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Review article

Ginger rhizomes (*Zingiber officinale*): A spice with multiple health beneficial potentials

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ABSTRACT

Ginger (*Zingiber officinale*) rhizomes are commonly used in foods and beverages for their characteristic pungency and piquant flavor. Ginger is widely employed in Chinese, Ayurvedic, Unani medicines and home remedies since antiquity for many ailments including pain, inflammation, and gastrointestinal disorders. The bioactive constituents of ginger have been identified. Many of the beneficial pharmacological effects of its ingredients have been experimentally verified in recent years. The mechanistic aspects of the health effects have also been investigated in many studies. This article briefly reviews the most salient investigations which have validated the potential of ginger with respect to the digestive stimulant, protection to the gastrointestinal tract, lipid lowering, anti-obesity, cardioprotective, antidiabetic, anti-inflammatory, and cancer preventive properties. Ginger compounds are potent antioxidants, and consequently, ginger extracts exert promising anti-inflammatory and cancer preventive effects. The most significant among all the nutraceutical attributes of ginger are its positive influence on gastrointestinal tract including digestive stimulant action, anti-inflammatory influence, and anticancer effect. While ginger is generally considered to be safe, it also deserves to be recommended as a functional ingredient in our daily food. The present treatise reviews all the experimentally validated health benefits of this spice, to make a claim on its nutraceutical application.

Contents

1. Introduction

Ginger (*Zingiber officinale* Roscoe) rhizome is one of the hot spices belonging to Zingiberaceae family; a herbaceous perennial plant native to Southern Asia. Ginger rhizome is extensively

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consumed as a spice in foods and beverages because of its characteristic pungency and piquant flavor. It is used in a variety of foods and also in carbonated drinks, in liquors and as a preserve in sugar syrup (*murabba*) [1]. Ginger is an excellent source of several bioactive phenolics, including non-volatile pungent compounds such as gingerols, paradols, shogaols, and zingerones. Ginger is also used in traditional oriental medicine (Ayurvedic, Chinese, and Unani systems of medicine) since antiquity (>2500 years) to treat different diseases that include rheumatoid arthritis, sprains and muscular aches, sore throats, nausea, constipation and indigestion, fever, infectious diseases, and helminthiasis [2]. It is particularly valued in medicine as a carminative and stimulant to the gastrointestinal tract [3]. Ginger is known to increase the motility of the gastrointestinal tract and has antibacterial, antiviral, analgesic, and antipyretic properties [4].

The efficacy of ginger rhizomes as a phytomedicine in the context of its use as a broad-spectrum antiemetic has been reviewed by Chrubasik et al. [5]. While the proprietary ginger preparations are clinically useful to alleviate osteoarthritic and other pain since ginger constituents interfere with the inflammatory cascade and the vanilloid nociceptor, this claim remains to be confirmed with more clinical trials. Currently, there has been a renewed interest in this medicinal spice and investigations involving isolation and identification of bioactive constituents, and experimental validation of its empirical pharmacological actions. Some phytochemical, pharmacological and toxicological properties of ginger have been reviewed [2]. The major pharmacological properties of ginger compounds include immune modulatory, anti-inflammatory, anti-tumorigenic, anti-hyperglycemic, and anti-lipidemic actions. Much knowledge on the health beneficial biological activities of ginger and its bioactive constituents has been added in the recent decade. The various pharmacological effects of 6-gingerol, both *in vitro* and *in vivo* and the underlying mechanisms have been briefly reviewed [6]. Because of its efficacy through regulation of multiple targets, and its safety, 6-gingerol has received considerable attention as a potential therapeutic agent. Nanoparticles derived from ginger have been developed as the novel natural delivery mechanism for improved prevention and treatment of inflammatory bowel disease [7]. The present review updates the recent information on the beneficial health effects of ginger and also covers the knowledge on other beneficial physiological effects hitherto not discussed.

2. Chemical constituents of ginger

The ginger rhizome contains 60–70% carbohydrates, 3–8% crude fiber, 9% protein, 8% ash, 3–6% fatty oil and 2–3% volatile oil. The characteristic flavor of ginger is due to zingerone, shogaols, gingerols, and volatile (essential) oils that comprise up to 3% of ginger on fresh weight basis (Fig. 1**)**. The volatile fragrant essential oil of ginger contains mainly sesquiterpenoids, with α-zingiberene (30–70%) as the main component, smaller amounts of other sesquiterpenoids: β-sesquiphellandrene (15–20%), β-bisabolene (10–15%), and α-farnesene, and monoterpenoids (β-phellandrene, camphene, cineol, geraniol, citral, *etc.*). Ginger also contains diterpenes and ginger glycolipids [2].

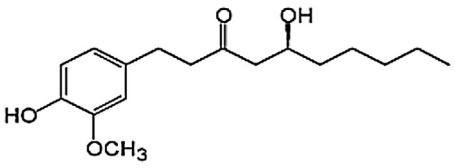
The pungency of the fresh ginger rhizome is due to gingerols, of which the major pungent principle is [6]-gingerol (1-[4′-hydroxy-3′-methoxyphenyl]-5-hydroxy-3-decanone), an oily liquid, and the most abundant constituent among the gingerols. The pungency of dried or cooked ginger is due to nonvolatile phenylpropanoid-derived compounds from gingerols, namely, shogaols. The less pungent zingerone is also produced from gingerols during drying process; which has a spicy-sweet aroma. Ginger also contains acrid resinous substances (5–8%).

3. Validated health effects of ginger constituents

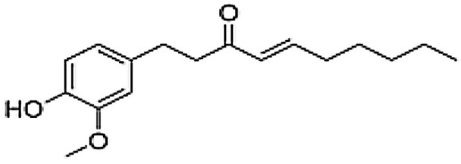
3.1. Digestive stimulant action

The digestive stimulant action of ginger is probably a most common experience. Ginger has a sialagogue action, stimulating the production of saliva, thus enabling swallowing. Spices such as ginger are common remedies used in traditional medicines or ingredients of pharmacological preparations to cure digestive disorders. The mechanism of digestive stimulant action of ginger has been understood in animal studies (Table 1) [8]. It has been documented that ginger stimulates bile acid production by the liver and its secretion into bile [9]. Bile acids are known to play a significant role in the digestion and absorption of dietary fat. Dietary ginger also significantly stimulates the activity of digestive enzymes of pancreas-lipase, amylase, and proteases (trypsin, chymotrypsin, and carboxy peptidase) [10]. Terminal digestive enzymes of small intestinal mucosa including disaccharidases are also beneficially stimulated by dietary ginger [11]. Dietary ginger is reported to stimulate digestion and absorption of dietary fat in

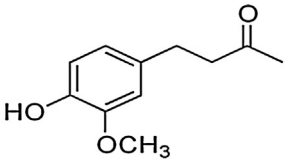
Ginger (*Zingiber officinale*) rhizome



6-Gingerol (Pungent compound in fresh ginger)



Shogaol (Pungent constituent of ginger produced on drying or cooking)



Zingerone (Pungent constituent of ginger produced on drying or cooking)

Fig. 1. Ginger (*Zingiber officinale*) rhizome and its bioactive compounds.