophages and splenocyte proliferation and cytokine production [27]. Ginger rhizome diet for 12 weeks showed increased haematocrit, haemoglobin, erythrocyte, MCH, MCHC, WBC values and neutrophils percentage. Ginger essential oil showed improvement in humoral and cell mediated immune response in immune suppressed mice [28]. The powdered ginger rhizome is capable to improve non-specific immune response in rainbow trouts [29].

6. Anti-cancer effects

An ethanolic ginger extract applied topically to mouse skin provided a extremely important protective effect against the increase of skin tumours, and this was related with the inhibition of 12-O-tetradecanoylphorbol-13-acetate (TPA) caused stimulation of epidermal ornithine decarboxylase,

cyclooxygenase and lipoxygenase activities [30]. A topical use of 6-gingerol inhibited COX-2 expression in mouse skin stimulated with the tumour promoter TPA. The inhibition of COX-2 expression was the result of the blocking of the p38 MAP kinase- NF κ B signalling pathway [31]. A cytotoxic or cytostatic effect facilitated by apoptosis was found for 6-gingerol and 6- paradol in human promyelocytic leukaemia HL-60 cells [32], and also for four diaryl heptanoids and two shogaols [33].

7. Antimicrobial effects

Gingerol and related compounds have been examined for antimicrobial activities. 10-gingerol has been stated as active inhibitor of *Mycobacterium avium* and *Mycobacterium tuberculosis* [34]. Ginger inhibits aspergillus, a fungus identified for production of aflatoxin, a carcinogen [11]. Ethanolic extract of ginger showed widest zone of inhibition against *Salmonella typhi* [35] and also clear inhibitory actions against *Candida albicans* [36]. The ethanolic extracts of emprit, gajah and red ginger varieties have different abilities to inhibit the growth of acne-origin bacteria. Ginger has a value of MIC against Propioni bacterium sp.1, Staphylococcus sp. and to Propioni bacterium sp.2 as much as 10, 5 and 20%, respectively [37].

8. Gastrointestinal Effects

Ginger has been noted as being beneficial in preventing post-operative nausea and vomiting in humans [38], without a significant result on gastric emptying [39]. There is proof that ginger rhizome (root) increases stomach acid production. It may interfere with antacids, sucralfate (Carafate), H₂ antagonists, or proton pump inhibitors. The powdered rhizome of ginger has long been used in traditional medicine for improving the symptoms of gastrointestinal tract illnesses [40]. Active constituents of ginger (gingerols) are effective in vitro against *Helicobacter pylori*, the primary etiological factor associated with dyspepsia, peptic ulcer disease and increase of gastric and colon cancer [41]. Ginger-free phenolic and hydrolyzed phenolic fractions of ginger were both potent inhibitors of gastric cell proton potassium ATPase activity and *H. pylori* growth, and advised that the two fractions could be low-cost multistep blockers against ulcer [42].

9. Cardiovascular Effects

Ginger extracts as well as 6- and 8-gingerol have been revealed to modulate eicosanoid reactions in smooth vascular muscles *ex vivo* [43]. Ginger exerts many direct and indirect effects on blood pressure and heart rate [40]. *In vitro* study shows that gingerols and the related shogaols exhibit cardio depressant activity at low doses and cardiostimulant properties at higher doses [44]. Crude extract (70% aqueous methanol) of fresh ginger made a dose dependent drop in arterial blood pressure of anaesthetised rats; this effect was exposed to be mediated through blockade of voltage-dependent calcium channels. In Guinea pig paired atria, the crude extract showed a cardio-depressant activity on the rate and force of spontaneous contractions [45].

10. Lipolytic or Cholesterol-lowering properties

Ginger may reduce the rate of weight gain and hence regulate the Body Mass Index (BMI). It can increase body composition by reducing body fat levels and increasing Soft Lean Mass (SLM). In addition, some enzymes such as Acetyl-coenzyme A, acyltransferase 1 and enoyl-CoA hydratase, which participate in the β -oxidation of fatty acids, have been increased by eating of Ginger. Moreover, ginger extract prevents high-fat diet-induced obesity. The aqueous extract of *Z. officinale* might prevent the intestinal absorption of dietary fat by preventing its hydrolysis. Therefore, ginger appears to develop body composition via its effects on liver enzymes, by reducing fat absorption, by increasing beta-oxidation of fats and energy reduction [46].

11. Antiarthritic Effect

An important study on osteoarthritis patients of knee has exposed that, extremely purified and standardized ginger extract had major effect on reducing symptoms of osteoarthritis of the knee [47]. Ginger is effective as indomethacin in releasing symptoms of osteoarthritis with negligible side effects [48]. A well characterized crude ginger extract was related with a fraction containing 6-gingerol and their derivatives to prevent joint swelling in an animal model of rheumatoid arthritis, streptococcal cell wall-induced arthritis. Both extracts established anti-inflammatory activity. The crude dichloromethane extract, having essential oils and other polar compounds, was more effective, when stabilised to 6-gingerol content, in preventing, both joint inflammation and destruction [49].

12. Effect on migraine

Migraine is characterized by attacks of extreme pulsatile and sore headache, typically autonomous in nature with or without aura. Related symptoms, such as nausea, vomiting and keen sensitivity to light (photophobia), and sound (phonophobia) may happen during the headache phase. Migraine affects a significant part (10-20 %) of world population (more women than men). Ginger is described in ayurvedic system of medicine to be beneficial in neurological disorders. 500-600mg of ginger powder administration at the onset of migraine for 3-4 days at break of 4 hours, stated to provide relief from migraine attack [50].

12. Radio Protective Activity

The radioprotective effect of the hydro-alcoholic extract of ginger rhizome was considered at an i.p. dose of 10 mg/kg, once daily for five sequential days before exposure to 6-12 Gy of gamma radiation, and were observed daily up to 30 days post-irradiation for the improvement of marks of radiation infection and mortality. The protection of ginger against radiation lethality was also confirmed [51]. Ginger extract moderates the neuro-behavioral effects of gamma radiation-induced conditioned taste aversion in Sprague/Dawley rats [52]. *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- κ B from cytosol to nucleus in HaCaT cells was repressed by 6- gingerol via suppression of I κ B α

phosphorylation (ser-32). Inspection by EMSAs and immunohistochemistry exposed that topical application of 6-gingerol (30 μ M) prior to UVB irradiation (5 kJ/m²) of hairless mice, also inhibited the induction of COX-2 mRNA and protein, as well as NF- κ B translocation [53].

13. Effect of ginger on eye

Compounds isolated from ginger were screened for their aldose reductase inhibitory activities *in vitro*. Ginger compounds inhibited sorbitol accumulation in human erythrocytes and lens galactitol accumulation in the galactose-fed cataract rat [54]. An *in vitro* test presented that an aqueous extract of ginger with dose 0.1 and 1.0 mg/mL reduced CML-KLH and MGO-derived progressive glycation end products (AGE) products by 60%-80% and glucose-derived AGE products by 50%-60% [55]. In the STZ-induced diabetic rats, feeding of ginger significantly suppressed the formation of different AGE products, including carboxymethyl lysine in the lens. Moreover, the development and beginning of cataract were delayed [56].

14. Neuro protective activity

The daily dose (4 mg/kg⁻¹) i.p. injection of pure monosodium glutamate (MSG) for 30 days and later removal 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 breaks studied. The neuroprotective effect is relatively attributable to an opposed action of ginger root extracts on monosodium glutamate effect, so the monoamines content was increased. Ginger extract has a neuroprotective role against monosodium glutamate toxicity effect [57].

2. CONCLUSION

Medicinal plants are a source of great economic value all over the world. *Zingiber officinale* is an important plant because of their numerous medicinal, ethno medicinal and nutritional values used in traditional medicine. Ginger is one of the well-known medicinal herbs that are used both by traditional healers and in some modern treatment modalities. The existing medicinal information is sufficient to recommend ginger and its extract as reliable treatment option for some diseases of human. Ginger is consumed worldwide as a spice and flavouring agent and is recognized to have many medicinal properties. Ginger has a number of chemical responsible to provide different medicinal properties such as neuro-protective, cardio-protective, anti-inflammatory, anti-microbial, antioxidant, anticancer properties, etc. This review will help to facilitate all necessary information about the ginger as one of the important medicinal plant and advance work should be assumed for the production of pharmaceutical products for their better economic and therapeutic utilization for the benefit of mankind.

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CONFLICT OF INTEREST

Authors have no any conflict of interest.

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