



Ginger (*Zingiber officinale*) – a spice with therapeutic properties

Imbir lekarski (*Zingiber officinale*) – surowiec o właściwościach terapeutycznych

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Abstract

Introduction. Ginger (*Zingiber officinale*) is a plant widely used all over the world. Due to its rich aroma and characteristic, spicy taste, it has been used in the kitchen as a spice additive. However, the multitude of phytonutrients it contains makes ginger a plant with a positive effect on the human body.

Objective. The aim of the study is to present the possibilities of using ginger and its bioactive ingredients in the treatment of selected diseases.

Brief description of the state of knowledge. Ginger is a source of many valuable nutrients that determine its organoleptic characteristics, which also has pro-health properties. Essential oils and oleoresin are the main compounds responsible for the specific smell and sharp taste of ginger [8]. Additionally, ginger contains many phytonutrients, such as sesquiterpenes and monoterpenes, which include α – zingiberene, α – faranezene, β – bisabolene, β – felandren, zingiberol, geraniol, linalool, and cineole, as well as zingerone and shogaole. Ginger has been used for a long time to treat gastrointestinal and cardiovascular disorders, rheumatic pains, diabetes, cancer and depression. It is still used in Chinese and Arab folk medicine as a warming agent, or as a remedy for the digestive system and liver diseases. Moreover, it is used in constipation, cold, rhinitis and bronchitis. Research also indicates high antioxidant, antimicrobial and anti-inflammatory properties. These health benefits are attributed to its phenolic compounds, mainly gingerols and shoagols.

Conclusions. Ginger is a rich source of multiple bioactive compounds which have medicinal value, and has a supporting effect in several diseases, such as diabetes, cardiovascular diseases, nausea, emesis and inflammatory processes.

Key words

ginger, health-promoting properties, antiemetic properties, hypoglycaemic properties, hypolipaeic properties, anti-inflammatory properties

Streszczenie

Wprowadzenie i cel pracy. Imbir (*Zingiber officinale*) jest rośliną szeroko stosowaną na całym świecie. Ze względu na bogaty aromat i charakterystyczny ostry smak znalazł zastosowanie w kuchni jako przyprawa. Jednak mnogość zawartych w nim fitoskładników sprawia, że imbir wykazuje również pozytywny wpływ na organizm człowieka. Celem pracy jest przedstawienie możliwości wykorzystania imbiru i jego bioaktywnych składników w leczeniu wybranych chorób.

Skrócony opis stanu wiedzy. Imbir jest źródłem wielu cennych składników odżywczych, które nadają mu właściwości organoleptyczne, ale także prozdrowotne. Olejki eteryczne i oleozywica są głównymi składnikami odpowiedzialnymi za specyficzny zapach i ostry smak imbiru. Ponadto imbir zawiera wiele fitoskładników, takich jak seskwiterpeny i monoterpeny, do których należą: α -zingiberen, α -faranezen, β -bisabolen, β -felandren, zingiberol, geraniol, linalool, cynoele, a także zingeron i szogaole. Imbir jest od dawna stosowany w leczeniu zaburzeń żołądkowo-jelitowych i sercowo-naczyniowych, bólów reumatycznych, cukrzycy, nowotworów i depresji. Nadal znajduje zastosowanie w chińskiej i arabskiej medycynie ludowej jako środek rozgrzewający lub jako lek na choroby układu pokarmowego i wątroby. Ponadto stosuje się go w zaparciach, przeziębieniach, nieżytach nosa i zapaleniu oskrzeli. Badania wskazują również na cenne właściwości antyoksydacyjne, przeciwbakteryjne i przeciwzapalne imbiru. Te korzyści zdrowotne przypisuje się zawartym w nim związkom fenolowym, głównie gingerolowi i shoagolowi.

Podsumowanie. Imbir jest bogatym źródłem wielu związków bioaktywnych, które posiadają właściwości lecznicze i mogą być stosowane wspomagająco w wielu chorobach, takich jak cukrzyca, choroby układu krążenia, nudności, wymioty i procesy zapalne.

Słowa kluczowe

imbir, właściwości prozdrowotne, właściwości przeciwwymiotne, właściwości hipoglikemiczne, właściwości hipolipemizujące, właściwości przeciwzapalne

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INTRODUCTION

Ginger (*Zingiber officinale*) is a plant belonging to the ginger family (*Zingiberaceae*). For centuries, humanity has been using ginger as a seasoning to highlight the taste of many dishes, and as a folk medicine [1]. The first reports about the medical usage of the ginger rhizome date back to the 6th century BC. Initially, this plant material was used mainly in the Far East, primarily in India and China [2]. Over time, it began to be exported to the Mediterranean area. Reports say that ginger was one of the ingredients of Miratydes's antidote, and the Greeks used it as a remedy for indigestion [3]. Later, ginger was used as a beer condiment. It is worth mentioning that ginger rhizomes were especially valued in the Middle Ages, and the value of a pound of this spice (about 0.45 kg) was equal to the price of one sheep [4].

The useful part of the ginger is the rhizome, which is often incorrectly called ginger root [5]. The rhizome is a thickened underground shoot that has storage and spore functions. Young rhizomes are eaten raw, candied and in a marinated form as an addition to many dishes, such as sushi. Older rhizomes are dried and ground-up. The loss of water causes a sharpening of the taste; in this form, ginger is used primarily in spice mixtures.

Due to the content of many different health-promoting compounds, ginger has been used in the treatment of many diseases, including digestive, cardiovascular and nervous system disorders, but also supportively in the treatment of diabetes, cancer and depression. Research also indicates its anti-inflammatory, antioxidant and antimicrobial properties [6]. Nowadays, ginger is still used in traditional Chinese medicine as a remedy in diseases of the digestive system and liver. It is also popular in the treatment of hypertension. On the other hand, in Arab countries, ginger rhizome is a valued warming agent. Moreover, it is used in constipation, cold, rhinitis, bronchitis, gastric hyperacidity and even ocular cataracts [7]. The main bioactivities of ginger are shown in Figure 1.

Ginger is a source of many valuable nutrients that determine its organoleptic characteristics, and also has pro-health properties. Essential oils and oleoresin are the main compounds responsible for the specific smell and sharp taste of ginger [8]. In addition, ginger contains many phytonutrients, such as sesquiterpenes and monoterpenes, which include α – zingiberene, α – faranese, β – bisabolene, β – phellandrene, zingiberol, geraniol, linalool, cineole, as well as zingerone and shogaol. Zingiberol, which is a mixture of cis and trans-b-eudesmol isomers, is a substance that produces the specific smell of ginger [9]. The compounds responsible for the characteristic taste of ginger are gingerols – non-volatile pungent phenolic compounds that are a combination of complex phenylpropane derivatives [2].

This review article provides evidence of the effectiveness of ginger and its bioactive compounds administration in the treatment of various diseases.

Anti-emetic properties. Ginger has a limiting effect to reduce nausea and vomiting, which may be caused mainly by early pregnancy, motion sickness, chemotherapy or anaesthesia [23]. In a study on animal tissues, it was observed that gingerols and shogaols show an inhibitory effect on the activity of M3 and 5-HT₃ receptors responsible for the symptoms of nausea [24]. Studies suggest that 6-, 8-,

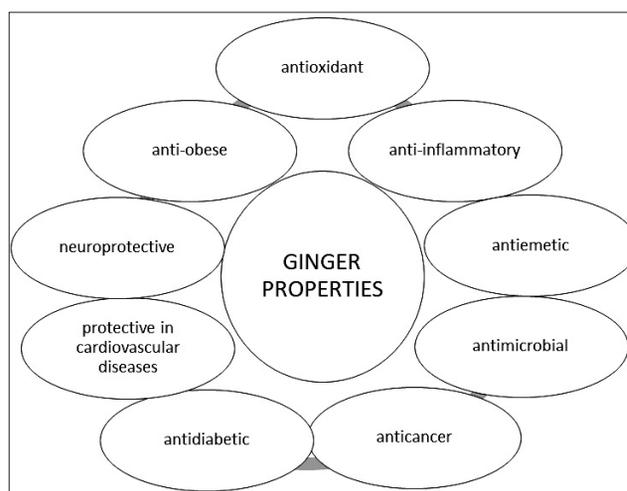


Figure 1. Overview of the main properties of ginger

Table 1. Biological activities of ginger active compounds

Active compound	Biological activity
gingerols	Anti-cancer
	Anti-tumour [10]
	Anti-inflammatory [11]
	Anti-oxidative [12]
	Preventing development of osteoarthritis [13]
Anti-obesity [14]	
α – zingiberene	Anti-inflammatory and anti-apoptotic [15]
	Anti-cancer [16]
β – bisabolene	Anti-cancer [17]
zingerone	Lowering body weight
	Hypolipaeamic
	Anti-inflammatory
	Anti-oxidative [18]
	Anti-tumour [19]
shogaol	Anti-inflammatory [20]
	anti-osteoclastogenic [21]
	curative in ulcerative colitis [22]

10-gingerol and 6-shogaol are responsible for the antiemetic effect of ginger, acting on the 5-HT₃ receptor ion channel, probably by binding to a modulatory site distinct from the serotonin binding site [25], but this hypothesis requires further research [26].

Ginger is often used as an effective and harmless treatment for nausea and vomiting in pregnancy [27]. Pongrojpaew et al. [28] conducted comparative studies on the use of ginger and dimenhydrinate (which is a substance used as an anti-emetic). 170 pregnant women who experienced nausea and vomiting caused by pregnancy participated in the study. It was proven that the administration of two capsules a day containing 0.5 g of powdered ginger was as effective as the administration of dimenhydrinate at a dose of 100 mg daily. Additionally, it was observed that ginger treatment had fewer side-effects. The anti-emetic effect of ginger in pregnant women was also analyzed by Portnoi et al. [29]. It has been observed that in women taking supplements containing ginger, the symptoms of pregnancy-related nausea were reduced. Additionally, it has been proven that the use of ginger supplements did not increase the incidence of malformations in fetuses.

A meta-analysis of 12 randomized clinical trials involving a total of 1,278 pregnant women showed that ginger supplementation significantly reduced nausea symptoms,

compared to placebo. However, no significant decrease in the number of vomiting episodes was observed. The supply of ginger did not increase the risk of spontaneous miscarriage and did not cause the side-effects of heartburn or excessive sleepiness in women [30]. Other research conducted on 15 studies and 3 prospective clinical studies showed that daily administration of 1 g of fresh ginger for 4 days decreased nausea and vomiting, and had no risk for women and their children [27].

Nausea and vomiting are also common among people undergoing chemotherapy. Statistics show that over 70% of patients report symptoms of nausea despite taking anti-emetic drugs [31]. Studies conducted on cancer patients undergoing chemotherapeutic treatment shows that ginger administration can reduce nausea and vomiting [32]. In the Ryan et al. [33] study, cancer patients were given a placebo or ginger capsules at doses of 0.5 g, 1.0 g and 1.5 g per day. The strongest effect was obtained with the daily supply of 0.5 and 1.0 g of ginger. Panahi et al. also proved that a daily intake of 1.5 g of ginger significantly reduced the incidence of nausea in women with advanced breast cancer within 6–14 hours after chemotherapy [34].

Hypoglycaemic properties. Diabetes mellitus is a metabolic disease related to improper carbohydrate metabolism. The current increase in the incidence has been called an epidemic. It is estimated that by 2030 there will be over 500 million people with diabetes in the world. The International Diabetes Federation reports that in 2040, 10% of adults will have diabetes [35].

The reason of increasing the morbidity is most likely because of change in lifestyle, consisting in lowering the physical activity of the society along with a change in the eating model, based on a large amount of highly processed, energy-rich food [36].

There are two main types of diabetes mellitus. Type 1 diabetes is caused by damage to the cells in the pancreas responsible for secreting insulin. Its occurrence is caused by abnormalities in the patient's autoimmune system. The occurrence of type 2 diabetes is often caused by an incorrect lifestyle, associated with an inadequate diet and lack of physical activity. As a consequence, there is a decrease in the sensitivity of peripheral tissues to insulin [37].

The treatment of diabetes is primarily based on the use of pharmacological hypoglycaemic agents, insulin therapy and lifestyle changes through the use of an appropriate diet and increase of physical activity. However, other, alternative treatments for diabetes are sought. Medicinal ginger is one of the many plants that have properties that improve glycaemia in sick people [38]. It is indicated that the positive effect of ginger is connected with the content of bioactive compounds, mainly gingerols and shogaols, zingerols and paradols [39].

Plenty of studies indicate that the administration of ginger extracts has a positive effect on blood glucose and tissue glycogen levels in rodent model [40] and on humans [41]. The mechanism of action is to increase peripheral tissue glucose utilization, regulate the secretion of glycolytic enzymes, and reduce hepatic and kidney gluconeogenesis [42]. Studies conducted on humans also showed that the supply of ginger lowered the blood glucose levels of people with diabetes while improving the ratio of LDL and HDL cholesterol in the blood. [43]. In a study by Shidfar et al. on patients with type 2 diabetes, a 3-month supply of capsules with powdered ginger

had a positive effect on the concentration of plasma glucose, glycosylated haemoglobin and insulin, and also increased the sensitivity of tissues to insulin [41]. Also, Mozzaffari-Khosravi et al. [44] observed that a 3-month supply of 3 g of ginger/day significantly reduced the concentration of free glucose in plasma, decreased the amount of glycated haemoglobin HbA1c, and increased insulin sensitivity in the study group of people with type 2 diabetes.

Influence on lipid profile. The term 'lipid profile' includes the following parameters: triglycerides, total cholesterol, LDL and HDL lipoproteins. Disorders of the lipid profile contribute to serious diseases of the cardiovascular system, including coronary heart disease, atherosclerosis, myocardial infarctions or strokes [45]. The bioactive compounds found in ginger can significantly improve lipid parameters while reducing the risk of cardiological complications.

In animal model studies, it was observed that the administration of 6-gingerol (Fig. 2), a bioactive compound found in the ginger rhizome, had a positive effect on the lipid profile, reducing the concentration of triglycerides, total cholesterol, free fatty acids and LDL cholesterol fraction in plasma [46]. A positive effect of 6-gingerol administration was also observed in high-fat diet-induced obese rats. Oral administration of 6-gingerol in dose 75 mg/kg-1 of body mass had the strongest effect on the improvement of body weight, glucose and insulin levels and lipid profile, as well as leptin, amylase and lipase serum levels [47].

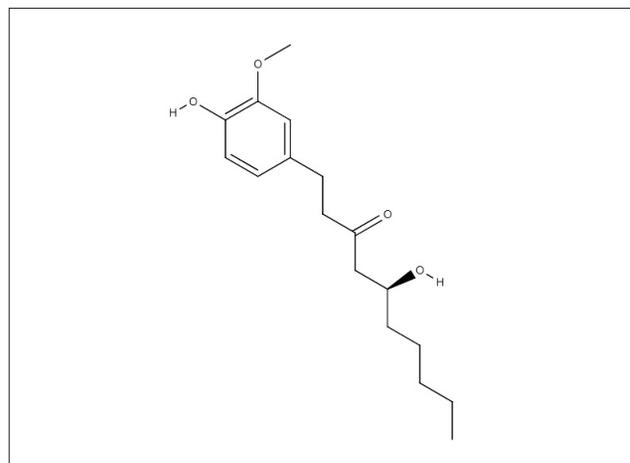


Figure 2. Chemical structure of 6-gingerol (5-hydroxy-1-(4-hydroxy-3-methoxyphenyl)decan-3-one)

A meta-analysis of 12 clinical trials showed that ginger supplementation lowered the concentration of triacylglycerols and LDL cholesterol. There was no statistically significant effect of ginger supply on the concentration of total cholesterol and HDL fraction. Additionally, it was noted that lower doses of ginger (up to 2 g per day) had a stronger effect in lowering TC and TG levels than doses above 2 g/day [48].

A study on patients with type 2 diabetes showed that daily oral supplementation with 1,600 mg of ginger improved insulin sensitivity and reduced blood glucose levels, as well as improved the lipid profile by lowering total cholesterol and triglycerides. There were no statistically significant changes in the concentration of LDL and HDL cholesterol between the study group and those receiving placebo [49].

Anti-inflammatory and analgesic properties. The ageing process is often associated with a reduction in the efficiency of the skeletal system, leading to degeneration or inflammation of the joints [50]. As a consequence, an elderly person may experience a reduction in the quality of life due to constant pain or discomfort, limited mobility and the stiffness of the affected joint, which prevents normal movements. Pharmacological agents, including non-steroidal anti-inflammatory drugs (NSAIDs), are often used to treat pain and reduce tissue inflammation [51]. However, long-term use of these agents may lead to gastric ulcer disease and deterioration of kidney function [52]. Therefore, scientists are looking for natural ingredients which can cause a therapeutic effect without the risk of undesirable effects of their long-term use. Ginger is used frequently in Chinese folk and Ayurvedic medicine as a plant material with anti-inflammatory and analgesic properties. Therefore, nowadays more attention is being paid to examining its therapeutic properties in the treatment of diseases of the musculoskeletal system. It is proved that the polyphenols found in plants belonging to the Zingiberaceae family have a strong anti-inflammatory effect. However, preliminary studies indicate that non-polyphenol compounds are also responsible for reducing inflammation [53]. It has been shown that the bioactive compounds of ginger can inhibit the activity of cyclooxygenase 2, an enzyme whose products increase the symptoms of inflammation. An inhibitory effect on the activity of cyclooxygenase 2 (COX 2) was shown by 10-gingerol, 8-shogaol and 10-shogaol [54].

In a rat model with induced arthritis, it was observed that the supply of ginger essential oil prevented the onset of chronic inflammation [55]. Moreover, Aryaeian et al. [56] analyzed the effect of ginger supplementation in people with rheumatoid arthritis (RA), which is an auto-immune disease caused by genetic and environmental factors. A 12-week supply of powdered ginger in the dose of 1,500 mg a day decreased the expression of some genes responsible for the occurrence of inflammatory reactions.

Safety of use. The Food and Drug Administration (FDA) in the USA considers ginger as a food additive 'generally recognized as safe' [57]. Despite the widespread use of ginger, the occurrence of an allergy to this spice is quite rare. This is probably due to the fact that ginger, as well as other spices, is related to the low amount of proteins ingested in them [58].

A case of sensitization caused by specific immunoglobulin E (IgE) in men working in the industry and having contact with spice dust was primary reported in 1985 [59]. Lopez-De-Los-Santos et al. [60] also reported IgE-mediated allergy to ginger in 4 patients. Three of them developed symptoms (e.g. vomiting, diarrhea, dyspnea, sweating) after ingesting raw ginger rhizome and one patient developed symptoms after handling ginger powder (facial angioedema and conjunctival injection). The researchers determined cysteine protease GP- I and an 8-, 10 kDa protein bands as potential ginger allergens.

Another study shows the research conducted in 2002 in which the skin prick test (SPT) was carried out in 589 patients suspected of food allergies. Results showed that prick-tests for ginger were currently negative [58]. Also, among patients with allergy to birch and/or mugwort pollen and celery, positive scratch test (SCT) for ginger was observed in only 3 patients [61].

CONCLUSIONS

Ginger is a spice that has been used for centuries as a remedy for a wide range of ailments. Its pro-health effects are related to the high content of bioactive compounds. Ginger has anti-inflammatory properties and can also prevent vomiting and nausea caused by many different factors. Thanks to its hypoglycaemic properties ginger can be used as adjunctive therapy in diabetes. Research also indicates the beneficial effect of the ginger rhizome in the normalization of the lipid profile, mainly the concentration of total cholesterol and triglycerides. A valuable aspect of using ginger is that it is natural plant material. Research has shown that ginger can have the same therapeutic effect as pharmaceuticals. It was observed that supplementation with ginger did not cause some of the side-effects that occurred with medicines. Ginger is not significantly toxic, and studies have found it safe even for pregnant women. Additionally, ginger is considered a safe ingredient that does not cause allergies among patients. It is worth including ginger in the daily menu, as a spice and as a source of compounds with pro-health properties.

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