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# Essential Oil of Ginger: Effect of Cultivation and Uses

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## Abstract

Ginger (*Zingiber officinale* Rosc.) is a spice used in many parts of the world for culinary and medicinal purposes. It is a good source of essential oil with both the rhizome and its essential oil becoming increasingly acceptable for traditional, medicinal and commercial uses. Essential oils may be referred to as ethereal oils or volatile oils due to their volatile nature at room temperature. This review is intended to highlight the uses of ginger essential oil as well as summarise the effect of site, duration and geographical location of cultivation on the oil. In view, there are vast and abundant uses of ginger essential oil and different cultivars of ginger would be observed to differ in weight yield and composition, with China ginger oil (4.07% yield) having 43 compounds and Indian ginger oil (1.26% yeild) having 60 compounds, hence differing in quality and bioactivity. It may be concluded in this review that various aspects of cultivation as earlier mentioned affect the composition, bioactivity, potency, colour, aroma and weight yield of ginger essential oil which essentially affect its use from one culture to another.

**Keywords:** ginger, essential oil, uses, cultivation, composition

## 1. Introduction

Ginger is a widely cultivated food and medicinal crop in many parts of the world. It is amongst the most widely used spices globally [1]. It was first cultivated in Ethiopia in the 1200s and continues to be cultivated despite challenges of low quality, reduced economic output and poor handling by farmers and sellers [2]. Although with similar health benefits as fresh ginger, ginger essential oil is said to be the most potent portion of ginger [3].

The essential oil of ginger is the yellowish or green coloured volatile oil extracted from ginger rhizomes, which is about 1–3% of a rhizome. It may be obtained from fresh ginger rhizome, dried rhizomes or ginger peel, with oil from the fresh ginger reported to be of better fragrance than that from dried ginger [4, 5]. As it is known with spices, ginger oil is generally regarded as safe [GRAS] [6, 7]. It is known as the oil of empowerment because it gives the user a feeling of self-assurance and courage [3].

Ginger oil may be extracted from ginger rhizomes in different ways. It can be obtained traditionally (when it is crushed, macerated in water for about 12 h, heated with sesame oil, filtered and centrifuged), conventionally (crushed, macerated in sesame oil for 7 days, filtered and centrifuged) or by hydro distillation (with the use of

Clevenger-type apparatus) [8]. GC-MS analysis of ginger essential oils shows its major constituents to be Zingiberene,  $\beta$ -bisabolene,  $\alpha$ -curcumene, camphene, citral and geranial [5].

The volatile oil of ginger possesses extensive biological effects. The essential oil of ginger has been indicated as an antispasmodic, anti-inflammatory, antinociceptive and antioxidant agent [9–12]. It has also been used in the treatment of joint stiffness and pain [13] as well as a tonic for the uterus, brain and the stomach [14]. In addition, it is useful in managing respiratory disorders [15], relieves anxiety and is heart and liver friendly [16–18]. In fact, it has been proffered that the benefits derived from the use of essential oils of ginger is similar to that derived from fresh ginger [3], suggesting that the chemical constituents of fresh ginger are retained in its oils. It possesses antiseptic, antimicrobial, healing, anti-nausea and anti-stress properties and is thus employed in facilitating healing after surgical procedures [19, 20]. It aids digestion and is used in the treatment of stomach disturbances [21]. In addition, the essential oil of ginger is useful as a flavouring, preservative, perfumery and pesticidal agent [22]. These properties have been attributed to the volatile constituents such as monoterpenes and sesquiterpenes and pungent fractions of ginger, specifically, shogaols, gingerols and paradols [23]. The constituents of ginger essential oil are however affected in composition, potency and quantity by place, duration and region of cultivation, thus affecting its bioactivity, colour, aroma and ultimately its use.

## 2. Uses of ginger essential oil

### 2.1 As spice

Globally, ginger is used as spice in foods in order to add flavour and nutrient to food. In many cultures, it is used in the making of several dishes, adding to them a hot and distinctive spicy flavour [24]. It may be used fresh or in the dried form and is an essential ingredient of most spice blends [25]. The inclusion of ginger oil in food has been demonstrated to improve the quality and flavour of the food [26].

### 2.2 As a herbal drug

In ayurveda, Chinese or Tibb-Unani traditional medicine, ginger essential oil has been extensively employed [5, 27]. Indeed, spices from the family Zingiberaceae, including ginger, are well utilised in traditional medicine for the management and treatment of several conditions and diseases such as stomach ailments and indigestion, respiratory disorders, infections and anxiety [3, 11]. In Iranian traditional medicine, it is believed that traditional medicine is more potent when formulated with ginger oil, as against when ginger rhizome is used in its formulation [8]. In Indian traditional medicine, it is used as stop excessive blood clotting while in Arabian traditional medicine, it is used as an aphrodisiac [28].

### 2.3 Antimicrobial agent

The antimicrobial activity of ginger essential oil has been linked with the presence of abundant oxygenated compounds present [5]. At 12% V/V, it was found to be effective in reducing *Listeria monocytogenes* burden in food [1]. Its antifungal activity has also been demonstrated by [29]. Ginger essential oil may therefore act as a

preservative agent in food and its inclusion or marination into food may hence enhance the shelf life of food [26]. This has been found to be better achieved with the volatile oil encapsulated in protein fibres [30], thus enabling a gradual and controlled release of the oil into the food item, enhancement of solubility, as well as prevention of alteration in the food taste and thermal destruction of the oil [31].

#### **2.4 As a supplement**

Dietary supplementation with essential oil of ginger has been recorded to improve immunological, haematological and biochemical parameters as well as performance of broilers [32]. This is proposed to enhance organic poultry which is evidently healthier and was recently recommended in the poultry industry. Supplementing fish diet with ginger oil also improved resistance to disease, immune response and growth of the fishes [33]. In addition, ginger supplement in broiler feed increased feed conversion rate, weight gain, improved blood parameters and general performance of the birds [34]. [35] also reported how the inclusion of ginger essential oil in rabbit diet improved meat quality, growth performance and weight gain.

#### **2.5 As an antioxidant**

The essential oil of ginger is a potent antioxidant agent [36]. It was reported by [37] to improve the antioxidant status of heat stressed broilers and has been proposed to be a better source of antioxidants in the diet of broilers than synthetic antioxidants. In addition, ginger essential oil inhibits *in vitro* lipid peroxidation as well as scavenging hydroxyl and superoxide radicals [11]. Antioxidant enzymes, such as glutathione (GSH), superoxide dismutase (SOD), catalase and glutathione peroxidase (GPx), which were reduced in oxidative stressed rats was reported to increase with the oral administration of ginger essential oil [21].

#### **2.6 Anti-cancer agent**

Bioactive compounds present in ginger such as 6-gingerol have been documented to bring about apoptosis in cancerous cells. Treatment with the essential oil of ginger was seen to reduce tumour sizes by over 50% [11].

#### **2.7 Anti-inflammatory agent**

The use of ginger oil in the reduction of inflammation has been documented by [11]. The aromatic components of the essential oil of ginger such as terpenes are responsible for its anti-inflammatory activity [38]. Ginger oil also alters T cell non-specific production and cell-mediated immune response [39].

#### **2.8 For commercial use**

Ginger oil was largely produced in Europe and America but is now a great commercial product globally especially in Jamaica, China, Indonesia, India and Australia [4]. Ginger essential oil is utilised in production companies as a preservative (an antimicrobial), a food enhancer (to improve taste or flavour) or an additive. It has been employed in the production of bakery products, pharmaceuticals, beverages, pesticides, hair care products, aromatic oils for aromatherapy amongst others.

## **2.9 As an antinausea, antiemetic and gastroprotective agent**

The antinausea, antiemetic and gastro-protective activities of ginger has been extensively documented [40]. It has been said that the primary use of ginger is to combat nausea [28]. A study by [41] showed that the inhalation of the volatile oil of ginger reduced the post-operative occurrence of nausea and vomiting in human subjects that underwent abdominal surgery. Ginger essential oil was also shown to inhibit gastric ulcer in rats by 85.1% which was confirmed by histopathology of the stomach lining [21].

## **2.10 As beverage**

There is an increased cognizance on the health benefits of consuming ginger-based beverages thereby, leading to growth in its demand [42]. The use of natural products such as ginger to spice up beverages is currently more acceptable than the use of chemicals or synthetic agents, as natural products are known to enhance health by enriching food products with bioactive phytoconstituents and other essential nutrients needed by the body [43].

## **2.11 As perfume**

The strong aroma of ginger has made it a very good source of perfume [29]. This aroma has been attributed to gingerol, a pungent ketone, present in large quantity in ginger oil. Aromatherapy has been employed in the curation of nausea and vomiting in breast cancer patients exposed to chemotherapy. Thus, inhalation of ginger oil has been ascertained to be an effective complementary therapy in most cases of nausea and vomiting induced by chemotherapy [44].

## **2.12 Other uses**

Other uses of ginger essential oil include its antispasmodic, antidiabetic, antihypertensive, neuroprotective, antiplatelet aggregation, anticholesterolemic, antiseptic, carminative, appetite enhancer and expectorant uses [40]. It also promotes sweating, soothes aches, relaxes peripheral blood vessels as well as stimulates blood circulation [45].

## **3. Effect of cultivation**

Effective systemic cultivation of essential oil producing plants is vital for the constant production of essential oil. Many factors influence the production of essential oil producing plants and may thus affect the production of the oils themselves [46]. Improved cultivars are now seen to give better quality and quantity of oil [5].

### **3.1 Chemical composition**

Cultivation site as well as duration of cultivation has been said to affect the chemical composition of the essential oil of ginger, as well as their profile/constituents. The geographical location of the world in which ginger is cultivated also affects its chemical composition [47]. For instance, ginger grown in China was found with 43 different compounds [48] while the same species of ginger grown in Ghaziabad (India) possessed



80 compounds with varied proportions reported [49]. At Fiji, the compounds present in the same species of ginger were varied from that in India [47]. This variation in chemical composition has affected the therapeutic and commercial use of ginger essential oil [5]. An instance would be the reported proportion of zingiberene which was found to be varied depending on the country of cultivation. 9.5% was found in ginger cultivated in Mauritius while 29.0% was found in Nigerian ginger, 1.3% in Sri Lankan ginger, 38.12% in Chinese ginger, 20–28% in Australian ginger, 46.2% in Indian ginger and so on [4]. The variation in the chemical composition of 17 cultivars of ginger from North India has also been documented (**Table 1**) [58].

### 3.2 Bioactivity

Since the chemical composition of essential oil is seen to be affected by place and/or duration of cultivation, it may be proposed that the cultivation also affects the bioactivity of the essential oil of ginger [5]. It is expected that since cultivation alters the chemical composition and peak of the different compounds present in ginger, the activity of a specific volatile oil of ginger will be dependent on the compounds present in the oil, its quantity as well as the intensity or peak of the compounds. For instance, sesquiterpenes which are known to be effective antioxidant and anti-inflammatory agents [59] are not abundant in Sri Lankan ginger essential oil while monoterpenes which are strong antimicrobial agents [60] are abundant in it [47].

### 3.3 Potency

The peak intensity of ginger essential oil cultivated in different areas was considered and it was found that both the site and duration of cultivation affected the quality

Region of cultivation	Weight yield	Number of compounds	Colour	Dominant compound
China	4.07% [48]	43 [48]	Pale yellow to Amber [7]	38.12% Zingiberene [4]
Ghaziabad (India)	1.26% [49]	80 [46]	Yellow [7]	46.2% Zingiberene [4]
West Africa (Nigeria)	1.02%-2.4% [7]	54 [50]	Pale yellow [7]	29% Zingiberene (Nigeria) [4]
Australia	NA	NA	Yellow [51]	Citral (Neral and geraniol). 20-28% Zingiberene [4]
Sri Lanka	NA	NA	Golden [52]	Antimicrobial compounds (Monoterpenes). 1.3% Zingiberene [4]
Iran	1.2% [53]	55-59 [8]	NA	$\beta$ -sesquiphellandrene, Zingiberene, caryophyllene, ar-curcumene, farnesene [29]
Ecuador	NA	70 [54]	NA	$\alpha$ -zingiberene (17.4%) [54]
Brazil (Rio-de-Janeiro)	2.3% [55]	NA	NA	$\alpha$ -Zingiberene [56]
Vietnam	2.1% [57]	NA	NA	Ar-curcumene [57]

**Table 1.**  
 Effect of region of cultivation on ginger essential oil.

or potency of compounds present in the essential oil [47]. The variation in the degree of pharmacological activity of the essential oil of ginger from different cultivars has been documented. It was noted that the intensity of the different compounds in different cultivars affects the potency of ginger essential oil. Essential oil of ginger from Brazil, for instance, was found to be more effective against *Staphylococcus aureus* bacteria compared with ginger essential oil from Vietnam. This has been attributed to variation in quantity of ar-curcumene,  $\alpha$ -zingiberene, geranial,  $\alpha$ -farnesene,  $\beta$ -bisabolene and  $\beta$ -sesquiphellandrene in both cultivars (**Table 1**) [7].

### 3.4 Aroma and commercial use

Australian ginger essential oil has a “lemony” odour due to the presence of high quantity (about 51–71%) of citral (neral and geranial). Jamaican cultivar contains higher levels of sesquiterpenes and lower citral content than the Australian cultivar. This is responsible for the intensity of aroma and pungency detected in the ginger oil with higher proportions of gingerols and other pungent compounds, thereby probably making it more commercially viable than those with less aroma (**Table 1**) [61].

### 3.5 Weight yield

The weight yield of ginger essential oil is also affected by cultivation. [58] reported that the period of cultivation affected the weight yield of essential oil. In that study, it was found that ginger grown for only 5 months produced more essential oil than those grown for 7–8 months. This study was carried out in Sri Lanka and it is proposed that the higher essential oil yield in the less mature ginger is due to less fibre content and lower chemical intensity of the rhizome [58]. The variation in the quantity of essential oils produced from 17 cultivars of ginger from North India has been documented [58]. Indeed, different cultivars of ginger have been said to possess varied oil yielding capacities. This was reiterated by [5] who reported a difference in the proportion of ginger essential oil from different cultivars. In other studies, ginger grown in China was reported to give a 4.07% yield of the total weight of ginger [48] while that grown in India (Ghaziabad) yielded 1.26% of total weight of ginger. This disparity in quantity has affected the commercial availability of ginger essential oil significantly (**Table 1**) [5].

### 3.6 Colour

It has been reported that ginger essential oil derived from different geographical regions of the world differ in colour. Essential oil of ginger from West Africa is pale yellow, from India, it is yellow while that from China is pale yellow to amber. This might also affect acceptability and hence its commercial use. The colour variation has been attributed to alterations in the chemical composition of the oil from one region to another (**Table 1**) [7, 48].

## 4. Conclusion

The numerous uses for ginger and its essential oil continues to draw the attention of many to it. However, careful considerations must be taken in the selection of ginger essential oil due the effect of cultivation on the oil. The composition, potency,

bioactivity in addition to colour, aroma and quality of this essential oil is altered from one region of the world to another. This variation is also observed with the duration as well as the season of cultivation. As the site, duration, period or season of cultivation of ginger may influence the presence and quantity of specific compounds, its chemical activity, the weight yield as well as the potency, odour, and taste of the oil, oils derived from different regions of the world should be analysed for their chemical components and properly documented in order that maximal benefits may be derived by the user.

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## **Conflict of interest**

The author declares no conflict of interest.


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