ISSN No:-2456-2165

The Health Benefits of Ginger's Antioxidative and Anti-Inflammatory Action

Shivam Pal[1]; Dr. Swarup J. Chatterjee[2]
S.N. College of pharmacy Jaunpur (U.P.) 222132

Abstract:- Ginger is a genus belonging to the family Zingiberaceae. It has around 50 genera, and there are about 1600 known species of aromatic perennial herbs that have creeping horizontal or tuberous rhizomes. It is mainly spread across the parts of tropical Africa, Asia, and the Americas. The main phenolic compounds found in the fresh ginger are gingerols, which besides 6-gingerol, include 4-, 5-, 8-, 10-, and 12-gingerols. The gingerols show a diversified bioactivity with many of them possessing antioxidant and anti-inflammatory activities, among others. Given the broad spectrum of biological activities and published data concerning the mechanisms of action, it would seem that a complex interaction between two critical events, including inflammation, and oxidative stress, may contribute to the broad spectrum of pharmacological activities of this compound. Indeed, such compound is of great attention considering its role in the immune system; hence, among them, immunomodulatory activity has been a challenge for most of the reports under study. Actually, these compounds might inhibit Akt and NF-κB pathways upon their activation hence leading to lowering the cytokines that promote inflammation whilst elevating those anti-inflammatory cytokines. Because the bioavailability of gingerols is extremely low, development and even improvement of treatment methods with such compounds are obligatory. The solution of the problem for finding new means of delivery systems with incorporated gingerols represents a good approach to the delivery of new drug systems in recent years. The purpose of this paper is to analyze the immunomodulating activity of gingerol, including its mechanism of action and roles of nanodrug delivery systems that have been designed for such an activity.

Keywords:- *Ginger, Antioxidative Effect, Anti-Inflammatory Effect, Other Benefits.*

I. INTRODUCTION

Ginger is a plant belonging to the zingiberaceae family. Some studies have pointed out that ginger is one of the most used herbal drugs in several countries. Scientific facts suggest one specific property of ginger with antioxidant and anti-inflammatory properties. A more specific, less studied bioactivity of ginger should be its neuroprotective effect. Ginger is one of the medicinal plants with health benefits widely applied in pharmaceutical formulation and foodstuffs.

Ginger is an almost magical and powerful herb with incredible potential for the treatment of a wide range of ailments. It has therapeutic value in treating degenerative disorders, including arthritis and rheumatism. Ginger is equally effective in digestive health issues, such as indigestion, constipation, and ulcers, and holds promise in the treatment of cardiovascular disorders like atherosclerosis and hypertension, as well as vomiting, diabetes mellitus, and cancer. In addition to these advantages, ginger has anti-inflammatory and anti-oxidative properties that may be useful to control the process of aging. Bioactive molecules in ginger, such as gingerols, contribute to antioxidant activity, which can combat oxidative stress. Oxidative stress is thought to be involved in various diseases; for example, it is implicated in the pathogenesis of heart diseases, neurodegenerative disorders, cancer, as well as the aging process. In addition, ginger has also shown potential as an antimicrobial agent, thus providing a vital tool in combating infectious diseases. Overall, the health benefits and therapeutic qualities of ginger make it a particularly remarkable natural remedy.

One of the essential uses of ginger is to treat urinary inflammatory problems. Additionally, its anti-inflammatory activity, attributed to modulation of the immune response during the cellular phase, has been described. Other highlighted capabilities of this herbal extract include antinociceptive effects caused by acetic acid. Its bioactive compounds exert an analgesic and anti-inflammatory effect by inhibiting the pathways of COX2 and LOX, thereby preventing arachidonic acid metabolism. The effect of ginger was proved to be close to the family of NSAIDs, but it does not cause an insult of stomach mucosa. We know that ginger does not impact mucosa because a raise of mucosal prostaglandin synthesis was measured after ginger intake, as ginger does not act as the inhibitor of COX1. More importantly, a study of a less-than-two-week intervention with oral ginger supplements in osteoarthritis patients demonstrated the effectiveness of ginger as an anti-inflammatory compound and pain reliever. Muscle pain and plasma PGE2 levels were assessed, proving its specificity to the COX2 enzyme. It also has biological activities, including antimicrobial, antioxidant, and anti-allergic activities, as well as helping prevent cancer, improving markers for colorectal cancer risk. In this sense, a great deal of studies manifested that ginger may prevent cardiovascular diseases, which are associated pathologies that act as the entity of cardiovascular diseases. The wide range of therapeutic effects and the potential utility of ginger in combining with other types of treatments were demonstrated by these findings.

II. LITERATURE SURVEY

- *Fitriyono Ayustaningwarno, et al:(June 2024)*

Ginger is a root used as a source of several biologically active compounds, including gingerol, shogaol, zingerone, and paradol. These exhibit antioxidant and anti-inflammatory properties, making ginger a very useful ingredient in health applications. It is also endowed with antioxidant properties that enhance tolerance to oxidative stress. Oxidative stress appears when the production of ROS exceeds the body's antioxidant defenses. Ginger bioactive compounds assist in the elimination of ROS and decrease the parameters of oxidative stress, hence boosting the activity of antioxidant enzymes and increasing the total antioxidant capacity.Given its abilities in preventing oxidative stress and inflammation-related diseases, there is a great potential for the development of functional food products from ginger. Such products would contribute to educating consumers about the various health benefits of ginger and to incorporating it in their diet.

- *Nur Fatin Nabilah Mohd Sahardi and Suzana Makpol, et al,(July 2019)*

Much of what has been identified regarding the effect of ginger on aging and degenerative diseases is generally narrow and definitely lacks important evidence. Although several studies have revealed that both ginger and its respective active compounds may possess anti-aging effects due to their antioxidant and anti-inflammatory properties, further research is required to clearly understand the relationship.In summary, although preliminary evidence is promising, further research will be necessary to fully elucidate the potential role of ginger in promoting healthy ageing and preventing degenerative diseases.

- *Neeru Bhatt, et al(January 2013)*

The ginger is a rhizomatic plant, which simply means it grows on and in an underground network of roots. This part of the plant can be found in many parts of the world, particularly in Southeast Asia and China, as well as in parts of Japan, Austria, Latin America, Jamaica, and Africa. From ancient times, ginger played a very large part in food and traditional medicine, mainly in the Indian subcontinent, being sought after for its medicinal merits.The medicinal properties of ginger have been acknowledged for hundreds of years, thereby ranking it among the most used spices in different cuisines across the globe. It is not only a popular condiment and flavouring agent but also serves as a garnish to many dishes. Health-wise, ginger is said to stimulate digestion and relieve bloating and gas, thus being good to individuals suffering from digestive disorders such as dyspepsia and colic.In addition to the digestive benefits, ginger has properties that can thin the blood and lower cholesterol levels, contributing to its role in the treatment and prevention of heart diseases. The main active components contained in ginger, specifically certain phenolic compounds, are responsible for these beneficial effects. Therefore, ginger is not only extolled for its unique flavour but also for its wide range of health benefits. Essential oils are crucial in maintaining health and wellness because they have strong antioxidant properties, and they can neutralize bad free radicals within the body. These oils also have good antimicrobial properties.

A. Procedure

- *Ginger*

Ginger (zingier) is the scraped or unscraped rhizome of zingiber officinale (zingiberaceae). The BP drug is known as commerce as 'unbleached ginger'. Z. officinale, a reed like plant, is grown in many parts of the world, including Jamaica, China, India and Africa. Jamaicaginger, once the traditional pharmaceutical ginger, has been largely replaced by other sources.

- *History*

Ginger (Zingiber officinale) has a history dating back more than 5,000 years in Southeast Asia, where this plant was considered a spice, medicine, and symbol of culture. Its first use was made by Austronesian people cultivating it across the Pacific and Indian Oceans during their voyages; the plant later became significant in the culinary and medicinal traditions of ancient India and China. Ayurvedic texts indicate that it could be used to improve digestion and to treat nausea and other such diseases, whereas traditional Chinese medicine considered it a warming herb suited for circulation or breathing disorders.

As the fame of ginger spread, it became a valuable commodity in the ancient world. Egyptians were using ginger both for cooking and for embalming purposes, and Greek and Roman physicians were hailing its medicinal properties. The Greek physician Dioscorides, living in the Roman Empire, authored a pharmacological text called De Materia Medica detailing its uses. In this era, ginger had also emerged as an expensive commodity traded through land routes like the famous Silk Road as the Middle Ages began in Europe, ginger became more and more popular, everyone using it when they could afford to have it abundantly available in every noble kitchen, used in spiced dishes or desserts. Because of its substantial cost, it was highly valued, second only to black pepper as the most expensive spice of the medieval era. During the Age of Exploration in the 15th and 16th centuries, European colonizers brought ginger to the New World. The tropical weather of the Caribbean proved an ideal climate for this spice. Nowadays, ginger comes from Jamaica among other main producers around the world. The production of ginger in the Americas satisfied much of the increased demand for the spice. By the 18th and 19th centuries, ginger had become staple spice in kitchens throughout Europe and North America. It was also added to drinks, where in the mid-19th century, ginger ale became a successful beverage.

In modern times, the cultivation of ginger spans tropical and subtropical regions around the world, where India is the largest producer. Modern agriculture in ginger encourages availability and diversity, allowing for innovations such as powdered ginger, essential oils, and extracts. It is one of the most integral staples in Asian, African, Middle Eastern, and Western cuisines, cherished for its warm, spicy flavour and versatility. Apart from being the

ISSN No:-2456-2165

spice that adds flavour to some food, ginger also has medicines for digestion, nausea, inflammation, and colds, furthered by modern scientific research. From ancient healing traditions to modern wellness practices, the development of ginger epitomizes its timeless importance in human culture and health.

B. Cultivation and Collection

➢ *Cultivation of Ginger*

Ginger is a perennial herb grown mostly for its rhizomes. It grows well in tropical and subtropical regions. Optimal growth requires well-drained, fertile soils with a pH between 5.5 and 6.5.

➢ *Propagation*

Propagation is achieved vegetatively using healthy rhizome sections containing viable buds. Rhizome pieces are pre-treated with antifungal agents before planting to prevent soil-borne diseases.

- *Planting:*

This is done during the onset of monsoon season, that is, April to June. Mulching with organic matter such as green leaves is vital for conservation of moisture, suppression of weeds, and improvement in soil quality.

- *Crop Management:*

The crops need frequent weeding, irrigation, and earthing up for proper development of rhizomes. Organic and inorganic fertilizers are provided for its support, as well as pest and disease control measures to prevent infestation.

➢ *Ginger Harvesting*

- *Harvesting*

8–10 months after planting, as the leaves begin to yellow and wilt, which is an indicator that it is mature. In the case of fresh ginger, it may be picked up at a time of 6 months.

- *Processing*

Rooted rhizomes are dug out with a lot of care and cleaned to remove soil, sorted in terms of size and quality. The rhizomes have to be peeled, washed and sun-dried for dried ginger.

- *Storage and Preservation*

All these require proper storage conditions, where the drug should be kept under cool, dry, and well-ventilated conditions; otherwise, it may get fungal contamination or spoil.

The active constituents of ginger valued in pharmacognosy are gingerol and shogaol, which have quite important therapeutic properties like anti-inflammatory effect and anti-emetic. Cultivation practices followed in ginger are characterised by a high yield and good quality of rhizomes for use in medicine as well as cooking and food preparations. For specific methodologies and pharmacognostic details, refer to the appropriate chapters of Trease and Evans' Pharmacognosy.

➢ *Chemical Constituents*

Ginger contains acrid resinous substances (5-8%), volatile oil (1-3%), starch (5%), protein (2-3%) and sugars such as sucrose, raffinose and glucose. The chemical constituents from the Ginger rhizome can be divided into two classes, the pungent and the flavouring principles. The pungent substances, gingerols are 1-(4-hydroxy-3-methoxyphenyl)-5-hydroxyalken-3-ones with an S(+)-configurations, having side chain of different lengths. On the basis of the length of side chain, gingerols are designated as 3,4,5,6,8 and 10 gingerols. The other gingerol analogues are zingerone or [4(4-hydroxy-3-methoxy-phenyl-butanone)], 6-shogaol, 4, 6,8 and 10-gingediols, methylgingedioles, and their acetates, hexahydro curcumin, dimethyl hexahydro curcumin, gingerdiones, dehydrogingerdiones, capsaicin, and 6,4-dicloroflavan. Gingerols and shogaols are non-volatile phenolic compounds with different side-chains. Gingerol is formed in the plant from phenylalanine, malonate and hexanoate. The pungency of gingerol is destroyed by boiling with 2% potassium hydroxide.Gingerol is the main phenolic compound and once degraded gives shogaols, zingerone, and paradol. Zingerone and shogaols exist in small levels in fresh ginger and large amounts in dried or extracted products. Zingerone is also formed from the breakdown of gingerols at this time; this molecule is much less pungent with a spicy-sweet scent. Other sesquiterpenoids bisabolene, geranyl acetate, terpeneol, terpenes, geraniol, alpha pinene, limonene, zigerbene, batabeasabolene, alpha paradol, farnesene, and monoterpenoid fraction (β-phelladrene, cineol, and citral) have smaller quantities in the product. Ginger contains a special group of compounds called diasyleheptanoids, which includes gingerenone.

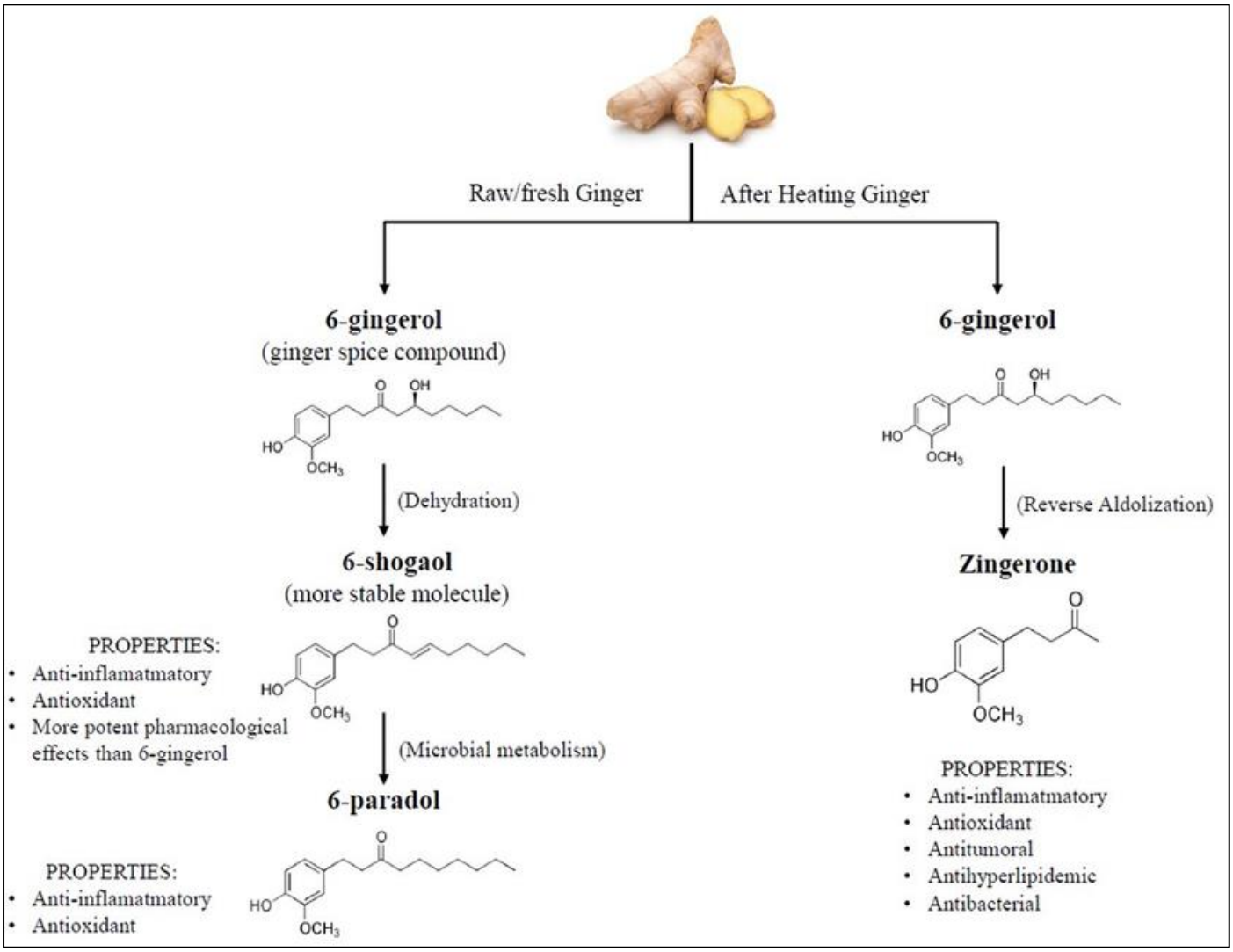

Fig 1 Bioactive Compound of Ginger

III. DISCUSSION

➢ *Antioxidative Effect*

Free radical scavengers, which can absorb free radicals generated in biological systems, are part of ginger's rich phytochemistry. Some of the free radicals produced during oxidation are crucial for the creation of energy. Increased free radical generation causes oxidative stress, which damages DNA. Extra antioxidant supplementation through dietary modules is necessary for organism life in such imbalanced conditions. Numerous in vitro and in vivo investigations have been conducted to investigate the anti-oxidative qualities of ginger and its constituents. Improving antioxidant status will undoubtedly strengthen the body's defenses against a variety of chronic illnesses. 6 Because ginger has an alpha, beta-unsaturated ketone moiety, it has demonstrated the most anti-inflammatory and antioxidant qualities.Ginger dramatically reduced induced lipid peroxidation and increased the levels of antioxidant enzymes and serum glutathione, according to animal models. Furthermore, animals given 1% w/w of ginger for four weeks while receiving 20 ppm of malathion saw a substantial reduction in malathion-induced lipid peroxidation. Glutathione (GSH), lindane-induced lipid peroxidation, and the GSH-dependent enzymes glutathione peroxidase, glutathione reductase, and glutathione-S-transferase were all markedly decreased by concurrent dietary administration of ginger (1%w/w).

Zingerone may be useful in treating Parkinson's disease since it scavenged O2-and OH and inhibited lipid peroxidation in vitro. The levels of glutathione peroxidase, glutathione reductase, superoxide dismutase, catalase, and glutathione in the hepatic tissue were are all markedly reduced by ethanol. A one-month treatment of rats with 1% dietary ginger improved this impact, suggesting that ginger may have a preventive function against ethanol-induced hepatotoxicity. In cases of renal failure, ginger and Arabic gum had reno protective benefits. Their anti-inflammatory qualities, which reduce serum c-reactive protein levels, and antioxidant action, which lower lipid peroxidation markers, malondialdehyde levels, and raise renal superoxide dismutase activity, may be the cause of these protective benefits. In patients with acute and chronic renal failure, they may be useful adjuvant therapy to slow the course of the illness and postpone the need for renal replacement therapy.

ISSN No:-2456-2165

➢ *Anti-Inflammatory Effect*

In ancient societies, medical doctorsconcentrated on herbs to improve the immunesystems of human body. In many countries ginger and itsproducts enhance the immune system Gingerol, Shogaol, and other structurally-related compound in ginger block prostaglandin and leukotriene biosynthesis through the inhibition of 5-lipoxygenase or prostaglandin synthetase.

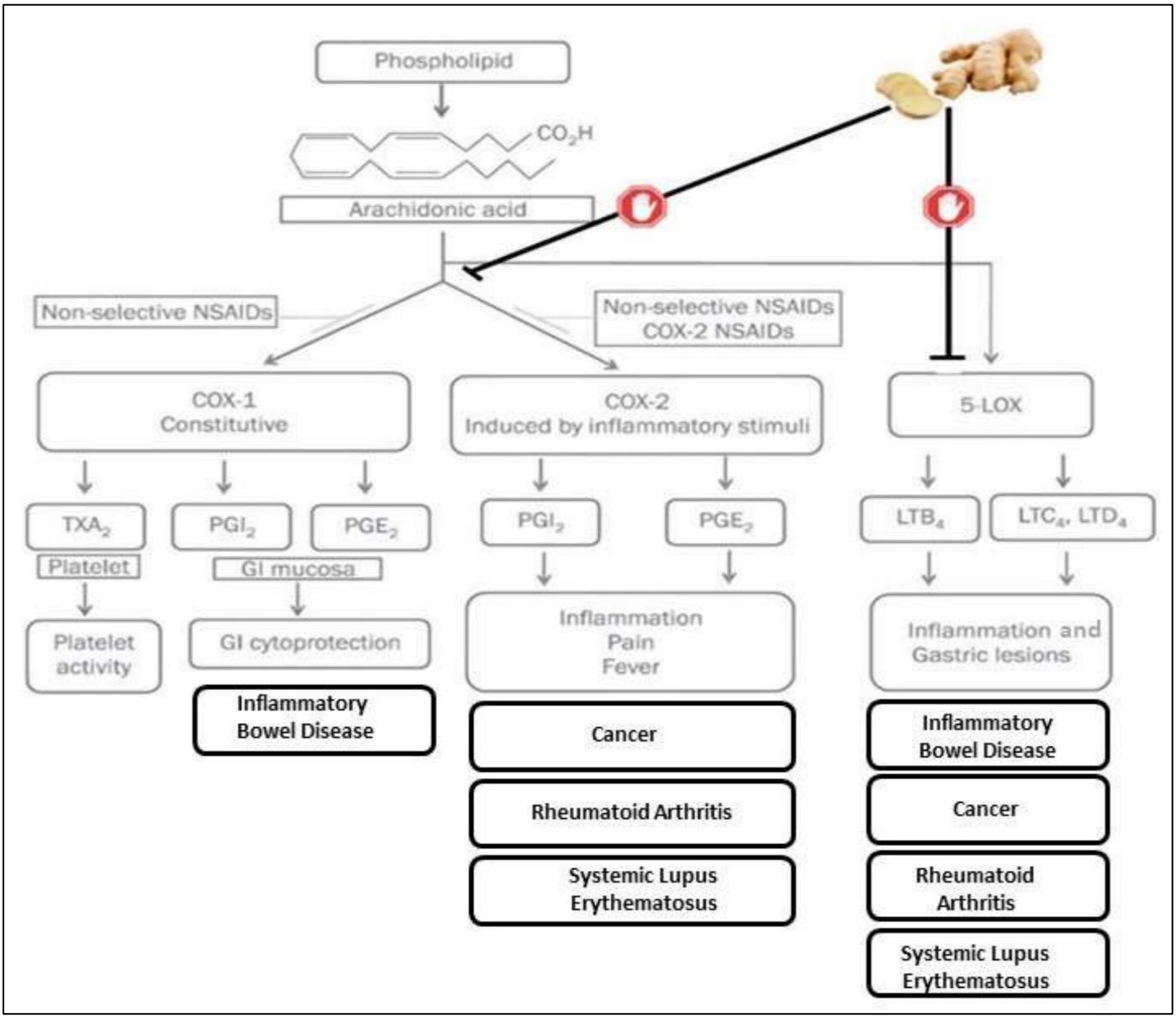

Fig 2 Ginger Action on Inflammation.

Besides, they can also suppress synthesis of pro-inflammatory cytokines such as IL-1, TNF-α,and IL-8. In another study, revealed that in macrophages,shogaol candown-regulate inflammatory iNOS and COX-2gene expressionreported that rhizomehexane fraction extract of Z. officinale suppressed theoverproduction of NO, PGE (2), TNF-alpha,and IL-1beta.Due to strong active compounds inginger rhizome for suppressing allergic reactions, itmay be applied for the treatment and prevention ofallergic diseases. Demonstrated that ginger extract can decrease the overexpression of NFκB and TNF-αIn liver-cancerous rats. The NF-κB activation is involved with various inflammatory diseases, from which cancer, atherosclerosis, myocardial infarction, diabetes, allergy, asthma, arthritis, Crohn's disease, multiple sclerosis, Alzheimer'sDisease, osteoporosis, psoriasis, septic shock, and AIDS are included. showed that gingerols can suppress the LPS-induced expression of COX-2 but shogaol containing extracts does not affect the COX-2 expression. These findings suggest that significantcompounds in ginger can inhibitPGE (2) production. Clinical trials of the activity of gingerin osteoarthritis patients have been contradictoryin results. In one study, ginger extract was shown to have astatistically significant effect on the symptomatologyof osteoarthritis of the knee. In another study, the effect ofginger on osteoarthritis was significant only in the first periodof treatment. In gout as a rheumatic disease of joints, 6-shogaol has stronganti-inflammatory and antioxidant effects and canbe taken as a curative agent.

➢ *Other Health Benefits*

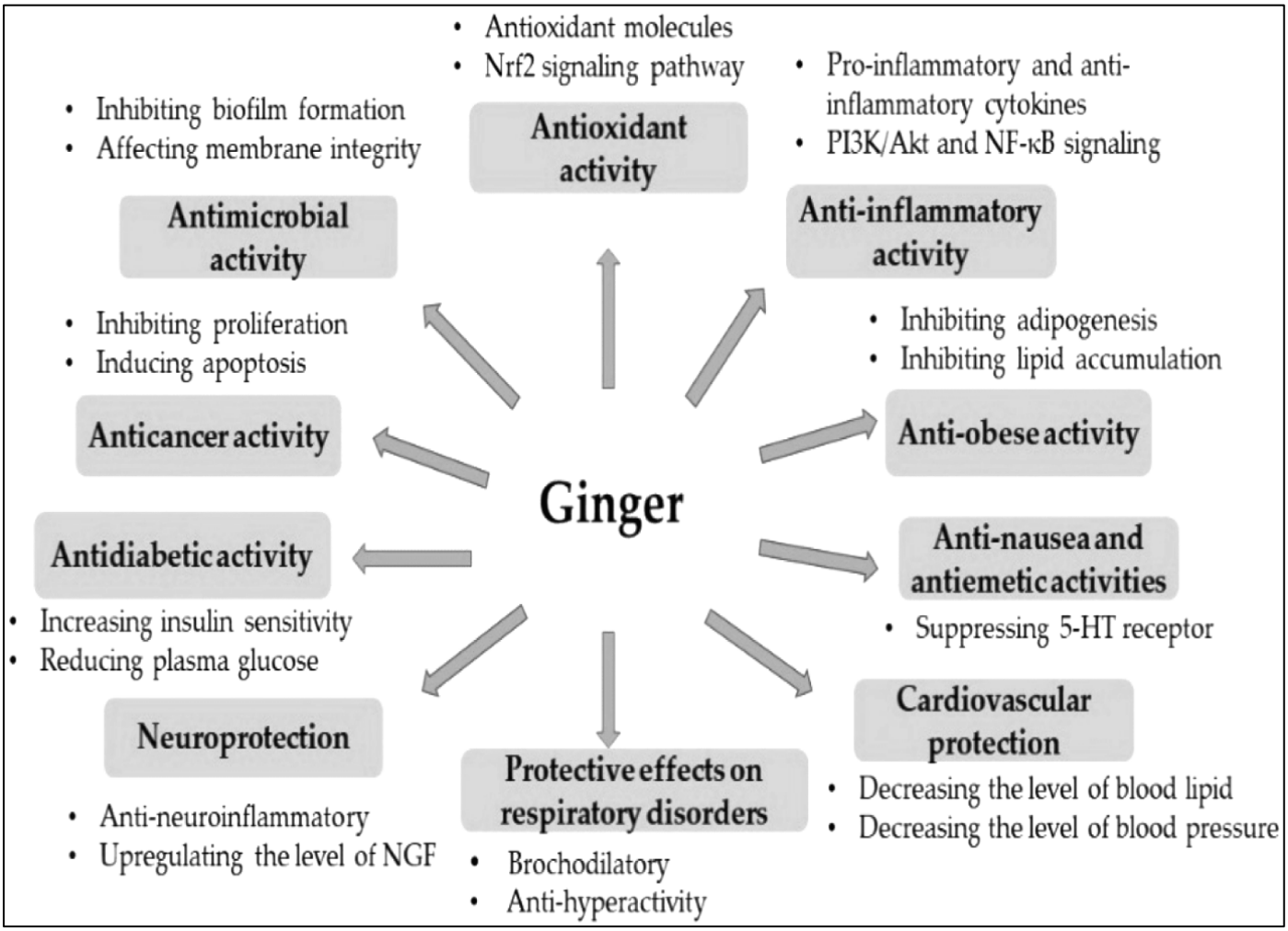

Fig 3 Health benefits of Ginger

➢ *In Diabetes and Hyperglycaemia*

Diabetes mellitus can be defined as a group of metabolic disorder, in which increase blood glucose level due to defect in insulin secretion or insulin action with impaired carbohydrate, lipid, and protein metabolism and significantly increase the morbidness and mortality rate.Diabetes is caused by increasing in level of production of reactive oxygen species as well as oxidative stress. Hyperglycaemic conditions prolonged in nature create predominance of oxidative stress over antioxidant defence systems leading to oxidative DNA damage, which possibly contributes to pancreatic beta-cell dysfunction.

Ginger has already been proved as an antidiabetic agent and helps in reducing hyperglycaemia and hypo-insulinemia conditions. Ginger may help in preventing the progression of type -2 diabetes through its hypoglycaemic effect and increased sensivity to insulin. The hypoglycaemic potential of ginger were evaluated on streptozotocin induced diabetic rats by administrating 500mg/kg, intra-peritoneal route daily for 2month. Ginger was significantly effective in reversing the diabetic proteinuria and decreasing blood glucose level in the ginger treated diabetic rats compared with the control diabetic rates. This experiment suggested that 6-gingerol have antidiabetic effect by its ability to enhance insulin sensitivity and hypolipidemic effect in type-2 diabetic animals. It is also helpful against oxidative stress hence useful in delaying or preventing complications of diabetes and aging.

➢ *Antithrombotic Effects*

Ginger has been documented to possess antithrombotic action because of its ability to inhibit aggregation of platelets and inhibit production of thromboxane-B2 in vitro studies. In addition, gingerdione inhibits the formation of 5-hydroxyeicosatetraenoic acid and prostaglandins-F2 from arachidonic acid. Shogaol looked to be a selective inhibitor of 5-HETE formation, whereas gingerol and favoured inhibiting cyclo-oxygenase.

➢ *Antimicrobial Effects*

Ginger is effective against gram positive and gram-negative bacteria as well as also inhibits the growth of pathogens like streptococcus pyrogens and streptococcus aureus, which causes various infections like skin infection, throat infection and other medical conditions.

➢ *Anticancer Effects*

Chemicals of Ginger are chemo-preventive dietary medium with inhibitory action against cyclo-oxygenase and

lypo-oxygenase activities, initiation of cell death, and antitumorigenic effects. Ginger prevents 5-lypo-oxygenase enzyme, which are the only food for prostate cancer cells die. Ginger induces cell death in leukemic, skin, lungs, kidney, and pancreatic cancer cells. The antineoplastic activity of ginger is attributed to the presence of certain chemical constituents such as 6-gingerol & 6-paradol, along with some other constituents. Hence, it can be safely used for cancer therapy. It is beneficial to inhibit constipation related cancer.

IV. CONCLUSION

In conclusion the present review shows, the antioxidative and anti-inflammatory activity of ginger have shown great potential in enhancing human health. Many studies show that the presence of bioactive compound found in ginger such as gingerol, shogaol, paradol etc is used to neutralize free radicals and decrease oxidative stress, these effects have been connected to reducing inflammation. One of the conditions that cause the chronic disease mention above namely metabolic disease, cardiovascular disease, cancer, arthritis, etc. Ginger may be useful in preventing or managing condition related to chronic inflammation through the modulation of inflammatory pathway and reduction of oxidative damage. Ginger holds out a lot of promise for being a natural remedy toward improving human health.

It has well known health promoting outlook due to immunonutrition and anti-inflammatory effect it can treat a vast disease and cure. Because of an anti-inflammatory effect of this one, it reduces muscular ache after intense exercise, therefore, the anticancer aspect is also well known that have functional ingredients like Gingerols, Shogaol and paradol which can fight numerous cancers, angiogenesis and metastasis, cause initiation of cell death and delay progression in the cycle of cells.

REFERENCES

[1]. Mashhadi NS, Ghiasvand R, Askari G, Hariri M, Darvishi L, Mofid MR. Anti-oxidative and anti-inflammatory effects of ginger in health and physical activity: review of current evidence. Int J Prev Med. 2013 Apr;4(Suppl 1):S36-42. PMID: 23717767; PMCID: PMC3665023.

[2]. Shukla Y, Singh M. Cancer preventive properties of ginger: A brief review. Food Chem Toxicol. 2007;45:683–90. doi: 10.1016/j.fct.2006.11.002. [DOI] [PubMed] [Google Scholar]

[3]. Ballester P, Cerdá B, Arcusa R, Marhuenda J, Yamedjeu K, Zafrilla P. Effect of Ginger on Inflammatory Diseases. Molecules. 2022 Oct 25;27(21):7223. doi: 10.3390/molecules27217223. PMID: 36364048; PMCID: PMC9654013.

[4]. Singletary K. Ginger: An overview of health benefits. Nutr. Today. 2010;45:171–183. doi: 10.1097/NT.0b013e3181ed3543. [DOI] [Google Scholar]

[5]. Kubra I.R., Rao L.J.M. An impression on current developments in the technology, chemistry, and biological activities of ginger (Zingiber officinale Roscoe) Crit. Rev. Food Sci. Nutr. 2012;52:651–688. doi: 10.1080/10408398.2010.505689. [DOI] [PubMed] [Google Scholar]

[6]. Mohd Yusof Y.A. Gingerol and Its Role in Chronic Diseases. Adv. Exp. Med. Biol. 2016;929:177–207. doi: 10.1007/978-3-319-41342-6_8. [DOI] [PubMed] [Google Scholar]

[7]. **Liu, X., Zhang, Z., & Wu, L. (2021).** "The role of ginger and its bioactive compounds in treating oxidative stress and inflammation in chronic diseases." *Antioxidants*, 10(11), 1791.

[8]. **Pothuraju, R., & Sarma, H. (2022).** "Ginger: An anti-inflammatory and antioxidant agent in treating cancers and inflammatory diseases." *Cancer Letters*, 534, 1-13.

[9]. **Kirtaniya, S., & Mukherjee, S. (2017).** "Exploring the medicinal properties of ginger and its role as a powerful antioxidant and anti-inflammatory agent." *Phytochemistry Reviews*, 16(5), 915-925.

[10]. Ajith TA, Nivitha V, Usha S. Zingiber officinale Roscoe alone and in combination with alpha-tocopherol protect the kidney against cisplatin-induced acute renal failure. Food Chem Toxicol 2007;45:921-7.

[11]. El-Ghorab AH, Nauman M, Anjum FM, Hussain S, NadeemM. Acomparative study on chemical composition and antioxidant activity of Ginger (Zingiber officinale) and Cumin (Cuminum cyminum). J Agric Food Chem 2010;58:8231-7.

[12]. Nile, S.H.; Park, S.W. Chromatographic analysis, antioxidant, anti-inflammatory, and xanthine oxidase inhibitory activities of ginger extracts and its reference compounds. *Ind. Crop. Prod.* **2015**, *70*, 238–244. [**Google Scholar**] [**CrossRef**]

[13]. Kumar, N.V.; Murthy, P.S.; Manjunatha, J.R.; Bettadaiah, B.K. Synthesis and quorum sensing inhibitory activity of key phenolic compounds of ginger and their derivatives. *Food Chem.* **2014**, *159*, 451–457. [**Google Scholar**] [**CrossRef**]

[14]. Ho, S.; Chang, K.; Lin, C. Anti-neuroinflammatory capacity of fresh ginger is attributed mainly to 10-gingerol. *Food Chem.* **2013**, *141*, 3183–3191. [**Google Scholar**] [**CrossRef**]

[15]. Kravchenko I., Eberle L., Nesterkina M., Kobernik A. Anti-inflammatory and analgesic activity of ointment based on dense ginger extract (Zingiber officinale) J. Herbmed. Pharmacol. 2019;8:126–132. doi: 10.15171/jhp.2019.20. [DOI] [Google Scholar]

[16]. Sharma, A., et al. (2017). "Antioxidant and Anti-inflammatory Properties of Ginger." *Phytotherapy Research*, 31(9), 1372-1384. https://onlinelibrary.wiley.com/doi/abs/10.1002/ptr.5946

[17]. Kumar, M., et al. (2021). "Anti-inflammatory and Antioxidant Potential of Ginger Extract." *Food Research International*, 143, 110295. https://www.sciencedirect.com/science/article/abs/pii/S2211912420305506

[18]. Zheng W, Wang SY. Antioxidant activity and phenolic compounds in selected herbs. J Agric Food Chem. 2001;49:5165–70. doi: 10.1021/jf010697n. [DOI] [PubMed] [Google Scholar]
[19]. Astley SB. Dietary antioxidants past, present and future. Trends Food Sci Technol. 2003;14:93–8. [Google Scholar]
[20]. Dugasani S, Pichika MR, Nadarajah VD, Balijepalli MK, Tandra S, Korlakunta JN. Comparative antioxidant and anti-inflammatory effects of [6]-gingerol, [8]-gingerol, [10]-gingerol and [6]-shogaol. J Ethnopharmacol. 2010;127:515–20. doi: 10.1016/j.jep.2009.10.004. [DOI] [PubMed] [Google Scholar]
[21]. Ahmed RS, Seth V, Banerjee BD. Influence of dietary ginger (Zingiber officinales Rosc) on antioxidant defense system in rat: Comparison with ascorbic acid. Indian J Exp Biol. 2000;38:604–6. [PubMed] [Google Scholar]
[22]. Habib SH, Makpol S, Abdul Hamid NA, Das S, Ngah WZ, Yusof YA. Ginger extract (Zingiber officinale) has anti-cancer and anti-inflammatory effects on ethionine-induced hepatoma rats. Clinics (Sao Paulo) 2008;63:807–13. doi: 10.1590/S1807-59322008000600017. [DOI] [PMC free article] [PubMed] [Google Scholar]
[23]. Aggarwal BB, Shishodia S. Molecular targets of dietary agents for prevention and therapy of cancer. Biochem Pharmacol. 2006;71:1397–421. doi: 10.1016/j.bcp.2006.02.009. [DOI] [PubMed] [Google Scholar]
[24]. Mashhadi NS, Ghiasvand R, Askari G, Hariri M, Darvishi L, Mofid MR. Anti-oxidative and anti-inflammatory effects of ginger in health and physical activity: review of current evidence. Int J Prev Med. 2013 Apr;4(Suppl 1):S36-42. PMID: 23717767; PMCID: PMC3665023.
[25]. Niccoli T. and Partridge L., Ageing as a risk factor for disease, *Current Biology*. (2012) **22**, no. 17, R741–R752, **https://doi.org/10.1016/j.cub.2012.07.024**, 2-s2.0-84866183226.
[26]. Peng, S.; Yao, J.; Liu, Y.; Duan, D.; Zhang, X.; Fang, J. Activation of Nrf2 target enzymes conferring protection against oxidative stress in PC12 cells by ginger principal constituent 6-shogaol. *Food Funct.* **2015**, *6*, 2813–2823. [**Google Scholar**] [**CrossRef**]
[27]. Kang, Q.; Yang, C. Oxidative stress and diabetic retinopathy: Molecular mechanisms, pathogenetic role and therapeutic implications. *Redox Biol.* **2020**, *37*, 101799. [**Google Scholar**] [**CrossRef**] [**PubMed**]
[28]. Conklin, K.A. Chemotherapy-associated oxidative stress: Impact on chemotherapeutic effectiveness. *Integr. Cancer Ther.* **2004**, *3*, 294–300. [**Google Scholar**] [**CrossRef**] [**PubMed**]
[29]. Reddy, Y.N.; Murthy, S.V.; Krishna, D.R.; Prabhakar, M.C. Role of free radicals and antioxidants in tuberculosis patients. *Indian J. Tuberc.* **2004**, *51*, 213–218. [**Google Scholar**]
[30]. Baliga MS, Haniadka R, Pereira MM, D'Souza JJ, Pallaty PL, Bhat HP, Popuri S. 2011. Update on the chemopreventive effects of ginger and its phytochemicals. Crit Rev Food Sci Nutr. 51:499–523. doi: 10.1080/10408391003698669
[31]. Gursoy UK , Marakoglu I , Oztop AY . Relationship between neutrophil functions and severity of periodontitis in obese and/or type 2 diabetic chronic periodontitis patients. *Quintessence Int (Berl)* . 2008;39:6. (Open in a new window)Web of Science ®(Open in a new window)Google Scholar
[32]. Berti, L.; Kellerer, M.; Capp, E.; Haring, H.U. Leptin stimulates glucose transport and glycogen synthesis in C2C12 myotubes: Evidence for a PI3-kinase mediated effect. *Diabetologia* **1997**, *40*, 606–609. [**Google Scholar**] [**CrossRef**] [**PubMed**]
[33]. Babu, P. V., et al. (2006). "Ginger and its Role in Human Health." *Comprehensive Reviews in Food Science and Food Safety*, 5(1), 13-23. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1541-4337.2006.00004.x