Revealing the Therapeutics Uses of Garlic (Allium sativum) and its Potential as a Good Candidate for Drug Discovery

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ABSTRACT

Garlic is one of the most important bulb vegetables, which is used as a spice and flavoring agent for foods. It has a tremendous pharmacological effect due to its biologically active constituent (Allicin and its derivatives) organo-sulfur compounds. This study reviewed the medicinal and nutritional values of garlic. Garlic contains different useful minerals, vitamins, and many other substances used for the health of human beings. The plant is rich in sugar, protein, fat, calcium, potassium, phosphorous, sulfur, iodine, fiber, and silicon in addition to vitamins. Garlic has remarkable therapeutic value and used for the treatment of various human ailments including anti-inflammatory, rheumatologic, blood circulation and anti-cramp, anti-ulcer, anticholinergic, analgesic, antimicrobial, anti-stress, immunity booster, anti-diabetes, blood pressure and cholesterol, cancer, hepatoprotective, anthelmintics, antioxidant, antifungal and wound healing, asthma, arthritis, chronic fever, tuberculosis, rhinitis, malaria, osteopathic skin disease including leprosy, discoloration of the skin and itches, indigestion, colic pain, enlargement of spleen, piles, fistula, fracture of the bone, gout, urinary diseases, diabetes, kidney stone, anemia, jaundice, epilepsy, cataract and night blindness. The use of this medicinal plant will help the promotion of the human health system.

Keywords: Allium sativum, Allicin, Drug discovery, Organo-sulfur, Therapeutic uses, Traditional medicine

INTRODUCTION

Natural products of plant sources have been used by men for thousands of years either in pure form or crude extracts to treat many diseases. Dietary supplement contributes a lot to combat different human ailments besides its nutritional value varies from culture to culture. Garlic (Allium sativum L.) has been identified as a remarkable therapeutic medicinal plant, as it played important dietary and medicinal roles in human life. It was seriously investigated over several years and used for centuries to fight infectious diseases. Garlic of the family Alliaceae and is the second most widely used Allium next to onion widely cultivated throughout the world as described, and used as a spice, additive as well as medicinal plant noticed. To this end, this document discusses the nutritional composition and therapeutics uses of garlic and highlights the potential of the plant for drug discovery.

METHODS

Data Sources and Data Extraction

An extensive search of literature and research was conducted to collect and rectify the information on phytochemistry composition, nutritional value, and contents of the crop and its therapeutic uses. Major databases and search engines were included. These are MEDLINE, EMBASE, BIOSIS, SCOPUS, Web of Science, Google scholar, Pdf searcher.org, Osun.org. Recently published papers were comprised and data extraction was performed methodologically based on previously identified keywords including allium sativum, garlic, allium, organosulfur compounds, allicin, and ajoene, medicinal value.

Data Presentation

The result was presented in tables and figures and then the information is supported by the results of various pharmacological...
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studies conducted on the crop. Finally, based on the reviewed information a conclusion was reached.

**RESULT**

**Phytochemical Constituents of Garlic**
Garlic contains sulfur compounds including alliin, allicin, ajoene, allyl propyl, diallyl, trisulfide, S-allyl cysteine, vinylthiines, S-allylmercaptopcystein, and, peptides, steroids, terpenoids, flavonoids, and phenols.7 Besides sulfur compounds, garlic amino acids, minerals (selenium, germanium, tellurium, and other trace minerals), enzymes (allinase, peroxidases, myrosinase).8 Garlic formulations consist of several organo-sulfur compounds, N-acetylcysteine (NAC), S-allyl-cysteine (SAC)12-14, and S-ally-mercapto cysteine (SAMC), which are derived from alliin.15 as shown in figure 1.

![Figure 1: Phytochemistry constituents of garlic.](image)

**Nutritional composition and values**
The results showed that garlic contains a high amount of nutrients, which is essential to promote human health. To mention some sugar, protein, fats, minerals (calcium, potassium, phosphorous, sulfur, silicon, fiber, iodine), and vitamins as described in figure 2.

![Figure 2: Nutritional composition of garlic.](image)

**Medicinal values of Garlic**
Due to its biologically active component allicin and its derivatives, garlic has been used as a medicine to cure a wide range of diseases and conditions related to the heart and blood system including high blood pressure,18 high cholesterol, coronary heart disease, heart attack, and “hardening of the arteries” (atherosclerosis) as pronounced,19 various types of cancer such as colon cancer, rectal cancer, stomach cancer, breast cancer, prostate cancer, prostate cancer, and bladder cancer, and lung cancer,3 cardiovascular disease including antilipemic, anti-hypertensive, cancer, diarrhea, pre-eclampsia, cold and flu.20 It also prevents bacterial,18,21, and fungal infection and preventing tick bites.9 The plant is effective to treat fever, cough, headache, stomach ache, sinus congestion, gout, rheumatism, hemorrhoids, asthma, bronchitis, shortness of breath, low blood pressure, low blood sugar, high blood sugar, and snakebites, fighting stress and fatigue,7 and maintaining the healthy liver function, asthma, arthritis, backache, bronchitis, chronic fever, tuberculosis, rhinitis, malaria, obstructive skin disease including leprosy, leucoderma, discoloration of the skin and itching,1 colic pain, enlargement of spleen, piles, fistula, fracture of bone, gout, urinary diseases, diabetes, kidney stone,11 anemia, jaundice, epilepsy, cataract and night blindness.22 Garlic has a crucial role in antilipemic (cholesterol lowering), antihypertensive, antibiotic, anti-tumor effects, to evade the developing of cancerous cells in stomach, liver and other organs of human. Antimicrobial activity andanthelmintic, diuretic, digestive, and vaginal Infections, platelet effects, sickle cell anemia, liver Protective/Detoxification Effects, antioxidative and radioprotective effects.7

**Antidiabetic activity**
Garlic extract was used to significantly decrease serum glucose, total cholesterol, triglycerides, urea, uric acid, aspartate aminotransferase, and alanine aminotransferase levels while increasing serum insulin in diabetic mice.23 The antidiabetic effects of garlic are mainly due to the volatile Sulphur compounds. Garlic is effective in reducing insulin resistance as well.24

**Antioxidant activity**
Diallyl sulfide (DAS) and Diallyl disulfide (DADS) and two hydrophilic organosulfur compounds, s-ethyl cysteine (SEC) and n-acetyl cysteine (NAC) contents of garlic, protected against lipid-related oxidation by activating associated antioxidant enzymes. The aged extracts obtained from the leaves showed the best antioxidant activity as a comparison to flowers and bulbs. Garlic is rich in antioxidants which help destroy free radical particles that can damage cell membranes and DNA, and may contribute to the aging process.25,26
Hepatoprotective activity
Excess intake of alcohol affects the production of oxygen radicals which leads to lowering the body’s normal defense mechanism, changed enzyme action, decreased DNA repair and reduced consumption of oxygen, lipid peroxidation, and protein oxidation. Oral administration of raw garlic protects tissue damage by increasing the antioxidant status against oxidative stress. Garlic plays an important role in antioxidants and it can be considered an ineffective drug for the cure of alcoholic disorders. Liver enzymes such as ALT, AST, and ALP are marker enzymes for liver function and integrity. Administration of lead showed a significant increase in plasma ALT and ALP activities, and equally decreased plasma AST activity levels. Post-lead treatment with garlic significantly reduced the activities of ALT and ALP and increased the activity of AST. Aged garlic and garlic’s diallyl sulfur compounds protected against acute chemically induced hepatotoxicity in rats. Aged Garlic Extracts have liver-protective effects and it has been shown to inhibit both the formation and bioactivation of liver carcinogenic nitrosamines and has prevented the mutagenic effects of aflatoxin B1.

Anti-inflammatory activity
Numerous compounds isolated from garlic moderate leukocyte cell proliferation and cytokine production. The Anti-inflammatory activity of garlic was observed in the treatment of patients with IBD, whole blood and peripheral blood mononuclear cells (PBMCs) were stimulated in the presence of different concentrations of garlic extract and the effect on leukocyte cytokine production was determined in vitro. By inhibiting Th1 and inflammatory cytokines while up-regulating IL-10 production, treatment with garlic extract may help to resolve inflammation related to IBD. The anti-inflammatory activity of garlic oil was due to the suppressed expression and production of proinflammatory cytokines TNF-α and IL-1β as mentioned elsewhere.

Cardiovascular activity
Garlic consumption has significant effects on lowering blood pressure, inhibition of atherosclerosis, reduction of serum cholesterol and triglycerides, inhibition of platelet aggregation, and increasing fibrinolytic activity. Garlic also reduces cholesterol synthesis by preventing 3-hydroxy-3-methylglutaryl-CoA. Garlic has been shown to prevent LDL oxidation, platelet aggregation, and arterial plaque formation, reduce homocysteine, lower blood pressure, and increase microcirculation, which is main in diabetes. Garlic may also help prevent cognitive decline by protecting neurons from neurotoxicity and apoptosis, thereby preventing ischemia or reperfusion related neuronal death and by improving learning and memory retention.

Hyperlipidemia
Garlic depressed the activity of hepatic lipogenesis and cholesterolegenic enzymes such as a malic enzyme, fatty acid synthetase, glucose 6-phosphate dehydrogenase, and 3-hydroxyl 3-methyl glutaryl CoA (HMG-CoA) reductase. In vitro studies have shown that water-soluble organosulfur compounds especially S-allyl cysteine (SAC) present in aged garlic extract and diallyl disulfide (DADS) present in garlic oil are also effective inhibitors of cholesterol synthesis. Garlic has a universal ability to lower cholesterol levels and reduce lipid peroxidation to prevent plaque formation. In vitro studies have revealed that it can suppress low-density lipoprotein (LDL) and increase the resistance of LDL to oxidation.

Antibacterial activity
Garlic extract inhibits different bacteria due to the presence of allicin.

Antiviral activity
An in vitro study of Garlic and its sulfur constituents demonstrated antiviral activity against Coxsackievirus spp, Herpes Simplex Virus types 1 & 2, Influenza B, Parainfluenza Virus type 3, Vaccinia Virus, Vesicular Stomatitis Virus, Human Immunodeficiency Virus Type 1, and Human Rhinovirus type 2. The order for a virucidal activity generally was: ajoene>allicin>allyl methyl thiosulfinate> methyl allylthiosulfinate.

Antifungal activity
Aqueous garlic extract and concentrated garlic oil showed inhibitory effects against Aspergillus. Allicin demonstrated fungicidal activity against numerous yeast and fungi, including Candida albicans, Cryptococcus Trichophyton, Histoplasma capsulatum, and Cryptococcus neoformans.

Anticancer activity
The research evaluated the use of garlic in leukemic, melanoma, and neuroblastoma cell lines. Allyl sulfides (a sulfur compound) are characteristic flavor components of garlic. These compounds inhibit both initiation and promotion stages of tumorigenesis in experimental carcinogenesis for various types of cancer. Pancreatic cancer risk was 54% lower in individuals who consumed larger amounts of garlic compared with those who ate lower amounts. two major compounds in aged garlic, S-allylcysteine, and S-allylmercapto-L-cysteine, had the highest radical scavenging activity. In addition, some organosulfur compounds derived from garlic, including S-allyl cysteine, have been found to retard the growth of chemically induced and transplantable tumors in several animals.
**Antihypertensive activity**
Dietary supplementation of garlic may be beneficial in reducing blood pressure and oxidative stress in hypertensive individuals. An in vitro study has confirmed that, the vasoactive ability of garlic sulfur compounds whereby red blood cells convert garlic organic polysulfide into hydrogen sulfide, a known endogenous cardio-protective vascular cell-signaling molecule.

**Antiplatelet effect**
Garlic preparations have demonstrated antiplatelet effects by obstructing cyclooxygenase activity and thromboxane A2 formation. Platelet aggregation control by garlic was observed in both in vitro and in vivo studies. In situ study the overall antithrombotic effects of garlic by modulation of fibrinolytic activity through increased plasminogen activation and by inhibiting thrombin formation.

**Anthelmintic activity**
The alcoholic extract of the bulb of garlic has also shown moderate in vitro anthelmintic activity against human *Ascaris lumbricoides*. Garlic has been reported to be effective in the exposure of dysentery and acts as a vermifuge. Oil of garlic has also been reported to possess the anthelmintic activity and discards all injurious parasites in the intestine. Garlic is used to treat intestinal worms. Garlic has anthelmintic activity against *Ascaridia galli* in chicken due to its allicin component (the main active component of garlic). Garlic oil caused mortality in *A. Galli* and *Heterakis galinarum*. Garlic extract significantly reduced the glucose uptake, glycogen content, and oxygen consumption in both parasites.

**Sickle Cell Anaemia**
Aged garlic extract (AGE) and other components of AGE, such as S-allylcysteine (SAC) and fructosyl arginine, could inhibit the formation of dense cells because AGE and SAC have been known to have antioxidant activity either fructosyl arginine does not contain sulfur molecules like many other garlic components, yet it was found to have antioxidant activity.

**Vaginal infections**
Garlic is one of the best antibiotics. It heals infections that cause vaginal irritation, vaginitis, or vaginal flow. For the cure of this disease, plenty of garlic has been eaten. It can also be used to fight scabies. Bacterial Vaginosis (BV) is one of the most common causes of vaginal discharge in women of reproductive ages. Garlic can be used as an alternative herbal medication for BV. Garlic boric acid, douching, and yogurt can be used as alternative herbal treatments for BV and yeast vaginitis.

**DISCUSSIONS**
Biological active components and their derivatives play a remarkable role in the nutraceutical applications of garlic. It has tremendous health benefits. The plant contains major nutrients such as protein, carbohydrates, fat, minerals and vitamins. Besides its nutritional value, the plant has various potential pharmacological activities against various life-threatening conditions. It also promotes and supports the heart, stomach, circulation, and lung. Garlic has come to an effective natural agent in all-rounded treatments for preventing wound infection, common cold, malaria, cough and lung tuberculosis, hypertension, sexually transmitted diseases, mental illness, kidney diseases, liver diseases, asthma, and diabetes.

**CONCLUSION**
Garlic has remarkable nutritional and therapeutic uses across the world due to the presence of major biologically active components of garlic (allicin) and its derivatives. It is a safe and rich source of biologically active compounds with low toxicity. All parts of the plant have been used from the earliest times as a condiment or spice for flavoring soup, sages, and salads and used in folk and traditional medicine. A higher concentration of sulfur compounds of garlic is responsible for its medicinal effects. Therefore, more pharmacological studies are needed to explore its medicinal values to support the health system of mankind.

**Availability of Data and Materials**
The authors confirm that the data supporting the findings of this research are included in the research work and no additional data will be available.

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**Conflict of Interest**
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Authors’ Contribution

Authors are equally contributed to the research work and they approved the final version of the manuscript.

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