THE NEW ARMENIAN MEDICAL JOURNAL
Volume17 (2023), Issue 3 p. 74-83

DOI: https://doi.org/10.56936/18290825-2023.17.3-74

DESCRIBING THE GINGER PLANT AND ITS EFFECTIVE INGREDIENTS ALONG WITH ITS THERAPEUTIC PROPERTIES IN VARIOUS COMPLICATIONS

Sani M.[1], Hokmabadi M.E.[2]

[1] Department of Nutrition, Tabriz University of Medical Sciences, Jolfa International Campus, Jolfa, Iran
[2] Department of Psychiatry and Behavioral Sciences, Psychiatry and Behavioral Sciences Research Center, Mashhad University of Medical Sciences, Mashhad, Iran

Received 20.04.2022; accepted for printing 5.06.2023

Abstract

Plants are one of the important and valuable sources in the preparation of medicines, both in traditional medicine and in the form of pure products. Ginger is obtained from a yellow plant with purple veins with the scientific name Zingiber officinale. Although ginger is usually referred to as the root of the plant, actually the part used is the swollen underground stem called the rhizome. The aroma and flavor of ginger are due to the presence of two types of volatile oils and non-volatile pungent compounds. The biologically active components of ginger are classified in the second category, among the most important molecules in this category, are gingerol and shogaol, which cause a pungent sensation in the mouth. Most properties of ginger are attributed to non-volatile components with a spicy taste. The properties of these substances can be reduced blood sugar, weight loss, increased blood insulin, effect on blood coagulation, effect on blood pressure, reduction of complications of gastrointestinal diseases, reduction of nausea caused by pregnancy, or the use of chemotherapy drugs, the protective effect of the tissue against chemical and radio damage with anti-inflammatory properties, antioxidant properties, antibacterial and antifungal properties, especially Candida albicans, anti-cancer properties through antioxidant and anti-inflammatory properties.

This study aimed to describe the ginger plant and its active ingredients and some features including anti-inflammatory effects, anti-oxidative effects, anti-cancer effects, and so on.

Keywords: *medicinal plants, ginger, antioxidant, anticancer.*

Introduction

Ginger is known as a spice and medicinal plant. In China, this plant has been used as a flavoring and antifungal agent for more than 2500 years. Ginger is obtained from a yellow plant with purple veins. Although ginger is usually referred to as the root of the plant, in fact, the part used is its swollen underground stem, which is called the rhizome [*Sharifi-Rad M et al., 2017*]. Ginger has been used since ancient times and still plays an important medicinal role in traditional Chinese medicine. In ancient Iran, this plant was also known as Shangvir and had medicinal uses. And it was sent from Iran and Arab countries to Western countries. In the West, a Greek physician first recorded the medical

Cite This Article as:

Sani M., Hokmabadi M.E. (2023). Describing The Ginger Plant And Its Effective Ingredients Along With Its Therapeutic Properties In Various Complications; The New Armenian Medical Journal, vol.17(3), p 74-83; https://doi.org/10.56936/18290825-2023.17.3-74

Address for Correspondence:

Mojtaba Sani, PhD
Department of Nutrition, Tabriz University of Medical Sciences
Jolfa 5166616471, Iran
Tel.: +4917643409320
E-mail: Mojtabasaani89@gmail.com

use of ginger in the first century AD [*Khodaie L, Sadeghpoor O, 2015*]. Ginger has been widely used in spices and medicinals for centuries. For example, it has been used to treat colds, rheumatism, neurological diseases, gingivitis, toothache, asthma, stroke, constipation, and diabetes [*Reddy Y et al., 2014*]. Studies show that ginger is still popular as a spice and medicinal plant [*Anh N et al., 2020*]. Many studies have been devoted to specific aspects of the therapeutic properties of ginger, for example, the study on the use of ginger as an anti-inflammatory agent for cancer prevention or as an anti-nausea agent [*Prakash J, 2019; Mashabela M, Otang-Mbeng W, 2023*]. The smell of ginger is related to the volatile oils in it, which include 1 to 4% of it. About 51 components have been identified in these oils, which are generally monoterpenoids. Some of these volatile oils smell less after drying [*Cimino C et al., 2021*]. The spiciness of fresh and wet ginger is due to gingerol, which is a homolog of phenol. The spiciness of dried ginger is due to shogaols, which are caused by the dehydration of gingerols. In another experiment on ginger 63 compounds were isolated, and 31 of them, were previously identified [*Wohlmuth H et al., 2005*].

In traditional medicine, ginger is recommended to reduce gastrointestinal problems and is also used for anti-nausea due to its direct cholinergic antagonism, which compounds such as gingerol and shogaol inhibit serotonin. Researchers also found in laboratory conditions that gingerol can reduce stomach ulcers and stomach cancer by reducing Helicobacter pylori [*Pertz H et al., 2011; Lete I, Allué J, 2016*]. It was found that ginger effectively improves digestion and stimulates the peristalsis movements of the intestines and digestive system [*Nikkhah Bodagh M et al., 2019*]. The antimicrobial activity of ginger powder has been determined against Salmonella, Escherichia coli, Candida albicans, Shigella, and Cryptococcus neoformans species [*Liu Q et al., 2017*]. In very extensive research conducted on ginger oil; they concluded that ginger oil cures many bacterial and fungal diseases. The effect of volatile oils on pathogenic agents shows their different chemical composition compared to pathogenic agents. In another study, it was found that 10-gingerols and 6-gingerdiol were introduced as the main antifungal agents [*Kalhoro M et al., 2022*]. Ginger has antimicrobial properties against Pseudomonas aeruginosa, Salmonella typhimurium, Escherichia coli, and Candida albicans. Also, the antifungal property of ginger, which is mainly due to gingerol, is important. Also, ginger has anthelmintic properties. Ginger has strong antioxidant properties against oxidation and has a protective effect against ultraviolet radiation [*Rahmani A et al., 2014; Aghazadeh M et al., 2016*]. The anti-inflammatory properties of ginger have been noticed for centuries, which were first reported to inhibit prostaglandin synthesis. Research has shown that ginger has anti-inflammatory properties and later it was found that two ginger compounds that mimic the properties of non-steroidal anti-inflammatory drugs in human leukocytes [*Grzanna R et al., 2005*]. More recent research showed that gingerols are very active in inhibiting both prostaglandins and leukotrienes [*Kiuchi F et al., 1992; Yücel C et al., 2022*]. Essential oils exert their immune system through antioxidant properties. Free radicals, which are created especially in stressful conditions, are short-lived compounds that have a great tendency to chemically react with free electrons and subsequently leave destructive effects on tissues [*Martemucci G et al., 2022*]. This study aimed to describe the ginger plant and its active ingredients and some features including anti-inflammatory effects, anti-oxidative effects, anti-cancer effects, and so on.

Introducing the ginger plant and its active ingredients: Ginger belongs to the family of flowering plants Zingiberaceae, whose root or rhizome is a very widely used herbal spice due to its aromatic and spicy taste. There are evidences that show that this plant has been used medicinally in China and India around 5000 years ago [*Kumar K et al., 2013*]. Ginger is traditionally used against diseases such as cholera, colds, diarrhea, nausea and abdominal pain, back pain, toothache, bleeding, high blood pressure, and chronic inflammatory arthritis rheumatoid [*Craig E, Cappelli L, 2018; Ballester P et al., 2022*]. In addition, in African folk medicine, this substance is used as a carminative, diuretic, and anti-inflammatory herbal remedy [*Afzal M et al., 2001*], and in Iranian traditional medicine, it was also used to treat nervous system diseases such as epilepsy, paralysis or stroke [*Khodaie L,*

Sadeghpoor O, 2015]. In addition, ginger is used as a traditional herbal medicinal product for the treatment of mild and spasmodic gastrointestinal disorders, including flatulence. As a plant, it was found that ginger as a medicinal plant has anti-cancer, antioxidant, anti-inflammatory, antimicrobial, neuroprotective effects, protective effects on the heart and blood vessels, protective effects on the respiratory system, anti-obesity, anti-diabetes, anti-nausea and anti-vomiting [*Mao Q et al., 2019*].

Ginger is rich in various chemical compounds including phenolic compounds, terpenes, polysaccharides, lipids, organic acids, and crude fibers. Among the essential elements found in ginger, we can mention manganese, copper, selenium, and zinc [*Akhlaghi N, Najafpour-Darzi G, 2023*]. This plant even contains small amounts of toxic elements such as cadmium, lead, and nickel. The health benefits of ginger are mainly attributed to its phenolic compounds such as gingerols and shogaols, which constitute approximately 1-3% of its weight [*Getaneh A et al., 2021; Dinu C et al., 2021*]. Chagols as spicy compounds in ginger are chemically similar to gingerol. The most common and main of this group is 6-shogaol. 6-shogaol is the dehydrated form of 6-gingerol and is produced when ginger is dried or cooked, the structure of both of which is shown in figure 1. In addition, shogaol (and gingerol) transforms into other substances over time with heat, which is why ginger loses its spicy when cooked. Compared to other spicy compounds, shogaol is relatively hotter than piperine, but less so than capsaicin [*Jung M et al., 2018*]. It has been reported that shogaols show stronger bioactive properties such as inhibiting free radicals, anti-inflammatory effects, and anti-cancer effects than gingerols [*Bischoff-Kont I, Fürst R, 2021*].

Anti-inflammatory effects of ginger and its compounds: Interest in studying the medicinal effects of ginger and its compounds such as 6-shogaol on pathological conditions has increased in the last few decades. Recent studies show that substances derived from ginger not only have an effect on diabetes, asthma, metabolic syndrome, and cancer but also has anti-inflammatory potential [*Ali B et al., 2005; 2008*]. The anti-inflammatory effects of ginger date back to the 1980s. In 1989, a study by Mascolo et al showed that oral administration of

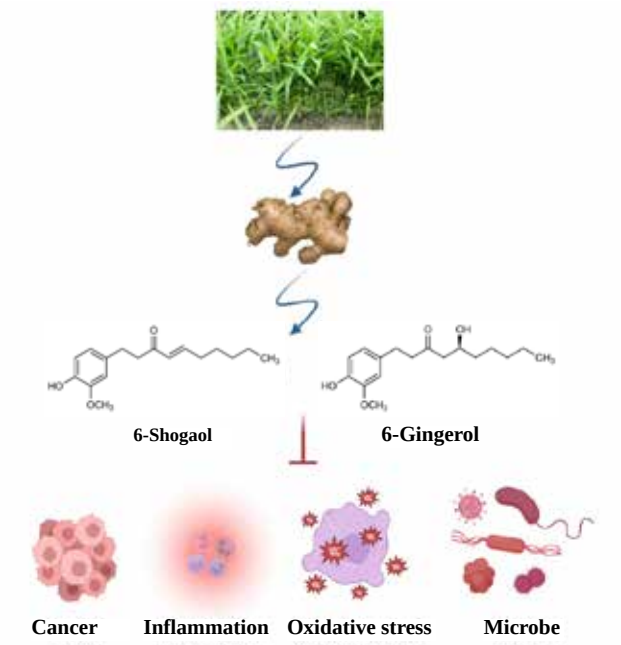

Figure 1. *The source, chemical structure and effects of 6-shogaol and 6-gingerol. Two effective substances, shogaol and gingerol, are obtained from the rhizome of the ginger plant, which have anti-cancer, anti-inflammatory, antioxidant and antibacterial properties*

the ginger extract at doses of 50 and 100 *mg/kg* reduced carrageenan-induced paw edema (carrageenan: a gum extracted from red seaweed) in rats by 22 and 38%, respectively. Although these studies provide promising evidence that 6-shogaol can be classified as an anti-inflammatory agent, the exact mechanism of its effect has not yet been determined [*Mashhadi N et al., 2013; Mehrzadi S et al., 2021*]. One of the anti-inflammatory effects of ginger, which has been widely studied, is the effect of ginger on rheumatism.

Ginger and seasonal rheumatism: Seasonal rheumatism or rheumatoid arthritis is an autoimmune disease associated with chronic joint inflammation and irreversible bone destruction. The symptoms of this disease include the loss of physical movements and cardiovascular, pulmonary, physiological, and skeletal disorders. A recent epidemiological study shows that about 1% of people worldwide currently have rheumatoid arthritis. In all populations, the disease is more common among women than men [*Cadena J et al., 2003; Tanaka Y, 2020*]. Two factors are considered in the treatment of this disease, which include drugs and changes in the person's lifestyle. Among the current drugs for the treatment of seasonal rheumatism, non-steroi-

dal anti-inflammatory drugs can be mentioned. For example, salicylic acid and steroids (usually cortisone injections). Although these drugs reduce pain, they are unable to repair damaged tissues. And while there is a wide range of medications available to manage pain and slow the progression of rheumatoid arthritis, no single drug is known to completely cure the disease [*Dennison E, Cooper C, 1998; Mohn E et al., 2018*]. In addition, gastric ulcer is a side effect of regular use of non-steroidal anti-inflammatory drugs, and adrenal suppression by steroids in rheumatoid arthritis patients [*Eamlamnam K et al., 2006*] these adverse side effects often force patients to look for complementary and alternative medicines [*Sostres C et al., 2010*]. Herbal medicines can be an alternative source of symptom relief in patients with seasonal rheumatism. Among all the studied plants, it has been observed that the two compounds of shogaol and gingerol in ginger play a central role in reducing unbearable pain and inflammation associated with this disease [*Al-Nahain A et al., 2014*]. In all the experiments conducted by a wide range of scientists, it has been observed that ginger and its compounds, both in the form of edible extract and in the form of oil, have anti-inflammatory effects in rheumatoid arthritis and they cause this effect by inhibiting the synthesis of prostaglandins and the biosynthesis of leukotrienes.

Anti-oxidative effects: Excessive production of free radicals, such as reactive oxygen species, plays an important role in causing many chronic diseases. All kinds of natural products have antioxidant potentials, such as vegetables, fruits, food flowers, grains, medicinal plants, and herbal extracts [*Lobo et al., 2010; Xu et al., 2017*]. Meanwhile, ginger contains several antioxidant compounds such as vitamin C, vitamin E, beta-carotene, lutein, lycopene, quercetin, genistein, and tannin [*de Lima et al., 2018*]. Ginger and its bioactive compounds such as 6-shogaol target antioxidant activity through the Nrf2 signaling pathway. Nrf2 is a transcription factor that under normal conditions binds to a repressor protein called Keap1, which causes proteasomal degradation of Nrf2. When the cell is exposed to oxidative stress and high amounts of reactive oxygen species, the oxidation of key cysteine residues in the Keap1 protein increases, and these structural changes weaken the binding ability of Keap1 to Nrf2. Therefore, the interaction between Keap1 and Nrf2 is separated and leads to the reduction of proteosomal degradation of Nrf2. Then the transcription factor Nrf2 is transported into the nucleus. After Nrf2 is transferred into the nucleus, it forms a heterodimer with small musculoaponeurotic fibrosarcoma proteins and binds to the antioxidant response element sequence in the promoter of the target genes, and activates the transcription of the target genes [*Chen H et al., 2014*]. The target genes cause the synthesis of antioxidant enzymes, including:

1) Superoxide dismutase (SOD) enzyme, of which three forms are known in humans: SOD1, which is found in the cytoplasm, SOD2, which is present in the mitochondria, and SOD3, which is in the extracellular space. SOD enzyme is the first line of defense against oxidative stress and catalyzes the dismutation of superoxide anion into oxygen molecules and hydrogen peroxide;

2) Catalase enzyme is one of the important intracellular antioxidant enzymes that act in the decomposition of hydrogen peroxide into water and oxygen;

3) Peroxiredoxin enzyme, which is involved in the destruction of hydrogen peroxide and peroxynitrite;

4) The enzyme heme oxygenase, which catalyzes the rate-limiting step of heme catabolism and plays a role in breaking down heme into iron, carbon monoxide, and bilirubin.

5) NADPH quinone oxidoreductase enzyme reduces quinone to hydroquinone and thus prevents the formation of free radicals caused by quinone derivatives.

6) The glutathione system is one of the most important antioxidant systems for many types of tissues in the body. Glutathione can remove a variety of oxidative species such as superoxide, hydroxyl radical, and peroxynitrite. In addition, 6-gingerol-rich fractions in ginger can reduce H2O2 and malondialdehyde levels, increase antioxidant activity, and increase glutathione in mice with oxidative damage caused by chlorpyrifos (a chemical that kills pests) [*Fukai T, Ushio-Fukai M, 2011; Peng S et al., 2015; Abolaji AO et al., 2017; Wang Y et al., 2018*]. The influence of shogaol on the Nrf2 athway is illustrated in figure 2.

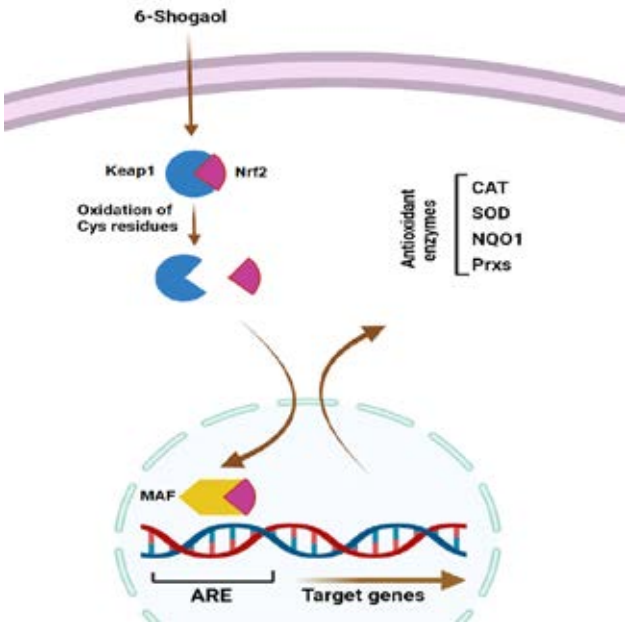

Figure 2. *Effects of 6-shogaol on the Nfr2 pathway in the cell. The active ingredient 6-shogaol can enter the cell and cause the Nrf2 molecule to separate from the Keap1 molecule. The released Nrf2 molecule enters the nucleus and, with the help of musculoaponeurotic fibrosarcoma, binds to antioxidant response elements located upstream of antioxidant genes and causes the transcription of antioxidant genes such as catalase, NQO1, superoxide dismutase, and peroxiredoxins (Prxs).*

Anti-cancer effects: Cancer is the leading cause of death and approximately 9.6 million deaths in 2018 were due to cancer. Many studies have shown that natural products such as fruits and medicinal plants have anticancer activity. Recently, ginger and a special compound in it called 6-gingerol have been investigated for their anticancer properties against different types of cancer such as breast, cervical, colorectal, and prostate cancer whose mechanisms of action include inhibition of proliferation and induction of apoptosis in cancer. Therefore, the use of ginger as a complementary medicine is very effective in cancer. Also, when receiving chemotherapy, ginger may reduce some of the symptoms of treatment (e.g., nausea) [*Tahir A et al., 2015; Liu C et al., 2017; Singh N, Yadav S, 2022*]. As we know, cancer cells are resistant to apoptosis. Research has shown that 6-gingerol prevents inhibition of this pathway in cancer cells and induces apoptosis. 6-gingerol stimulates P53 by affecting reactive oxygen species. P53 activates Bax and inhibits Bcl-2 and Bcl-xL (apoptotic inhibitory proteins) to initiate apoptosis from the intracellular pathway. Bax then forms an oligomer and forms a channel on the mitochondrial outer membrane. Cytochrome C proteins that exist in the outer membrane of the mitochondria are released into the cytosol through this channel and are connected to the adapter protein called Apaf and form a cartwheel-like structure called the apoptosome. The apoptosome complex activates caspase, the initiator of the intracellular pathway called caspase 9. The initial caspase eventually activates its downstream caspases, caspases 3 and 7, which are the executive caspases. Executive caspases cause the degradation of intracellular proteins and finally cell death. In addition to the mentioned pathway, 6-gingerol can trigger apoptosis by inhibiting the pathway that causes the proteasomal degradation of P53. In normal cell conditions, the phosphorylation of epidermal growth factor receptors causes the conversion of Src to phosphorylated Src. Phosphorylated Src then phosphorylates STAT3. Phosphorylated STATs are connected in the form of dimers and are connected to the MDM2 gene promoter in the cell nucleus and cause the transcription of this protein. MDM2 then moves to the cytoplasm and is phosphorylated there. MDM2 cannot bind to p53 in a phosphorylated state. As a result, P53 is ubiquitinated and degraded by the proteasome [*Park Y et al., 2006; Sp N et al., 2021*].

Antimicrobial effects: The spread of bacterial, fungal, and viral infectious diseases has been a public threat due to antimicrobial resistance. Several plants and spices have been developed as effective natural antimicrobial agents against many pathogenic microorganisms [*Awan UA et al., 2017*]. In recent years, it has been reported that ginger has antibacterial, antifungal, and antiviral activities [*Nassan M, Mohamed E, 2014; Moon Y et al., 2018*]. Observations have shown that ginger prevents the growth of the Pseudomonas aeruginosa strain, which is resistant to several drugs, by affecting the integrity of the membrane and preventing the formation of biofilm [*Chakotiya A et al., 2017*]. According to an experimental study, the development of caries caused by Streptococcus mutans was reduced in a group of mice [*Kim H, Park H, 2013*]. The compounds in ginger essential oil have lipophilic properties. These compounds make the cell wall as well as the cytoplasmic membrane more permeable and destroy the integrity of

the membrane in fungi [*Nerilo S et al., 2016*]. An experimental study has shown that ginger essential oil effectively prevents the growth of Fusarium verticillioides by reducing ergosterol biosynthesis and negatively affecting membrane integrity. In addition, ginger essential oil has been effective in suppressing the growth of Aspergillus flavus as well as the production of aflatoxin and ergosterol.

Analgesic effects: Pain is an unpleasant signal when an injury or damage occurs. This sensation is a complex experience that varies greatly from person to person and even between people with similar injuries or illnesses. The amount of pain can be very mild, almost undetectable, or explosive. Pain in different forms such as acute and chronic pain, neuropathic, inflammatory, and cancer pain [*Chen J et al., 2021*]. Different types of pain relievers are used to manage different types of pain. Meanwhile, opioids and non-steroidal anti-inflammatory drugs are one of the most widely used pain relievers in the world but both opioids and non-steroidal anti-inflammatory drugs have side effects such as hormone imbalance, drug dependence, nausea, indigestion, and peptic ulcer [*Slater D et al., 2010; Castellsague J et al., 2012*]. Therefore, finding an optimal painkiller that has no side effects or fewer side effects than the currently used painkillers is needed. In a study, by analyzing 16 studies for the effect of 6-shogaol and 6-gingerol on mechanical, spontaneous, and thermal pain caused by nerve damage or chemical injection in rodents, it was observed that despite being a low amount of its dose, ginger is effective on different types of pain. Also, prescribing it with non-steroidal anti-inflammatory drugs has reduced migraine attacks. A clinical report has shown that osteoarthritis patients who received both ginger extract and ibuprofen experienced significant pain reduction. In addition, the aqueous extract of ginger effectively reduces neuropathic pain caused by chemotherapy [*Kim S et al., 2022*].

Ginger and testosterone: Increasing and protecting testosterone production is one of the goals of many scientists because of its important role as a primary sex hormone in men [*Kelly D, Jones T, 2013*]. Since 1991, various in vivo studies have discovered the relationship between ginger and testosterone. The results of these studies showed that ginger increases testosterone production in men, especially under conditions of oxidative stress. Another study on diabetic and hypertensive mouse models showed that the group of mice exposed to ginger and its extracts had higher serum testosterone levels than the control group. While the compounds derived from ginger (zingerone, geraniol and 6-gingerol), when taken separately, did not affect serum testosterone levels in diabetic rats. Also, another study was conducted on male rats that were under the influence of drugs that lead to reproductive toxicity, to show the effect of ginger in improving testosterone levels in these rats. These toxins were often chemical compounds (such as aluminum chloride, and sodium metabisulfite), metals (such as lead), or drugs. Examples of drugs used in this field that can cause reproductive toxicity include lamotrigine (antiepileptic drugs), cyclophosphamide (anticancer drugs), busulfan (anticancer drugs), and carbendazim (fungal drugs). In general, all of these studied poisons reduced testosterone levels in experimental animals, and ginger as a complementary medicine counteracted this reduction [*Banihani S, 2018; Almatroodi S et al., 2021*].

Conclusion

The use of traditional and native plants as complementary medicine has increased in the world in recent years. Today, all over the world, the use of medicinal plants is used to treat and prevent a wide range of disorders. Herbal medicines have attracted the attention of many specialists and researchers due to having rich and effective components, less toxicity, and side effects compared to conventional drugs.

In this article, the therapeutic uses of ginger as one of the most widely used medicinal plants in the treatment of diseases were described. Considering that the ginger plant has many uses in traditional medicine in the treatment of diseases, and on the other hand, today's modern science also discovers the mechanisms related to the useful components of this plant in the control of disorders such as cancer, inflammation, digestive disorders, oxidative stress, the pain, and bacterial infections confirm this issue. Therefore, it is suggested to use this plant as a medicinal plant, following the considerations related to the recommended dosage and duration of use.

REFERENCES

1. *Abolaji AO, Ojo M, Afolabi TT, Arowoogun MD, Nwawolor D, Farombi EO (2017).* Protective properties of 6-gingerol-rich fraction from Zingiber officinale (Ginger) on chlorpyrifos-induced oxidative damage and inflammation in the brain, ovary and uterus of rats. Chemico-Biological Interactions, 270: 15-23 https://doi.org/10.1016/j.cbi.2017.03.017
2. *Afzal M, Al-Hadidi D, Menon M, Pesek J, Dhami M (2001).* Ginger: an ethnomedical, chemical and pharmacological review. Drug Metabolism and Drug Interactions. 18(3-4): 159-190 https://doi.org/10.1515/DMDI.2001.18.3-4.159
3. *Aghazadeh M, Bialvaei AZ, Aghazadeh M, Kabiri F, Saliani N., et al (2016).* Survey of the antibiofilm and antimicrobial effects of Zingiber officinale (in vitro study). Jundishapur Journal of Microbiology. 9(2): e30167 doi: 10.5812/jjm.30167
4. *Akhlaghi N, Najafpour-Darzi G (2023).* Potential Applications of Ginger Rhizomes as a Green Biomaterial: A Review. International Journal of Engineering. 36(2): 372-383 DOI: 10.5829/ije.2023.36.02b.16
5. *Ali BH, Blunden G, Tanira MO, Nemmar A (2008).* Some phytochemical, pharmacological and toxicological properties of ginger (Zingiber officinale Roscoe): a review of recent research. Food and Chemical Toxicology. 46(2): 409-420 https://doi.org/10.1016/j.fct.2007.09.085
6. *Ali BH, Wabel NA, Blunden G (2005).* Phytochemical, pharmacological and toxicological aspects of Hibiscus sabdariffa L.: a review. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives. 19(5): 369-375 https://doi.org/10.1002/ptr.1628
7. *Almatroodi SA, Alnuqaydan AM, Babiker AY, Almogbel MA, Khan AA, Husain Rahmani A (2021).* 6-Gingerol, a Bioactive Compound of Ginger Attenuates Renal Damage in Streptozotocin-Induced Diabetic Rats by Regulating the Oxidative Stress and Inflammation. Pharmaceutics. 13(3): 317 https://doi.org/10.3390/pharmaceutics13030317
8. *Al-Nahain A, Jahan R, Rahmatullah M (2014).* Zingiber officinale: A Potential Plant against Rheumatoid Arthritis. Arthritis. 159089 doi: 10.1155/2014/159089
9. *Anh NH, Kim SJ, Long NP, Min JE, Yoon YC., et al* (*2020).* Ginger on human health: a comprehensive systematic review of 109 randomized controlled trials. Nutrients. 12(1): 157 https://doi.org/10.3390/nu12010157
10. *Awan UA, Ali S, Shahnawaz AM, Shafique I, Zafar A., et al (2017).* Biological activities of Allium sativum and Zingiber officinale extracts on clinically important bacterial pathogens, their phytochemical and FT-IR spectroscopic analysis. Pakistan Journal of Pharmaceutical Sciences. 30(3): 729-745
11. *Ballester P, Cerdá B, Arcusa R, Marhuenda J, Yamedjeu K, Zafrilla P (2022).* Effect of Ginger on Inflammatory Diseases. Molecules (Basel, Switzerland). 27(21): https://doi.org/10.3390/molecules27217223
12. *Banihani SA (2018).* Ginger and testosterone. Biomolecules. 8(4): 119 https://doi.org/10.3390/biom8040119
13. *Bischoff-Kont I, Fürst R (2021).* Benefits of Ginger and Its Constituent 6-Shogaol in Inhibiting Inflammatory Processes. Pharmaceuticals (Basel, Switzerland). 14(6) https://doi.org/10.3390/ph14060571
14. *Cadena J, Vinaccia S, Pérez A, Rico MI, Hinojosa R, Anaya JM (2003).* The impact of disease activity on the quality of life, mental health status, and family dysfunction in colombian patients with rheumatoid arthritis. Journal of Clinical Rheumatology: Practical Reports on Rheumatic & Musculoskeletal Diseases. 9(3): 142-150 DOI: 10.1097/01.RHU.0000073434.59752.f3
15. *Castellsague J, Riera-Guardia N, Calingaert B, Varas-Lorenzo C, Fourrier-Reglat A., et al (2012).* Safety of Non-Steroidal Anti-Inflammatory Drugs (SOS) Project. Individual NSAIDs and upper gastrointestinal complications: a systematic review and meta-analysis of observational studies (the SOS project). Drug Safety. 35: 1127-1146 https://doi.org/10.1007/BF03261999

16. *Chakotiya AS, Tanwar A, Narula A, Sharma RK (2017).* Zingiber officinale: Its antibacterial activity on Pseudomonas aeruginosa and mode of action evaluated by flow cytometry. Microbial Pathogenesis, 107: 254-260 https://doi.org/10.1016/j.micpath.2017.03.029

17. *Chen H, Fu J, Chen H, Hu Y, Soroka DN., et al (2014).* Ginger compound [6]-shogaol and its cysteine-conjugated metabolite (M2) activate Nrf2 in colon epithelial cells in vitro and in vivo. Chemical Research in Toxicology. 27(9): 1575-1585 https://doi.org/10.1021/tx500211x

18. *Chen J, Abbod M, Shieh JS (2021).* Pain and Stress Detection Using Wearable Sensors and Devices-A Review. Sensors (Basel, Switzerland). 21(4) https://doi.org/10.3390/s21041030

19. *Cimino C, Maurel OM, Musumeci T, Bonaccorso A, Drago F., et al (2021).* Essential oils: Pharmaceutical applications and encapsulation strategies into lipid-based delivery systems. Pharmaceutics. 13(3): 327 https://doi.org/10.3390/pharmaceutics13030327

20. *Craig E, Cappelli LC (2018).* Gastrointestinal and Hepatic Disease in Rheumatoid Arthritis. Rheumatic Diseases Clinics of North America. 44(1): 89-111 https://doi.org/10.1016/j.rdc.2017.09.005

21. *De Lima RM, Dos Reis AC, de Menezes AA, Santos JV, Filho JW., et al (2018).* Protective and therapeutic potential of ginger (Zingiber officinale) extract and [6]-gingerol in cancer: A comprehensive review. Phytotherapy Research. 32(10): 1885-1907 https://doi.org/10.1002/ptr.6134

22. *Dennison EM, Cooper C (1998).* Corticosteroids in rheumatoid arthritis. BMJ (Clinical research ed). 316(7134): 789-790

23. *Dinu C, Gheorghe S, Tenea AG, Stoica C, Vasile GG., et al (2021).* Toxic Metals (As, Cd, Ni, Pb) impact in the most common medicinal plant (Mentha piperita). International Journal of Environmental Research and Public Health. 18(8): 3904 https://doi.org/10.3390/ijerph18083904

24. *Eamlamnam K, Patumraj S, Visedopas N, Thong-Ngam D (2006).* Effects of Aloe vera and sucralfate on gastric microcirculatory changes, cytokine levels and gastric ulcer healing in rats. World Journal of Gastroenterology. 12(13): 2034-2039 doi: 10.3748/wjg.v12.i13.2034

25. *Fukai T, Ushio-Fukai M (2011).* Superoxide dismutases: role in redox signaling, vascular function, and diseases. Antioxidants & Redox Signaling. 15(6): 1583-1606 https://doi.org/10.1089/ars.2011.3999

26. *Getaneh A, Guadie A, Tefera M (2021).* Levels of heavy metals in ginger (Zingiber officinale Roscoe) from selected districts of Central Gondar Zone, Ethiopia and associated health risk. Heliyon. 7(4): e06924 https://doi.org/10.1016/j.heliyon.2021.e06924

27. *Grzanna R, Lindmark L, Frondoza CG (2005).* Ginger--an herbal medicinal product with broad anti-inflammatory actions. Journal of Medicinal Food. 8(2): 125-132 https://doi.org/10.1089/jmf.2005.8.125

28. *Jung MY, Lee MK, Park HJ, Oh EB, Shin JY., et al (2018).* Heat-induced conversion of gingerols to shogaols in ginger as affected by heat type (dry or moist heat), sample type (fresh or dried), temperature and time. Food Science and Biotechnology. 27: 687-693 https://doi.org/10.1007/s10068-017-0301-1

29. *Kalhoro MT, Zhang H, Kalhoro GM, Wang F, Chen T., et al (2022).* Fungicidal properties of ginger (Zingiber officinale) essential oils against Phytophthora colocasiae. Scientific Reports. 12(1): 2191 https://doi.org/10.1038/s41598-022-06321-5

30. *Kelly DM, Jones TH (2013).* Testosterone: a metabolic hormone in health and disease. The Journal of endocrinology. 217(3): R25-R45 https://doi.org/10.1530/JOE-12-0455

31. *Khodaie L, Sadeghpoor O (2015).* Ginger from ancient times to the new outlook. Jundishapur Journal of Natural Pharmaceutical Products. 10(1): e18402 doi: 10.17795/jjnpp-18402

32. *Kim HS, Park HD (2013).* Ginger extract inhibits biofilm formation by Pseudomonas aeruginosa PA14. PloS One. 8(9): e76106 https://doi.org/10.1371/journal.pone.0076106

33. *Kim S, Cheon C, Kim B, Kim W (2022).* The Effect of Ginger and Its Sub-Components on Pain. Plants (Basel, Switzerland). 11(17) https://doi.org/10.3390/plants11172296

34. *Kiuchi F, Iwakami S, Shibuya M, Hanaoka F, Sankawa U (1992).* Inhibition of prostaglandin and leukotriene biosynthesis by gingerols and diarylheptanoids. Chemical & Pharmaceutical Bulletin. 40(2): 387-391 https://doi.org/10.1248/cpb.40.387

35. *Kumar KM, Asish GR, Sabu M, Balachandran I (2013).* Significance of gingers (Zingiberaceae) in Indian System of Medicine - Ayurveda: An overview. Ancient Science of Life. 32(4): 253-261 doi: 10.4103/0257-7941.131989

36. *Lete I, Allué J (2016).* The Effectiveness of Ginger in the Prevention of Nausea and Vomiting during Pregnancy and Chemotherapy. Integrative Medicine Insights. 11: 11-17 https://doi.org/10.4137/IMI.S36273

37. *Liu CM, Kao CL, Tseng YT, Lo YC, Chen CY (2017).* Ginger phytochemicals inhibit cell growth and modulate drug resistance factors in docetaxel resistant prostate cancer cell. Molecules (Basel, Switzerland). 22(9): 1477 https://doi.org/10.3390/molecules22091477

38. *Liu Q, Meng X, Li Y, Zhao CN, Tang GY, Li HB (2017).* Antibacterial and Antifungal Activities of Spices. International Journal of Molecular Sciences. 18(6): https://doi.org/10.3390/ijms18061283

39. *Lobo V, Patil A, Phatak A, Chandra N (2010).* Free radicals, antioxidants and functional foods: Impact on human health. Pharmacognosy Reviews. 4(8): 118-126

40. *Mao QQ, Xu XY, Cao SY, Gan RY, Corke H., et al (2019).* Bioactive compounds and bioactivities of ginger (Zingiber officinale Roscoe). Foods. 8(6): 185 https://doi.org/10.3390/foods8060185

41. *Martemucci G, Costagliola C, Mariano M, D'andrea L, Napolitano P, D'Alessandro AG (2022).* Free radical properties, source and targets, antioxidant consumption and health. Oxygen. 2(2): 48-78 https://doi.org/10.3390/oxygen2020006

42. *Mashabela MN, Otang-Mbeng W (2023).* The Therapeutic and Phytopharmacological Potential of Ginger (Zingiber officinale). DOI: 10.5772/intechopen.105900

43. *Mashhadi NS, Ghiasvand R, Askari G, Hariri M, Darvishi L, Mofid MR (2013)* Anti-oxidative and anti-inflammatory effects of ginger in health and physical activity: review of current evidence. International Journal of Preventive Medicine. 4(1): S36-S42

44. *Mehrzadi S, Khalili H, Fatemi I, Malayeri A, Siahpoosh A, Goudarzi M (2021).* Zingerone Mitigates Carrageenan-Induced Inflammation Through Antioxidant and Anti-inflammatory Activities. Inflammation. 44(1): 186-193 https://doi.org/10.1007/s10753-020-01320-y

45. *Mohn ES, Kern HJ, Saltzman E, Mitmesser SH, McKay DL (2018).* Evidence of Drug-Nutrient Interactions with Chronic Use of Commonly Prescribed Medications: An Update. Pharmaceutics. 10(1) https://doi.org/10.3390/pharmaceutics10010036

46. *Moon YS, Lee HS, Lee SE (2018).* Inhibitory effects of three monoterpenes from ginger essential oil on growth and aflatoxin production of Aspergillus flavus and their gene regulation in aflatoxin biosynthesis. Applied Biological Chemistry. 61: 243-250 https://doi.org/10.1007/s13765-018-0352-x

47. *Nassan M, Mohamed E (2014).* Immunopathological and antimicrobial effect of black pepper, ginger and thyme extracts on experimental model of acute hematogenous pyelonephritis in albino rats. International Journal of Immunopathology and Pharmacology. 27(4): 531-541 https://doi.org/10.1177/039463201402700409

48. *Nerilo SB, Rocha GH, Tomoike C, Mossini SA, Grespan R., et al (2016).* Antifungal properties and inhibitory effects upon aflatoxin production by Zingiber officinale essential oil in Aspergillus flavus. International Journal of Food Science & Technology. 51(2): 286-292

49. *Nikkhah Bodagh M, Maleki I, Hekmatdoost A (2019).* Ginger in gastrointestinal disorders: A systematic review of clinical trials. Food Science & Nutrition. 7(1): 96-108 https://doi.org/10.1002/fsn3.807

50. *Park YJ, Wen J, Bang S, Park SW, Song SY (2006).* [6]-Gingerol induces cell cycle arrest and cell death of mutant p53-expressing pancreatic cancer cells. Yonsei Medical Journal. 47(5): 688-697 https://doi.org/10.3349/ymj.2006.47.5.688

51. *Peng S, Yao J, Liu Y, Duan D, Zhang X, Fang J (2015).* Activation of Nrf2 target enzymes conferring protection against oxidative stress

in PC12 cells by ginger principal constituent 6-shogaol. Food & Function, 6(8): 2813-2823 https://doi.org/10.1039/C5FO00214A

52. *Pertz HH, Lehmann J, Roth-Ehrang R, Elz S (2011).* Effects of ginger constituents on the gastrointestinal tract: role of cholinergic M3 and serotonergic 5-HT3 and 5-HT4 receptors. Planta Medica. 77(10): 973-978 DOI: 10.1055/s-0030-1270747

53. *Prakash J (2019).* Medicinal properties of Ginger (Zingiber officinale roscoe). Natural Medicines: CRC Press. 419-435

54. *Rahmani AH, Shabrmi FM, Aly SM (2014).* Active ingredients of ginger as potential candidates in the prevention and treatment of diseases via modulation of biological activities. International Journal of Physiology, Pathophysiology and Pharmacology. 6(2): 125-136

55. *Reddy YA, Chalamaiah M, Ramesh B, Balaji G, Indira P (2014).* Ameliorating activity of ginger (Zingiber officinale) extract against lead induced renal toxicity in male rats. Journal of Food Science and Technology, 51(5): 908-914 https://doi.org/10.1007/s13197-011-0568-9

56. *Sharifi-Rad M, Varoni EM, Salehi B, Sharifi-Rad J, Matthews KR., et al (2017).* Plants of the genus Zingiber as a source of bioactive phytochemicals: From tradition to pharmacy. Molecules. 22(12): 2145 https://doi.org/10.3390/molecules22122145

57. *Singh N, Yadav SS (2022).* Ethnomedicinal uses of Indian spices used for cancer treatment: A treatise on structure-activity relationship and signaling pathways. Current Research in Food Science. 5: 1845-1872 https://doi.org/10.1016/j.crfs.2022.10.005

58. *Slater D, Kunnathil S, McBride J, Koppala R (2010).* Pharmacology of nonsteroidal antiinflammatory drugs and opioids. Seminars in Interventional Radiology, 27(4): 400-411 DOI: 10.1055/s-0030-1267855

59. *Sostres C, Gargallo CJ, Arroyo MT, Lanas A (2010).* Adverse effects of non-steroidal anti-inflammatory drugs (NSAIDs, aspirin and coxibs) on upper gastrointestinal tract. Best Practice & Research Clinical Gastroenterology. 24(2): 121-132 https://doi.org/10.1016/j.bpg.2009.11.005

60. *Sp N, Kang DY, Lee JM, Bae SW, Jang KJ (2021).* Potential antitumor effects of 6-gingerol in p53-dependent mitochondrial apoptosis and inhibition of tumor sphere formation in breast cancer cells. International Journal of Molecular Sciences. 22(9): 4660 https://doi.org/10.3390/ijms22094660

61. *Tahir AA, Sani NFA, Murad NA, Makpol S, Ngah WZW, Yusof YAM (2015).* Combined ginger extract & Gelam honey modulate Ras/ERK and PI3K/AKT pathway genes in colon cancer HT29 cells. Nutrition Journal. 14(1): 1-10

62. *Tanaka Y (2020).* Rheumatoid arthritis. Inflammation and Regeneration. 40: 20

63. *Wang Y, Branicky R, Noë A, Hekimi S (2018).* Superoxide dismutases: Dual roles in controlling ROS damage and regulating ROS signaling. The Journal of Cell Biology. 217(6): 1915-1928 https://doi.org/10.1083/jcb.201708007

64. *Wohlmuth H, Leach DN, Smith MK, Myers SP (2005).* Gingerol content of diploid and tetraploid clones of ginger (Zingiber officinale Roscoe). Journal of Agricultural and Food Chemistry. 53(14): 5772-5778 https://doi.org/10.1021/jf050435b

65. *Xu DP, Li Y, Meng X, Zhou T, Zhou Y., et al (2017).* Natural antioxidants in foods and medicinal plants: Extraction, assessment and resources. International Journal of Molecular Sciences. 18(1): 96 https://doi.org/10.3390/ijms18010096

66. *Yücel Ç, Karatoprak GŞ, Açıkara ÖB, Akkol EK, Barak TH., et al (2022).* Immunomodulatory and anti-inflammatory therapeutic potential of gingerols and their nanoformulations. Frontiers in Pharmacology. 13: 902551 https://doi.org/10.3389/fphar.2022.902551

THE NEW ARMENIAN MEDICAL JOURNAL
Volume17 (2023). Issue 3

CONTENTS

THE NEW ARMENIAN MEDICAL JOURNAL

Volume17 (2023). Issue 3

The Journal is founded by
Yerevan State Medical
University after M. Heratsi.

Rector of YSMU

Armen A. Muradyan

Address for correspondence:

Yerevan State Medical University
2 Koryun Street, Yerevan 0025,
Republic of Armenia

Phones:

(+37410) 582532 YSMU
(+37493 588697 Editor-in-Chief
Fax: (+37410) 582532
E-mail:namj.ysmu@gmail.com, ysmiu@mail.ru
URL:http//www.ysmu.am

Our journal is registered in the databases of Scopus, EBSCO and Thomson Reuters (in the registration process)

SCOPUS EBSCO
REUTERS

Copy editor: Tatevik R. Movsisyan

Printed in "LAS Print" LLC
Director: Suren A. Simonyan
Armenia, 0023,Yerevan,
Acharyan St. 44 Bulding,
Phone: (+374 10) 62 76 12,
E-mail: las.print@yahoo.com