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Review Article

Pharmacological Application of Ginger

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Abstract

The basic four components of the Zingiber officinale plant, often known as ginger, are phenols, alkaloids, mucilage, and volatile oils. However, an aromatic essential oil made mainly of sesquiterpenoids, particularly (-)-Zingiberene with smaller amounts of bisabolene, farnesene, -sesquiphellandrene, phellandrene, cineol, and citral. Recent research has shown that ginger has a number of health advantages, including the reduction of menstrual cramps, immune-boosting qualities, treatment of lymphoma, osteoarthritis, ovarian cancer, radiation exposure, blood sugar and cholesterol problems, cataract prevention, chemotherapy-induced nausea relief, and more.

Keyword: Ginger; Traditional medicine; Gingerol; Shogaol; Zingerone

Introduction

Zingiber officinale, also known as ginger, was first grown in China and is now found everywhere [1]. Despite being a herb, the rhizomes, or ginger root is frequently referred to as a spice because of its potent flavor [2]. The best time to plant Ginger is in the spring, and it can be cultivated 3-5 months after it is planted and a tropical climate with high rainfall and a hot, dry season favours its growth [1-3]. It has been an inseparable part of human lives since the 1500s owing to its aroma, flavor, and medicinal attributes, which have been utilized to serve a wide range of purposes, like lending flavor to food and curing many ailments [4-6]. Ginger is currently experiencing a resurgence in popularity, and there are numerous scientific projects aimed at isolating and identifying the active components of ginger and validating the pharmacological activities. The objective of this essay is to review the most significant and recent reports on these probes [7,10].

History

In numerous cultures around the world, ginger has long been revered. It has long been valued for its fragrant, culinary, and medicinal qualities and is mentioned in ancient Chinese, Indian, and Middle Eastern writings [8,9,12]. The trade of such spices was the root of the world's economy for centuries [10]. However, it becomes almost lost in history after the fall of the Roman Empire but became popular again when Europe rediscovered it [10]. In recent years, Ginger has become more valued as a spice than for its medicinal properties [11,12]. For over Two thousand years, Chinese medicine has recommended using Ginger to help cure and prevent several health problems [13].

Classification and type of Ginger

Ginger has various blossom shapes, much like other plants. The floral arrangements, rhizome sizes, leaf forms, and other characteristics of the various species of ginger plants are very diverse [19]. This aromatic herb have a taxonmy as ilusterated in Table 1 and it goes by many names, but first and foremost, it is named by its scientific species, Zingiber officina l [14].

Types of Ginger Plants

Spiral Ginger: Southeast Asia is home to this ginger plant's native habitat. The Costus plant is also known as spiral ginger because its stalks are bamboo-shaped and twist to create a circular pattern. It blooms in summer season and thrive in a variety

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Table 1: Ginger Taxonomy.

Domain	Eukarya
Kingdom	Plantae
Phylum	Magnoliophyta
Class	Liliopsida
Order	Zingiberales
Family	Zingiberaceae
Genus	Zingiber Mill
Species	Zingiber officinale

Table 2: Chemical names, formulas, and Basic properties of Gingerol.

Molecular formula	$C_{17}H_{26}O_4$
Name	6-gingerol
IUPAC name	5-hydroxy-1-(3-hydroxy-4-methoxy-phenyl)decan-3-one
Molecular weight	294.386g/mol
Phase	Solid (at STP)
Boiling point	453°C
Melting point	31°C
Density	1.083g/cm^3
Solubility	Insoluble in water

of climates, including subtropical, temperate, and grasslands. Green bracts that create flower heads are this plant distinct feature and the bracts are arranged in an overlapping pattern with reddish tinge [15].

Hidden Ginger: The hidden ginger plant receives its name because its flowers are concealed by leaves. Yet, the name most people use to refer to this plant is curcuma. The curcuma is a deciduous plant with green or multi-colored leaves and branching rhizomes as its distinguishing features. Sometimes, a red flaw is found on the leaves. The stems of Curcuma plants are made of leaf petioles, and leaves grow from these petioles. As a result, these stems are often sometimes known as pseudo stems. The tops of the curcuma plant's pseudo-stems sprout flowers. Curcuma thrives in containers, but because it spreads quickly, the rhizomes must be often replanted [21].

Zingiber: Zingiber has a creamy golden color flowers that affixed to bracts with a pine-cone shape. The green bracts have a transparent edge, and the plant's cones contain a milky substance that is used to manufacture shampoo [22].

Butterfly Lily: The butterfly lily is also known as the White Ginger plant, Ginger Lily, Garland Lily, and Hedychium. This plant grows anywhere between 0.5 and 6 meters tall. The blossoms are quite large, and the leaves have a pleasant aroma. Hydechium is primarily used in gardening and transplanted frequently because their rhizomes spread quickly [16].

Globba: The blossoms of the Globba plant, which grows to a height of about 2 feet, hang from the stem. The leaves of the globba are long, and the branches are short in length. This plant's blooming season starts in July and continues up to the dormancy period in the fall. Bracts of globba are mauve-purple. The globba does well in the shade and is thought to thrive best in a well-drained, fertile soil. For propagation, little pieces of ginger root are employed [24].

Alpinia: Southeast Asian red ginger is renowned for its steady expansion. It has an 8-foot maximum height with pseudo stem of an alpinia plant is mushy, and the blooms are smaller. This plant has a pattern of tightly folded leaves, and its stem resembles a banana tree. Rhizome cutting is used to propagate Alpinia and it requires a lot of organic matter and a well-drained soil to grow healthily [17-21,25].

Chemical Constituent of Ginger and their Property

Chemical Composition of Ginger

Phenols, alkaloids, mucilage, and volatile oils are the four main components of ginger root [5]. Up to 3% of ginger contains an aromatic essential oil with sesquiterpenoids as its main constituents, primarily (-)-Zingiberene with smaller concentrations of β-sesquiphellandrene, bisabolene, farnesene, monoterpenoids, β-phellandrene, cineol, and citral [31].

Ginger's spicy flavor comes from nonvolatile phenylpropanoid-derived compounds that are formed when gingerols are dried or heated. Additionally, gingerols are changed into the less potent chemical gingerone, which has a spicy-sweet odor, during this process [8].

Ginger contains sugar, soluble and insoluble fiber, fatty acids, and amino acids, as well as calories, fat, carbohydrates, protein, and cholesterol [32]. It is also a good source of minerals like potassium, manganese, silicon, calcium, magnesium, phosphorus, sodium, iron, and zinc, as well as vitamin A, C, E, and B-complex [5].

Ginger's Chemical Composition Properties

Gingerol: The majority of ginger's spicy flavor and stimulating qualities are attributed to gingerol, it is an acrid component with basic features shown in Table 2. It is the active ingredient in fresh ginger, contains antioxidants and anti-inflammatory solid components, and gives ginger its characteristic flavor [3,8]. It is believed that the gingerols, which give ginger its pungency, are what make them effective for reducing fever and pain. Cold and flu viruses may be naturally killed by its volatile oils [2,30].

Gingerol reduces the proliferation of pancreatic cells as well as the invasion, motility, adhesion, and other behaviors of breast cancer cell lines. It induces viability reduction of gastric cancer cells, inhibits the growth of H.pylori associated with dyspepsia and pud, has antibacterial, anti-inflammatory, and anti-tumor-promoting activities, and the development of gastric and colon cancer [15,27]. Due to its anti-thrombotic characteristics, gingerol can lessen platelet aggregation [5,7,23].

Table 3: Chemical names, formulas, and physicochemical properties of Shogaol.

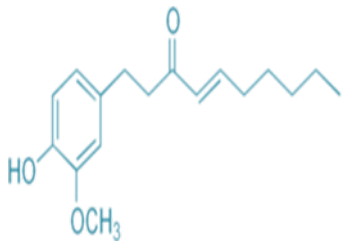
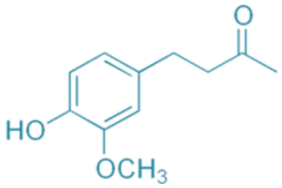
Molecular formula	$C_{17}H_{24}O_3$
Name	Shogaol
IUPAC name	(*E*)-1-(4-Hydroxy-3- methoxyphenyl)dec-4-en-3-one
Molecular weight	276.37
Chemical structure	Structure diagram: 
Boiling point	427-428°C
Melting point	32.5-34°C
Density	1.033g/cm^3
Solubility	Soluble in water, insoluble in paraffin oil

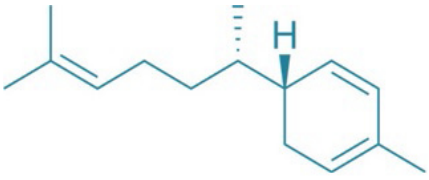
Table 4: Chemical names, formulas, and physicochemical properties of Zingerone.

Molecular formula	$C_{11}H_{14}O_3$
Name	Zingerone
IUPAC name	4-(4-hydroxy-3-methoxyphenyl)butane-2-one
Molecular weight	194.227g/mol
Chemical structure	Structure diagram: 
Phase	Solid (at STP)
Boiling point	141°C
Melting point	40.5°C
Density	1.14 g/cm^3
Solubility	Insoluble in water

Shogaol: Shogaol, also known as (6)-Shogaol, is a pungent component of ginger with basic qualities listed in Table 3. Its chemical structure is similar to that of Gingerol and it is produced during storage or by excessive heat and are most likely the result of a dehydration reaction, like Zingerone [26,29].

Zingerone: Zingerone, also known as vanillyl acetone, is a crucial component that gives ginger its pungency and is utilized as a flavoring agent in spice oils and perfumery to impart spicy scents with the fundamental characteristics shown in Table 4 [3,11]. Other flavoring substances like eugenol and vanillin share a chemical structure with gingerone. Zingerone is not present in fresh ginger; however, cooking it converts Gingerol, which is, into Zingerone through a retro-aldol reaction (reversal of aldol addition) [6,7].

Table 5: Chemical names, formulas, and Physicochemical properties of Zingiberene.

Molecular formula	$C_{15}H_{24}$
Name	Zingiberene
IUPAC name	2-Methyl-5-(6-methylhept-5-en-2-yl)cyclohexa-1,3-diene
Molecular weight	204.35 g mol^{-1}
Chemical structure	**Structure diagram**: 
Boiling point	134-135°C, 407-408 K, 273-275°F (at 2.0 kPa)
Melting point	167-168°C
Density	871.3 mg cm^{-3} (at 20 °C)

Zingiberene: Zingiberene, a monocyclic sesquiterpene, is the main component of ginger oil (Zingiber officinale), from which it gets its name [2,27]. It has a characteristic that is illustrated in Table 5.

Use of Ginger

Traditional use: Ginger is typically used as a ginger seasoning or flavoring agent in several recipes and foodstuffs, which vary according to the region in which they are prepared [4,15,24,25]. Ginger is a commonly used traditional treatment in naturopathy and ayurveda for a number of illnesses including muscle strains, sore throats, persistent coughs, asthma, headaches, colds, and diabetes [7,12,13,24-30]. It also helps congestion, flatulence, and nausea.

It is a common ingredient in traditional Chinese remedies, and usage of it generally seems harmless [6,29,31]. When used internally, ginger has stimulant, aromatic, and carminative effects. It also has a sialogogue effect when chewed. It is quite useful in atonic dyspepsia, particularly if it is accompanied by a lot of flatulence, and as a supplement to purgative medications to treat griping because of its stimulating, fragrant, and carminative qualities [8,23,24,32].

Medicinal use: In herbal therapy, ginger is a great digestive aid and intestinal spasmolytic. Recent scientific studies have found that ginger has a number of medical benefits [9,10,17,25,35].

Blood sugar and cholesterol management: STZ-induced diabetic rats received an intraperitoneal injection of an aqueous extract of raw ginger at a dose of 500mg/kg every day for seven weeks. The STZ-injected rats exhibited hyperglycemia accompanied by weight loss, indicating their diabetic condition. When compared to control diabetic rats, ginger-treated diabetic rats dramatically reduced serum levels of glucose, cholesterol, and triacylglycerol at a dose of 500mg/kg. Urine protein levels were significantly reduced as a result of the ginger therapy. Also, during the course of treatment, the diabetic rats given ginger maintained their initial weights. In addition, Ginger reduced urine production and water consumption in the STZ-induced diabetic rats [7,13,19,23].

Blood thinner: Gingerols, the active components of Ginger, represent a potential new class of platelet activation inhibitors. Supplementing 5gm of ginger powder with a fatty meal prevented the fall in fibrinolytic activity. This fibrinolytic-enhancing property is a further addition to the therapeutic potential of Ginger [24,29,32].

Cataract prevention: Age is associated with the development of several pathophysiologies, including diabetic cataracts for that Antiglycating potential of Zingiber delay of diabetic cataract. According to molecular studies, feeding ginger greatly reduced the production of Age products in the eye lens, including carboxymethyl lysine. In addition, it also countered hyperglycemia-induced osmotic stress in the lens [28,30-33].

Management of Chemotherapy-induced nausea: A diterpenoid constituent of Ginger has been shown to have activity similar to other antiemetic drugs used as adjuncts to chemotherapy. The antiemetic effects of Ginger are due to its local effect on the vagal receptors in the stomach [22]. This herb may be useful when consumed a few days before and a few days after chemotherapy to reduce nausea from this treatment. Researchers randomly assigned patients with bone cancer to either ginger root powder capsules or placebo capsules as an additional antiemetic to ondansetron and dexamethasone. There was more severe nausea and vomiting in the placebo group compared to the ginger group [23,30,34].

Protection against Colorectal Cancer and diarrhea: Gingerone, the active component that gives ginger its anti-diarrheal properties, can prevent E.coli heat-labile enterotoxin-induced diarrhea [30,33]. Also another active component of ginger, Gin-

gerols, also inhibit the growth of human colorectal cancer cells [19,33,35].

Gastrointestinal motility: Recent double-blind trials provide some indication to Ginger's effectiveness in decreasing gastrointestinal distress; this herb may be helpful for conditions that involve slow GI motility [7,17,19,26].

Inflammation reduction: Cyclooxygenase (COX) is an enzyme responsible for forming important substances called prostanoids, including prostaglandins, prostacyclin, and thromboxane. There are several types, including COX-1, 2, and 3. Inhibition of COX can help provide relief from the symptoms of inflammation and pain. The benefits of non-steroidal anti-inflammatory medications are achieved by inhibiting COX. This class of medications, including rofecoxib, celecoxib, and others, inhibit COX-2 [7,26,28,33,34]. Ginger roots have been used to treat inflammation and have been reported to inhibit COX. Ultrafiltration liquid chromatography-mass spectrometry was used to screen a chloroform partition of a methanol extract of ginger roots for COX-2 ligands and purified 10-gingerol, 8-Shogaol, and 10-Shogaol inhibited COX-2. However, No inhibition of COX-1 was detected. This can explain, in part, the anti-inflammatory properties of Ginger [7,19,26,30,33].

Lymphoma: Galangal, components of dietary ginger, are effective apoptosis inducers in Human T lymphoma Jurkat cells [19,30].

Osteoarthritis: There was a statistically significant reduction in knee osteoarthritis symptoms after taking ginger extract [19,30].

Ovarian cancer: Ginger's anticancer properties are attributed to certain pungent Vallinoids, viz. [6]-Gingerol and [6]-paradol, and some other constituents like Shogaols and Zingerone. Laboratory investigations in a variety of experimental models have revealed several potential pathways that may be involved in the chemopreventive actions of ginger and its constituents [24,27]. Ginger can kill ovarian cancer cells. It has been demonstrated that ginger spice can aid in reducing inflammation, which can aid in the growth of ovarian cancer cells. Several ovarian cancer cell lines were able to trigger cell death at a rate that was comparable to or superior to that of the platinum-based chemotherapy medicines that are frequently used to treat ovarian cancer [17,26,30].

Pregnancy: Ginger juice is effective in quelling morning sickness and relieving the severity of nausea and vomiting during pregnancy without harming the unborn child [17,19]36,37].

Radiation exposure: Irradiation of the animals resulted in a dose-dependent elevation in the lipid peroxidation and depletion of GSH; both effects can lessened by pretreatment with Ginger. Ginger also had a dose-dependent antimicrobial activity against Salmonella typhimurium, Escherichia coli, and Candida albicans [17,19,36].

Surgery-induced nausea: Ginger tea effectively prevents nausea and vomiting that often afflicts patients after surgery. In traditional Chinese medicine, ginger has been used to alleviate gastrointestinal problems like nausea and vomiting [17,19,38].

Immune Boosting Action: Ginger can help stimulate healthy perspiration, which is frequently beneficial during colds and the flu, in addition to being warming on a chilly day. A good sweat may do much more than assist detoxification [17,19,39]. Also it has a sialagogue effect, which increases salivation and facilitates swallowing [31].

Migraine Relief: Due to its capacity to prevent prostaglandins from generating pain and inflammation in blood vessels, ginger help to reduce migraines [17,19,40].

Menstrual Cramp Relief: Menstrual cramps are treated with ginger tea in Chinese medicine [7,19,40].

Summary

Currently, ginger grows almost all over the world and served in many forms and is used in a variety of dishes. Furthermore, numerous scientific research have shown that it has great pharmacological action to treat and prevent some pains as well as their severity.

Author Statements

Conflict of Interest

The authors, Neima Mohammed Ali and Tadios Tesfaye Mamo, declare there is no conflict of interests.

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