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Review

Pharmacological Uses and Health Benefits of Ginger (*Zingiber officinale*) in Traditional Asian and Ancient Chinese Medicine, and Modern Practice

Mohamad Hesam SHAHRAJABIAN[1,2], Wenli SUN[1,2], Qi CHENG[1,2*]

[1]*Chinese Academy of Agricultural Sciences, Biotechnology Research Institute, Beijing 100081, China*
[2]*Qi Institute, Nitroegn Fixation Laboratory, Building C4, No. 555 Chuangye County, Jiaxing 314000, Zhejiang, China; hesamshahrajabian@gmail.com; sunwenli@caas.cn; chengqi@caas.cn (*corresponding author)*

Abstract

Ginger (*Zingiber officinale*) has been used as a spice and a medicine for over 200 years in traditional Chinese medicine. Ginger is an important plant with several medicinal and nutritional values used in Asian and Chinese tradition medicine. Ginger and its general compounds such as Fe, Mg, Ca, vitamin C, flavonoids, phenolic compounds (gingerdiol, gingerol, gingerdione and shogaols), sesquiterpenes, paradols has long been used as an herbal medicine to treat various symptoms including vomiting, pain, cold symptoms and it has been shown to have anti-inflammatory, anti-apoptotic, anti-tumor activities, anti-pyretic, anti-platelet, anti-tumourigenic, anti-hyperglycaemic, antioxidant anti-diabetic, anti-clotting and analgesic properties, cardiotonic, cytotoxic. It has been widely used for arthritis, cramps, sprains, sore throats, rheumatism, muscular aches, pains, vomiting, constipation, indigestion, hypertension, dementia, fever and infectious diseases. Ginger leaves have also been used for food flavouring and Asian traditional medicine especially in China. Ginger oil also used as food flavouring agent in soft drink, as spices in bakery products, in confectionary items, pickles, sauces and as a preservatives. Ginger is available in three forms, namely fresh root ginger, preserved ginger and dried ginger. The pharmacological activities of ginger were mainly attributed to its active phytocompounds 6-gingerol, 6-shogaol, zingerone beside other phenolics and flavonoids. Gingerol and shogaol in particular, is known to have anti-oxidant and anti-inflammatory properties. In both traditional Chinese medicine, and modern China, Ginger is used in about half of all herbal prescriptions. Traditional medicinal plants are often cheaper, locally available and easily consumable raw and as simple medicinal preparations. The obtained findings suggest potential of ginger extract as an additive in the food and pharmaceutical industries.

Keywords: ginger; modern medicine; pharmacological science; traditional Chinese medicine

Introduction

Ginger occurrence, cultivation, chemical constituents, nutrient composition and chemical composition

Traditionally, Chinese medicine includes herbal medicines and acupuncture (Akinyemi *et al*., 2016; Shahrajabian *et al*., 2018; Ogbaji *et al*., 2018; Shahrajabian *et al*., 2019a,b,c,d,e; Shahrajabian *et al*., 2020). *Zingiber officinale* is a member of the *Zingiberaceae* plant family, native to East and southern Asia, consisting of 49 genera and 1300 species, 80-90 of which are *Zingiber*. Its generic name *Zingiber* is derived from the Greek *zingiberis*, which comes from the Sanskrit name of the spice, singabera; the Latin name, *Zingiber*, means shaped like a horn and refers to the roots, which resemble a deer's antlers (Sharma *et al*., 2017). The plant is known as Sringavera in Sanskrit (Vasala, 2004). Ginger (*Zingiber officinale* Roscoe.) has a long history of being used as a medicine and herbal since ancient time and had been used as an important cooking spice throughout the world (Nour *et al*., 2017). It is a plant that is used in folk medicine from south-east Asia, and in Greco-Roman traditions, Brazil, Australia, Africa, China, India, Bangladesh, Taiwan, Mexico, Japan, Jamaica, the India, the Middle East and parts of the United Sates also cultivate the rhizomes for medicinal purpose (Langner *et al*., 1998; Blumenthal *et al*., 2000; Sekiwa *et al*., 2000; Yadav *et al*., 2016). El-Sayed and Moustafa (2016) reported that ginger rhizome is widely used as a spice or condiment. For

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centuries has been an important ingredient in traditional Chinese medicine, Ayurvedic, and Unani-tibb herbal medicines for the treatment of different diseases (Willetts *et al*., 2003; Ali *et al*., 2008; Memudu *et al*., 2012). *Zingiber officinale* was also one of the first oriental spices to be grown to the Europeans, it was introduced to northern Europe by the Romans who got it from Arab traders and was one of the most popular spices in the Middle Ages (Kala *et al*., 2016). Alakali *et al*. (2009) also mentioned that ginger was one of the earliest oriental species known in Europe in the 9th century, in the 13th century, it was introduced to East Africa by the Arabs. In West African and other parts of the tropics, it was introduced by the Portuguese in the 16th century (Kochhar, 1981). The spice was known in Germany and France in the ninth century and in England in 10th century for its medicinal properties (Yadav *et al*., 2016). Elzebroek and Wind (2008) found that Marco Polo, introduced to ginger while visiting China and Sumatra in the 13th century, transported some to Europe. They have also discussed how the cultivation of ginger in Mexico was initiated by the Spaniard, Francesco de Mendoza. In China, dried Ginger, known as Gan-jiang is mentioned in the earliest of herbals, She Nung Ben Cao Jing, attributed to Emperor Shen Nung (almost 2000 BC). Chinese records dating from 4th century BC indicate that Ginger was used to treat numerous conditions including stomach ache, diarrhea, nausea, cholera, henorrhage, rheumatism, and toothaches. Not only in traditional Chinese medicine, but also in modern China, Ginger is used in about half of all herbal prescriptions, because of its ability to act as messenger, servant and guide herb that brings other herbal medicines to the site where they are needed (Afzal *et al*., 2001). Ginger cultivation back about 3000 years ago in India, and it remains an integral part of Indian cuisine where it is commonly used in many popular dishes (Daily *et al*., 2015). Lister (2003) revealed that the ginger plant has a long history of cultivation known to originate in China and it was one of the most parts of Chinese traditional medicine, and then spread to India, Southeast Asia, West Africa and the Caribbean. In Korea, ginger has been used to season foods for the last 1000 years approximately (Daily *et al*., 2015). Sliced ginger with sugar added is used to make tea, prickled ginger slices (Gari) are frequently used a condiment in Japan, and ginger is commonly used to flavour cookies and cakes in Western countries.

Zingiber officinale Roscoe classification is Kingdom: Plantae-plants, Subkingdom: Tracheobionta-vascular plants, Superdivision: Spermatophyta-seed plants, Division: Magnoliophyta-flowering plants, Class: Liliopsida-Monocotyledons, Subclass: Zingiberidae, Order: Zingiberales, Family: Zingiberaceae- Ginger family, Genus: *Zingiber* P. Mill - Ginger, Species: *Zingiber officinale* Roscoe- Garden ginger. Red Ginger (*Z. officinale* var. *rubra*) is a variance of the *Zingiber officinale* species cultivated in Indonesia and Malaysia. Moreover, having gingerols and shogaols, it is loaded with anthocyanin and tannin in its root bark. Traditionally, it is used in species, syrup and as remedy for rheumatism, osteoporosis, asthma and cough. Some of the country grows with variation in species viz: Indian, Nepal, Bangladesh, Sri Lanka ginger - (*Zingiber officinale*), Jamaican ginger - (*Zingiber officinale*), Chinese ginger - (*Asarum splendens*), Australian ginger - (*Alpinia caerulea*), Nigerian ginger - (*Zingiber officinale* white and yellow variety), Japanese ginger - (*Zingiber mioga*), Indonesian ginger - (*Alpinia galangal*), and Hawaiian Island - (*Zingiber zerumbet*) (Sandeep, 2017). Common names of Ginger in different countries are, Chinese: Geung, Cook Islands: Kopakai, English: Ginger, Fiji: Cagolaya ni vavalagi, Hawaiian: Awapuhi Pake, India: Adrak and Inchi, Japan: Shoga, Java: San gurng, Gung Guung, San geong, Atjuga, Niue: Poloi, Solomon Islands: Papasa, Spanish: Jengibre, Thailand: Khing, Vietnamese: Gung. Black ginger, the rhizome of *Kaempferia parviflora* (Zingiberaceae), has traditionally been used as food and a folk medicine for one thousand year in Asian traditional medicine especially in Thailand. The dried rhizome is pulverized and used as tea bags, while fresh one is utilized to brew wine. As dietary supplements, it has been made into various preparations such as medicinal liquor or liquor plus honey, pills, capsules and tablets. It has been claimed that black ginger is appropriate to cure allergy, asthma, impotence, gout, diarrhoea, dysentery, peptic ulcer and diabetes (Toda *et al*., 2016). Other notable member of this family (Zingiberacea) is turmeric otherwise called red ginger (*Curcuma longa*) (Akinyemi *et al*., 2015). It is a rhizomatous herbaceous perennial plant, in the ginger family, employed as a dye source food colorant due to its characteristics yellow colour (Chan *et al*., 2009).Ginger is a warm-season crop adapted for growth in tropical and subtropical regions. Best growth occurs under moist conditions and temperatures of 25-28 °C. Growth efficiency declines with temperatures above 30 °C and below 24 °C. Ginger grows well in full sun. Vegetative growth is promoted with long day lengths, and rhizome enlargement is promoted under shorter day lengths. Ideal pH is 5.5-6.5 and it requires a deep (25-40 cm), rock-free, sandy loam soil, high in organic matter with adequate drainage that allows for proper hilling of the crop. Ginger is usually available in three different forms: 1) Fresh (green) root ginger, 2) Preserved ginger in brine or syrup, 3) Dried ginger spice. Fresh ginger is usually consumed in the area where it is produced, although it is possible to transport fresh roots internationally. Both mature and immature rhizomes are consumed as a fresh vegetable. Preserved ginger is only made from immature rhizomes. Most preserved ginger is exported; Hong Kong, China and Australia are the major producers of preserved ginger and dominate the world market. Dried ginger spice is produced from the mature rhizome. As the rhizome matures the flavour and aroma become much stronger. Dried ginger is exported, usually in large pieces which are ground into a spice in the country of destination. Dried ginger can be ground and used directly as a spice and also for the extraction of ginger oil and ginger oleoresin. The main area under ginger covering is related to Nigeria 56.23% of the total global area followed by India (23.6%), China (4.47%), Indonesia (3.37%), and Bangladesh (2.32%) (Dhanik *et al*., 2017). Top ten Ginger producing country of the world has been shown in Table 1.

The nutritional composition of Ginger is shown in Table 2; nutritional profile is presented in Table 3 and the active chemical constituents in shown in Table 4.

Table 1. Top ten Ginger producing country of the world (Dhanik *et al*., 2017)

No.	Country	Production (Tonnes)
1	India	683000
2	China	425000
3	Nepal	235033
4	Indonesia	232669
5	Nigeria	160000
6	Thailand	140000
7	Bangladesh	69000
8	Japan	57835
9	Cameroon	46350
10	Philippines	28216

Table 2. Nutritional composition of Ginger (per 100 g) (Sandeep, 2017)

Constituent	Value
Moisture	15.02±0.04
Protein (g)	5.087±0.09 (5.98)
Fat (g)	3.72±0.03 (4.37)
Insoluble fibre (%)	23.5±0.04 (30.0)
Soluble fibre (%(	25.5±0.04 (30.0)
Carbohydrate (g)	38.35±0.1
Vitamin C (mg)	9.33±0.08 (10.97)
Total carotenoids (mg)	79±0.2 (92.96)
Ash (g)	3.85±0.61 (4.53)
Calcium (mg)	88.4±0.97 (104.02)
Phosphorous (mg)	174±1.2 (204.75)
Iron (mg)	8.0±0.2 (9.41)
Zinc (mg)	0.92±0 (1.08)
Copper (mg)	0.545±0.002 (0.641)
Manganese (mg)	9.13±0.01(10.74)
Chromium (µg)	70±0 (83.37)

All value in this table represent the mean ± SD (n=4). Figures in the parenthesis represent the dry weight values (Shirin Adel and Prakash, 2010)

Table 3. Nutritional profile of Ginger (100 g) (Singh *et al*., 2017)

Types of nutrient	Examples of nutrient	Amount
Protein	----	1.8 g
Water	----	78.9 g
Phyto-sterols	----	15 mg
	Total Carbohydrate	18 g
Carbohydrates	Dietary Fibre	2 g
	Sugar	1.7 g
	Total Fat	750 mg
	Saturated Fat	203 mg
Fats and Fatty acids	Monounsaturated Fat	154 mg
	Polyunsaturated Fat	154 mg
	Omega-3 Fatty Acids	34 mg
	Omega-6 Fatty Acids	120 mg
	Vitamin C	5 mg
	Vitamin E	260 mcg
	Vitamin K	0.1 mcg
	Thiamin	25 mcg
Vitamins	Riboflavin	34 mcg
	Niacin	750 mcg
	Vitamin B6	160 mcg
	Folic acid	11 mcg
	Pantothenic Acid	203 mcg
	Choline	28.8 mg
	Calcium	16 mg
	Iron	600 mcg
	Magnesium	43 mg
	Phosphorous	34 mg
Minerals	Potassium	415 mg
	Sodium	13 mg
	Zinc	340 mcg
	Copper	226 mcg
	Manganese	229 mcg
	Selenium	0.7 mcg

Table 4. Active chemical constituents of Ginger (Kathi, 1999)

Phenols	Volatile	Others
	Sesquiterpenes	
Gingerols and Shogoals	Bisapolene, Zingiberene, Zingiberol, Sesquiphellandrene, Curcurmene	6-dehydrogingerdione, Galanolactone, Gingesulfonic acid, Zingerone, Geraniol, Neral, Monoacyldigalactosylglycerols, Gingerglycolipids

Minerals content of ginger for ginger root (Ground) consists of calcium (114 mg per 100 g), iron (19.8 mg per 100 g), magnesium (214 mg per 100 g), manganese (33.3 mg per 100 g), phosphorus (168 mg per 100 g), potassium (1320 mg per 100 g), sodium (27 mg per 100 g), and zinc (3.64 mg per 100 g), and minerals contents for ginger root (raw) are calcium (16 mg per 100 g), iron (0.6 mg per 100 g), magnesium (43 mg per 100 g), phosphorus (34 mg per 100 g), potassium (415 mg per 100 g), sodium (13 mg per 100 g), and zinc (0.34 mg per 100 g) (USDA, 2013). It was found that ginger contained 1.5%-3% essential oil, 2-12% fixed oil, 40-70% starch, 6-20% protein, 3-8% fibre, 8% ash, 9-12% water, pungent principles, other saccharides, cellulose, colouring matter and trace minerals (Chan *et al*., 2009).

Ginger is called different names in different parts of the world such as *Zingiberis* rhizome, Shen jiany, Cochin, Asia ginger, Africa ginger and Jamaican ginger (Peter, 2000). Kala *et al*. (2016) stated that ginger oil also used as food flavouring agent in soft drink, as spices in bakery products, in confectionary items, pickles, sauces and as a preservatives. There is variability in the compounding of ginger products. The relative composition in the extraction of ginger is determined by species of ginger, maturity of the rhizome, climate in which the plants are grown, when harvested, and preparation method of the extract (Grzanna *et al*., 2005). Gaur *et al*. (2016) also reported that agro-climatic conditions are known to influence the production of secondary metabolites in ginger rhizome when same cultivar is grown in two different locations. Ginger is affected by leaf spots; leaves may have small, whitish spots with yellow edges; these get larger and spread, making the leaf yellow then brown, killing it. Early in the crop, it can cause severe losses. *Fusarium* spp., *Rhizoctonia* spp. and *Pseudomonas solanacearum* have been found in diseased leaves. Ginger propagation is usually performed with rhizome but has a lot of obstacles, the obstacles among other is the availability of good quality seed rhizome (Melati *et al*., 2016). Rhizome again, filled out, no wrinkles, bright shiny skin colour, and free of pests' attacks is characteristics of high-quality seed (Hasanah *et al*., 2004).

Medicinal uses and potential health benefits in traditional and modern medicine industry

Ginger has direct anti-microbial activity and thus can be used in treatment of bacterial infections (Tan and Vanitha, 2004). In traditional Chinese medicine, it is employed in colic and in atonic dyspepsia and used as a stimulant (Keys, 1985; Grant and Lutz, 2000; Sharma, 2017; Yilmaz *et al*., 2018). Ginger is regarded as a Yang herb, which can decrease Yin and nourish the body (Jittiwat and Wattanathorn, 2012). Mishra *et al*. (2012) also revealed that ginger in traditional Chinese medicine, characterized as spicy and hot, and it is claimed to warm the body and treat cold extremities, improves a weak and tardy pulse, address a pale complexion, and strengthen the body after blood loss. In traditional Chinese medicine is used as herbal therapy against several cardiovascular diseases (Wynn *et al*., 2001), based, on the historical usage of ginger as an antiemetic agent in the East Traditional Medicine. The antiemetic effect of ginger has been known as a treatment method in traditional medicine especially the Chinese and Iranian medicine (Eric Chan *et al*., 2011; Palatty *et al*., 2013; Naderi *et al*., 2016; Soltani *et al*., 2018). Sharma (2017) explained that many of herbs and plant extracts such as ginger is based on what has been used as part of traditional medicine systems and there is a large body of anecdotal evidence supporting their use and efficacy. Some other researchers emphasized that ginger plays an important role in Ayurvedic, Chinese, Arabic and African traditional medicines used to treat headaches, nausea, colds, arthritis, rheumatism, muscular discomfort and inflammation (Baliga *et al*., 2011; Dehghani *et al*., 2011). Recently, ginger rhizomes are used in traditional medicine as therapy against several cardiovascular diseases such as hypertension (Ghayur *et al*., 2005). Niksokhan *et al*. (2014) reported that ginger has been used in traditional medicine of Iran as an anti-edema drug and is used for the treatment of various diseases including nausea, gastrointestinal disorders, respiratory disorders, athero-sclerosis, migraine, depression, gastric ulcer, cholesterol; and other benefits of giner are reducing pain, rheumatoid arthritis, anti-inflammatory, and antioxidant effects. Surh *et al*. (1998), and Manju and Nalini (2010) mentioned that ginger is one of the most widely used spices in India and has been utilized frequently in traditional oriental medicine for common cold, digestive disorders and rheumatism. Ursell (2000) and Oludoyin and Adegoke (2014) reported that ginger is a perennial plant with narrow, bright green, grass-like leaves, and it is cultivated in the tropics for its edible rhizomes and has been found to be useful for both culinary and medicinal purposes. Schwertner and Rios (2007) reported that the main components of ginger are 6-gingerol, 6-shogaol, 8-gingerol, and 10-gingerol and these constituents have previously been

shown to exhibit strong antioxidant activity. 6-gingerol was reported as the most abundant bioactive compound in ginger with various pharmacological effects including antioxidant, analgesic, anti-inflammatory and antipyretic properties (Kundu *et al*., 2009; Dugasani *et al*., 2010). The shogaols can be partially transformed to paradols upon cooking or metabolized to paradols in the animals' body after being consumed and absorbed by digestive system (Wei *et al*., 2017). Gingerol and shogaol in particular, is known to have anti-oxidant and anti-inflammatory properties (Kim *et al*., 2005) and it is shown in Fig. 1.

Ginger extract can remove disorders caused by oxidative stresses as a strong anti-oxidant. Studies have shown that extant phenolic compounds and anthocyanins including gingerols and the sugevals had many neuro protective effects such as analgesic effects, memory improvement, and learning caused by the aging process (Fadaki *et al*., 2017). For culinary purposes ginger is suitable for all dished both sweet such as drinks, puddings, apple pie, cakes, breads, candies, etc; and savoury such as soups, sauces, stews, savory puddings, grills, roasts, etc) (Oludoyin and Adegoke, 2014). Oludoyin and Adegoke (2014) stated that the active hypoglycemic component of ginger was not affected by heat, hence, the consumption of ginger in raw and cooked forms in different cuisines maybe an effective regimen in the management of diabetes. Similarly, the medicinal uses of ginger are enormous such as exert anti-microbial, anti-nausea (Portnoi *et al*., 2003), anti-pyretic (Suekawa *et al*., 1984), analgesic, anti-inflammatory, hypoglycaemic (Ojewole, 2006; Young et al., 2005), anti-ulcer, antiemetic (Mascolo *et al*., 1989), cardio tonic, anti-hypertensive (Ghayur and Gilani, 2005), hypolipidemic (Al-Amin *et al*., 2006), anti-platelet aggregation (Bordia *et al*., 1997) effects in both laboratory animals and human subjects. Turmeric is one of the main ingredients for curry powder, and used as an alternative to medicine and can be made into a drink to treat colds and stomach complaints (Chan *et al*., 2009). In folk medicine, turmeric has been used in lowering blood pressure and as tonic and blood purifier (The Wealth of India, 2001). Phytochemical investigation of several types of ginger rhizomes has indicated the presence of bioactive compounds, such as gingerols, which are antibacterial agents and shogaols, phenylbutenoids, diarylheptanoids, flavanoids, diterpenoids, and sesquiterpenoids (Sivasothy *et al*., 2011; El Makawy *et al*., 2019). It has been proved in some researches that ginger leaves has great potential to be developed into functional foods and other health products, because it has higher antioxidant activity than rhizomes and flowers (Park *et al*., 2014). When compared to the Indian varieties, the Chinese ginger is low in pungency and is principally exported as preserves in sugar syrup or as sugar candy (Govindarajan, 1982).Semwal *et al*. (2015) reported that an infusion of ginger rhizomes with brown sugar is administered to relieve common colds, while scrambled eggs with powdered ginger is taken as a home remedy to reduce coughing in China. While, ginger is used in the United States as a remedy to alleviate motion sickness and morning sickness during pregnancy and to reduce hear cramps (Semwal *et al*., 2015). Furthermore, there are many studies that proved their beneficial effects against the symptoms of diseases, acting as anti-inflammatory, anti-tumour, anodyne, neuronal cell protective, anti-fungal and anti-bacterial agent (Mesomo *et al*., 2012; Yassen and Ibrahim, 2016). Various ginger compounds and extracts have been tested as anti-inflammatory agents, where the length of the side chains determines the level of the effectiveness (Bartels *et al*., 2015). But, a combination of ginger extracts is more effective in decreasing inflammatory mediators than an individual compound (Lantz *et al*., 2007). The active ingredients in ginger are thought to reside in its volatile oils (Aldhebiani et al., 2017). The major ingredients in ginger oil are bisabolene, zingiberene, and zingiberol (Moghaddasi and Kashani, 2012). Some other scientists noted that the interest in ginger is endorsed to its several biologically active compounds content such as gingerol, shogaols, gingerdiol, gingerdione, α-zingiberene, curcumin, and β-sesqui-phellandrene (Zhao *et al*., 2011). Ginger has been part of the folk medicine and popular nutraceuticals (Bartels *et al*., 2015). Ginger consists of a complex combination of biologically active constituents, of which compounds gingerols, shogoals and paradols reportedly account for the majority of its anti-cancer inflammatory properties (Tjendraputra *et al*., 2001). 6-paradol was suggested as a therapeutic agent to effectively protect the brain after cerebral ischemia, likely by attenuating neuroinflammation in microglia (Gaire *et al*., 2015). *Zinger officinale* used as a condiment in several countries but also it acts as a treatment for ailments; for instance, gastrointestinal disorders, colds, arthritis, hypertension and migraines (White, 2007; Hosseini *et al*., 2015). Maghbooli *et al*. (2014) confirmed

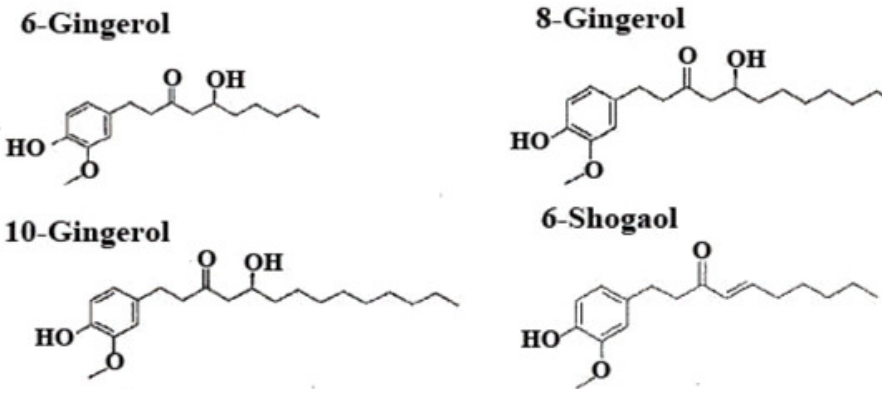

Fig. 1. Structure of 6-Gingerol, 8-Gingerol, 10-Gingerol and 6-Shogaol

the efficiency of ginger powder in the therapy of common migraine attacks and its similarity to the antiepileptic drug. Many studies have reported that Ginger has useful effects to cancer prevention (Lee *et al*., 2008), also treatment of nausea and vomiting due to pregnancy and chemotherapy (Pongrojpaw *et al*., 2007; Ryan *et al*., 2012). The anti-spasmodic effect of Ginger is due to the blocked of cyclooxygenase and 5-lipoxygenase (van Breemen *et al*., 2011). Also, it has been reported that ginger lowers blood pressure through blockade of voltage dependent calcium channels (Ghayur and Gilani, 2005). Khaki *et al*. (74) reported that ginger has a protective effect against DNA damage induced by H_2O_2 and maybe promising in enhancing healthy sperm parameters. In Iran, traditionally ginger rhizome was used for enhancing male sexuality, regulating female menstrual cycle, and also reducing painful menstrual periods (Hafez, 2010). Adib Rad *et al*. (2018) reported that ginger as well as Novafen is effective in relieving pain in girls with primary dysmenorrhea, and treatment with natural herbal medicine, non-synthetic drug, is recommended to reduce primary dysmenorrhea. Karangiya *et al*. (2016) concluded that the supplementation of garlic improves the performance of broilers when added at the rate of 1% of broiler and can be a viable alternative to antibiotic growth promoter in the feeding of broiler chicken. Manju and Nalini (2010) found that ginger supplementation to 1,2-dimethyl hydrazine (DMH) treated rats inhibited colon carcinogenesis, as evidenced by the significantly decreased number and incidence of tumours; in addition ginger optimized tissue lipid peroxidation and antioxidant status in DMH treated rats. Dinesh *et al*. (2015) suggested that for growth promotion and management of soft rot disease in ginger, GRB35 *B. amyloliquefaciens* and GRB68 *S. marcescens* could be good alternatives to chemical measures; they also recommend the use of *B. amyloliquefaciens* for integration into nutrient and disease management schedules for ginger cultivation. Mahsani and Bukhari (2019) found that the extract of ginger rhizome have different effects on cells and anti-bodies of the immune system in smokers and non-smokers, although both benefited from enhancement of the thyroid gland. In their research, it has been found that ginger maybe beneficial for smokers with anemia, while for non-smokers, it may lead to a stronger antibody response or humoral immunity against infections. Vemuri *et al*. (2017) found that aqueous natural extracts mixtures (NE mix) prepared from common spice like ginger is a potential alternative therapeutic approach in certain types of cancer. Bartels *et al*. (2015) concluded that ginger maybe considered as a part of the symptomatic treatment of osteoarthritis (OA), where the patient is motivated for trying this nutraceutical. Schnitzer *et al*. (2002) mentioned that evidences is now provided suggesting that it may have a place in the management of OA of the knee, and coated ginger extract maybe considered for this purpose in the future. Adib Rad *et al*. (2018) found that Ginger reduced menstrual pain, and it is effective in relieving pain in girls with primary dysmenorrhea; moreover, Drozdoz *et al*. (2012) mentioned that Ginger is a safe drug with minimal side effects. Singara *et al*. (2017) reported that ginger is an effective non pharmacological option for treating hyperemesis gravidarum with respect to the inherent heterogeneity of the available studies. Gholampour *et al*. (2017) found that ginger extract appears to exert protective effects against ferrous sulphate-induced hepatic and renal toxicity by reducing lipid peroxidation and chelating iron. Atashak *et al*. (2014) mentioned that 10 weeks of either ginger supplementation or progressive resistance training (PRT) protects against oxidative stress and therefore both of these interventions can be beneficial for obese individuals. Jittiwat and Wattanathorn (2012) demonstrated that ginger pharmacopuncture at GV20 can improve memory impairment following cerebral ischemia more rapidly than acupuncture, and one probable mechanism underlying this effect is improved oxidative stress. Yilmaz *et al*. (2018) found the positive effects of ginger in folliculogenesis and implantation. They have also found that ginger may enhance implantation in rats in long term with low dose. In other studies, the favourable outcomes have been reported on the positive effects of ginger on male infertility and sperm indices (Khaki *et al*., 2012; Ghlissi *et al*., 2013). Akinyemi *et al*. (2016) described that dietary supplementation with both types of rhizomes, namely ginger and turmeric, inhibited arginase activity and prevented hypercholesterolemia in rats that received a high-cholesterol diet. In conclusion, these activities of ginger represent possible mechanisms underlying its use in herbal medicine to treat several cardiovascular diseases. Amri and Touil-Boukoffa (2016) concluded that Ginger has an important anti-hydatic effect *in vitro*, and this herbal product may protect against host's cell death by reducing the high levels of nitric oxide (NO). They finally suggest the promising use of ginger in the treatment of *Echinococcus granulosus* infection. Soltani *et al*. (2018) recommend administration of oral ginger one hour before operation to control the severity of postoperative nausea and vomiting (PONV) in patients undergoing laparoscopic cholecystetcomy. Daily *et al*. (2015) claimed that ginger root supplementation significantly lowers blood glucose and HbA1c levels, and when combined with dietary and lifestyle interventions, it may be an effective intervention for managing Type 2 diabetes mellitus. Islam *et al*. (2014) boiled ginger extracts can be used in food preparation as well as against pathogenic bacteria during active infection. Viljoen *et al*. (2014) suggested potential benefits of ginger in reducing nausea symptoms in pregnancy. They have found that ginger could be considered a harmless and possibly effective alternative option for women suffering from nausea and vomiting during pregnancy (NVP). Zaman *et al*. (2014) mentioned that ginger root extract significantly inhibited the gastric damage and ginger root showed significant anti-ulcerogenic activity in the model studied; it can be a promising gastro-protective agent. Willetts *et al*. (2003) concluded that ginger extract is a more effective treatment than placebo for nausea and retching during pregnancy. Yadav *et al*. (2016) demonstrated that ginger is one of the most commonly used spices and medicinal plants, and it is effective to improve diet induced metabolic abnormalities; however the efficacy of ginger on the metabolic syndrome associated kidney injury remains unknown. Naderi *et al*. (2016) stated that ginger powder supplementation at a dose of 1 g/d can reduce inflammatory

markers in patients with knee osteoarthritis, and it thus can be recommended as a suitable supplement for these patients. Mahmoud and Elnour (2013) discovered that ginger has a great ability to reduce body weight without inhibiting pancreatic lipase level, or affecting bilirubin concentration, with positive effect on increasing peroxisomal catalase level and HDL-cholesterol. Ebrahimzadeh Attari *et al*. (2015) revealed a minor beneficial effect of ginger powder supplementation on serum glucose and a moderate, significant effect on total cholesterol, as compared to the placebo. Malhotra and Singh (2003) also mentioned the effect of ginger on lowering cholesterol, and anti-hyperlipidemic agent, the role of ginger in the treatment of nausea and vomiting (anti-emetic), ginger possesses anti-skin tumour promoting effects, and that the mechanism of such effects may involve inhibition of tumour promoter-caused cellular, biochemical, and molecular changes (chemo-protective), anti-viral activity, anti-motion and anti-nauseant effects, anti-inflammatory, diminishing or eliminating the symptoms of hyperemesis gravidarum, ginger influence on exert abortive and prophylactic effects in migraine headache without any side effects and anti-ulcerogenic, Ginger and its constituent play pharmacological effects in cancer management via modulation of molecular mechanism, and the mechanism consist of inhibition of VEGF, activation of Bax, inhibition of Lypoxygenase, activation o P53, inhibition of Interlukin, inhibition of Bcl2 and Survivin, inhibition of Cycloxygenase, inhibition of IFN-γ, suppression of TNF and NF-kB and activation of G0/G1 phase (Rahmani *et al*., 2014). Accumulating evidence suggests that many dietary factors may be used alone or in combination with traditional chemotherapeutic agents to prevent or treat disease, and ginger is example of medicinal plants which is gaining popularity amongst modern physicians (Sakr and Badawy, 2011). Gagnier *et al*. (2006) provide an excellent framework for the development of future trials that focus on providing satisfactory answers to issues relating to the efficacy of *Z. officinale* to ameliorate different types of pain, as well as, dosing strategies, treatment duration, safety, and cost effectiveness.

Conclusions

Ginger is used worldwide as a cooking spice, condiment and herbal remedy, and it is also extensively consumed as a flavouring agent. Ginger, a plant in the Zingiberaceae family, is a culinary spice that has been as an important herb in traditional Chinese medicine for many centuries. More than 60 active constituents are known to be present in ginger, which have been broadly divided into volatile and non-volatile compounds. Hydrocarbons mostly monoterpenoid hydrocarbons and sesquiterpene include the volatile component of ginger and impart distinct aroma and taste to ginger. Non-volatile compounds include gingerols, shogaols, paradols, and also zingerone. The active ingredients like gingerols, shogaols, zingerone, and so forth present in ginger exhibit antioxidant activity. Among gingerols and shogaol the major pungent components in the rhizome are 6-gingerol and 6-shogaol. Gingerol, the active constituent of ginger has been isolated and studied for pharmacological and toxic effects. Fresh ginger has been used for treatment of nausea, cold-induced disease, colic, asthma, cough, heart palpitation, swellings, dyspepsia, loss of appetency and rheumatism. Medicinal properties associated with ginger are, anti-inflammatory properties, anti-thrombotic properties, cholesterol-lowering properties, blood pressure-lowering properties, anti-microbial properties, anti-oxidant properties, anti-tumor properties, and hypoglycaemic properties. Consumption of ginger also has beneficial effects on heart disease, cancer, hypertension, obesity, diabetes, osteoarthritis, and bacterial infections. Ginger is an herbal, easily available, low price medication which is associated with low risk can be substituted for chemical, scarce and expensive drugs. Based on other scientific literature, ginger demonstrates some promising health benefits, and more information gleaned from additional clinical studies will help confirm whether ginger's multiple health benefits can be significantly realized in humans. Herbal remedies and other nutraceuticals are increasingly and extensively used by a substantial part of the population. To sum up, treatment with natural herbal medicine especially ginger, non-synthetic drug is recommended.

Conflict of Interest

The authors declare that there are no conflicts of interest related to this article.

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