WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Garlic (Allium Sativum) its Phytochemistry, Pharmacognosy & Medicinal Uses

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ABSTRACT

Medicinal plants have been used from ancient times for human healthcare as in the form of traditional medicines, spices, and other food components. As per the literature survey, Its found that Garlic has a pharmacological activity such as antifungal, anticancer, antithrombotic, Cardiovascular, antidiabetic, anti-microbial, antioxidant, antiviral and antiparasitic activities. Methods Literature has been collected through SciFinder, Web of Science, Google Scholar, Pubmed, and a library. This review shares updated information on the botany, health benefits, phytochemistry of Garlic. It is used in industries like pharmaceutical, food, and Cosmetics. Conclusion Existing literature authenticates the potential benefits of Garlic from nutritional as well as medicinal perspective. This food grain need to be explored for identification, isolation, and characterization of a bioactive compounds against varied ailments.

Keywords : Antifungal,Anticancer,Anthithrombotic,Cardiovascular,Antimicrobial,Antioxidant,Antiviral, Antiparasitic, Pubmed, Google scholar

INTRODUCTION

Garlic is a widely distributed plant. Nowadays, it is cultivated all over the world. In our region, it is the most important preventive remedy, a universal folk spice and food, a well-trusted remedy. In the past, garlic has been utilized as a remedy during the various epidemics such as typhus, dysentery, cholera, influenza, and whenever an epidemic has emerged, garlic has been the first preventive and curative remedy(1). Ancient Chinese and Indian medicine recommended garlic to aid respiration and digestion and to treat leprosy and parasitic infestationv (2). Garlic (Allium sativum L.; Family: Amaryllidaceae) is an aromatic herbaceous annual spice and one of the oldest authenticated and most important herbs that have been used from ancient times as traditional medicine(3).Consuming 1-2 garlic cloves daily may have health benefits, but consuming more can have adverse reactions like foul breath, heartburn, stomach problems, and others(4). In ancient Greece, Hippocrates, the Father of Medicine, advocated the use of garlic as a cleansing agent, for pulmonary problems and for abdominal growths. Pliney the Elder, a famous Roman naturalist recommended garlic for ailments such as gastrointestinal tract disorders, animal bites, joint disease and seizures, in his book Historia Naturatis (5).

In the plant kingdom, many plants are characterized as medicinal plants due to their chemical composition. These plants are of vital consideration because they possess significant pharmaceutical and therapeutic potential. The chemistry of such plant compounds are of pharmaceutical significance and hold therapeutic potential against a wide range of ailments and diseases through human history(6) In addition, many compounds have been identified and isolated from garlic extracts including 33 sulfur compounds and 17 amino acids which include alanine, arginine, aspartic acid, asparagine, histidine, leucine, methionine, phenylalanine, proline, serine, threonine, tryptophan, and valine(7)

Objectives

The main objective is to study the following

- chemical constituents present in garlic
- the Morphological characters for physical identification of garlic
- Drug interactions of garlic i.e garlic should not be taken with which of the following drugs & Side effects of garlic
- Uses of garlic

Pharmacognostic activities

synonym	**Garlic , Allium**
Biological source	It consist of bulbs of plant known as Allium sativum linn . it contain not less than 0.2% of allin
Family	Liliaceae
Geographical source	It is cultivated in central asia southern europe usa and india . it is almost cultivated in every state and cultivated as a spice
Chemical constituent	Includes sulfur-containing compounds such as ajoenes (E-ajoene,Z-ajoene), thiosulfinates (allicin), vinyldithiins, sulfides (diallyl disulfide (DADS), diallyl trisulfide.

Oil-Soluble Organosulfur Compounds

Allicin is easily transformed into oil-soluble polysulfides,mostly diallyl disulfide (DADS), also into diallyl sulfide(DAS), diallyl trisulfide (DATS) and diallyl tertasulfide

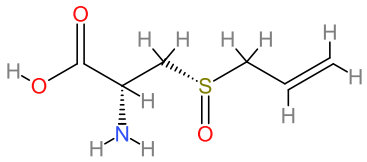
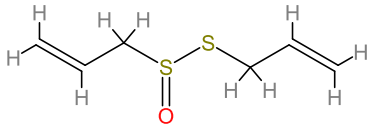
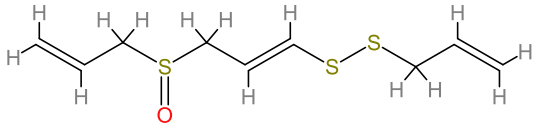
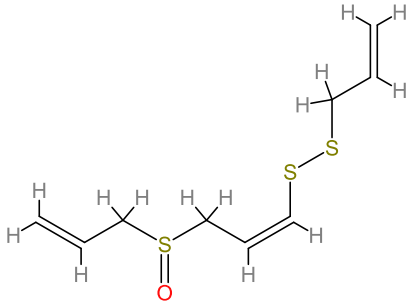
Water-Soluble Organosulfur Compounds

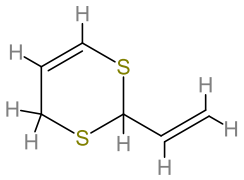
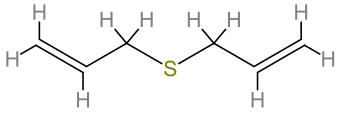
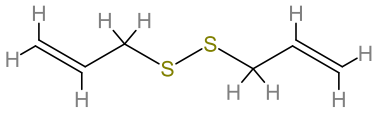
The reactions of allicin with SH groups can yield SAC or S-allylmercaptocysteine (SAMC), that are water soluble compounds (9)

Macroscopic characters.

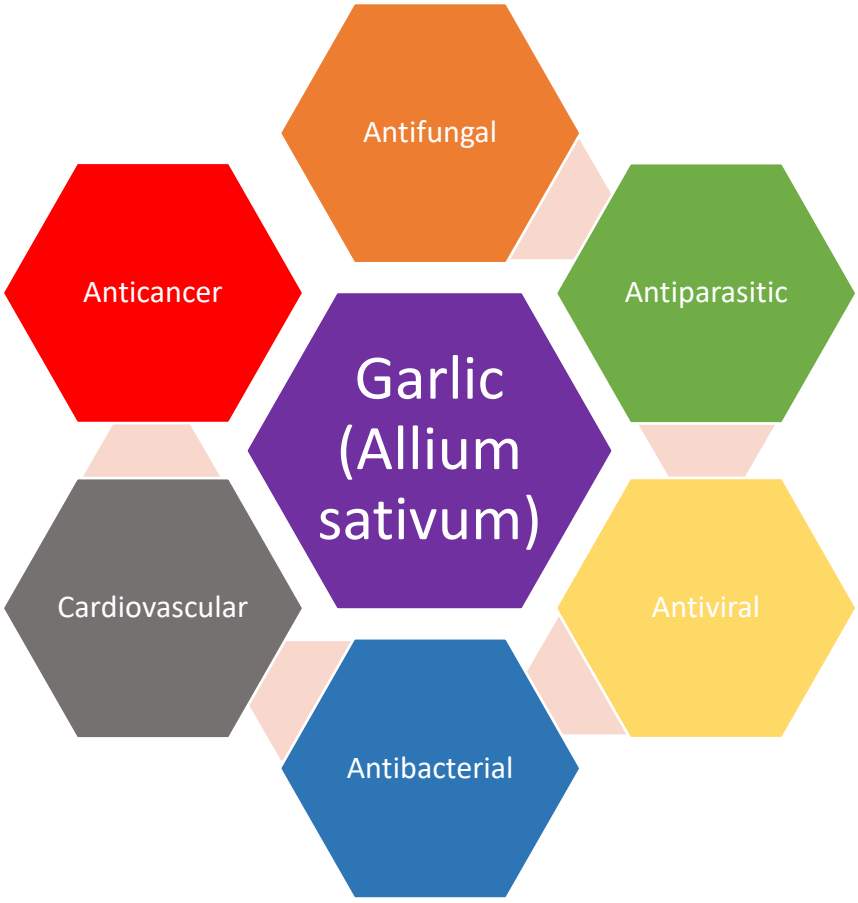
Colour	**Bulbs are white to pink in colour**
Odour	Characteristic and aromatic
Taste	Aromatic & pungent
Size	1.5 to 2

List and structure of some sulphur containing compounds isolated from Allium sativum

Compounds	Molecular formula	Structure
Alliin	$C_6H_{11}NO_3S$	
Allicin	$C_6H_{10}OS_2$	
E- Ajoene	$C_9H_{14}OS_3$	
Z- Ajoene	$C_9H_{14}OS_3$	

2-Vinyl-4H-1,3-dithiin	$C_6H_8S_2$	
Diallyl suphide(DAS)	$C_6H_{10}S_2$	
Diallyldisulphide (DADS)	$C_6H_{10}S_2$	

Schematic representation of different pharmacological activities of Garlic (Allium Sativum)



Antifungal activity :

Garlic oil is a kind of fungicide, but little is known about its antifungal effects , the chemical constituents, antifungal activity, and effects of garlic oil were studied with Penicillium funiculosum (12). The antifungal activity, kinetics, and molecular mechanism of action of garlic oil against Candida albicans were investigated in this study using multiple methods. Using the poisoned food technique, we determined that the minimum inhibitory concentration of garlic oil was 0.35µg/mL(13). The success of garlic extracts in the treatment of human cryptococcosis has been reported previously. Patients were given intravenous or intramuscular aqueous extracts of garlic in addition to garlic given orally. The success rate of this therapeutic regimen was reported to be 69%. However, the achievable antifungal activity in the urine or serum was not determined for those patients on oral therapy alone or for those on a combined regimen of oral and parenteral therapy(14). Garlic extracts also have a strong antifungal effect and inhibit the formation of

mycotoxins like the aflatoxin of Aspergillus parasiticus. Allicin was assumed to be the main component responsible for the inhibition of fungal growth. A concentrated garlic extract containing 34% allicin, 44% total thiosulfinates, and 20% vinyldithiins possessed potent in vitro fungistatic and fungicidal activity against three different isolates of Cryptococcus neoformans. Pure allicin was found to have a high anticandidal activity with a minimum inhibitory concentration of7 µg/mL(15) The garlic extract acted by affecting the fungal cell wall and causing irreversible ultrastructural changes in the fungal cells, which lead to loss of structural integrity and affected the germination ability These changes in the cytoplasmic content lead to nucleus and cell organelles damage that ultimately leads to cell death (16)

Antiparasitic properties :

The antiparasitic effects of freshly crushed garlic were known by many ancient cultures. Albert Schweizer used to treat people suffering from dysentery or intestinal worms with freshly crushed garlic. Several years ago we found out that Entamoeba histolytica, the human intestinal protozoan parasite, is very sensitive to allicin, as only 30 µg/mL of allicin totally inhibits the growth of amoeba cultures(17). Various studies reported the anti-protozoal activity of garlic extracts and its phytochemicals against several protozoan parasites. For instance, an in vitro study revealed that the aqueous,ethanolic, and dichloromethane A. sativum extracts exhibited anthelmintic activity against Haemonchuscontortus and the ethanolic extract was the most effective one, while aqueous garlic extract showedpotent activity against Trichuris muris and Angiostrongylus cantonensis(18).

Antiviral activity :

Fresh garlic extracts in which allicin is known to be the main active component have been shown to have in vitro and in vivo antiviral activity. Among the viruses which are sensitive to garlic extracts are the human cytomegalovirus, influenza B, herpes simplex virus type 1, herpes simplex virus type 2, parainfluenza virus type 3, vaccinia virus, vesicular stomatitis virus, and human rhinovirus type 2(19). Interestingly, in vivo experiment exhibited the antiviral activity of garlic extract and they reported that garlic showed protective activity against influenza viruses by improving the production of neutralizing antibodies when given to mice and this activity was based on the presence of several phytochemicals namely, ajoene, allicin, allyl methylthiosulfinate, and methyl allyl thiosulfinate(20).

Antibacterial activity :

Garlic was later utilised in World War II to treat wounded soldiers due to its antibiotic properties. Garlic began to gain interest once again when Cavallito andBailey (1944) identified the main compound responsible for the antimicrobial properties of garlic as allicin, a thiosulfinate that comprises more than 70% (w/w) of thiosulfinates extracted from fresh garlic(21) It's declared that garlic, as an anti-bacterial agent, is effective against many more gram negative and gram positive bacteria like Helicobacter pylori, Escherichia coli(E.coli), and Lactobacillus casei. This effect is sourced from allicin inside it.(22) Aged garlic extract demonstrated dose-dependent antimicrobial activity against three different reference strains of Helicobacter pylori at concentrations of 2–5 mg/ml; however,heat treatment of the extracts reduced the anti-bacterial effects (23) Furthermore, in a clinical trial, the treatment of raw garlic inhibited Helicobacter pylori in the stomach of patients with H. pylori infection(24) Moreover, garlic extracts prevented the growth of enterotoxigenic E. coli strainsand other pathogenic intestinal bacteria, which are the main cause of diarrhea in humans and animals.Besides the antibacterial activity of garlic, it was reported to prevent the toxins produced by bacteria linfection(25) A synergistic effect of allicin against M. tuberculosis was also found with antibiotics such as streptomycin or chloramphenicol. antibacterial activity of allicin is the apparent inability of most bacteria to develop resistance to it because the mode of action is completely different from that of other antibiotic substances. It has been proposed that the development of resistance to beta-lactam antibiotics is1000-fold easier than development of resistance to allicin (26)

Immunomodulatory Activity

Particularly, in inflammatory diseases, garlic is associated with the decrease of both inflammatory mediators and reactive oxygen species (ROS) generation and is involved in the cellular immune response, acting as an immunomodulator(27) The oil and extracts of garlic have anti-inflammatory, antibacterial, fibrinolytic, and wound-healing properties that may make it a substitute for classic antibiotics and antiseptics. Administering garlic oil to female rats reduced postoperative inflammation(28) Garlic has great potential to treat inflammatory diseases, such as arthritis, in humans, because of its low or absent toxicity.(29).A study reported that the garlic extracts remarkably impaired the liver inflammation anddamage caused by Eimeria papillate infections(30)

Anti-Diabetic Activity

One study confirms that additional garlic contributes to reduce premeal blood sugar levels in type 2 diabetes mellitus if taken for at least 3 months as part of supplementary or combined therapy. It is unclear if garlic reduces post meal blood sugar levels or hemoglobin A1c levels(31).Ethanolic garlic extracts exhibited an antidiabetic effect against streptozotocin- and alloxan-induced diabetic mice and rabbits by activating the insulin secretion from parietal cells of the pancreas.Another clinical study examined the antidiabetic effect of garlic pills administration at 900 mg/dayin patients with type II diabetes(32) The use of garlic as a folk medicine for diabetes has been reported in Europe, in India, and in the Middle East . Although garlic has long been believed to possess a hypoglycemic effect, no well-controlled clinical trials of the hypoglycemic effect of garlic in DM patients have been reported(33)

Antioxidant activity

Accumulating studies have found that garlic has strong antioxidant properties. A study evaluated the antioxidant capacities of both raw and cooked garlic, and found that the raw garlic exhibited stronger antioxidant activity. Usually, raw garlic had a stronger antioxidant activity than cooked garlic, and the antioxidant activity of fermented garlic, such as black garlic, was stronger than that of crude garlic(34) Garlic and its constituents protect tissue against

oxidativedamage and improve organ functions in various animal models. Whole garlic and aqueous garlic extract exhibit direct antioxidant effects and enhance the serum levels of twoantioxidant enzymes: catalase and glutathione peroxidase(35)

Cardiovascular activity

Garlic can also reduce oxidative stress, increase the production of NO and hydrogen sulfide(H2S), and inhibit the angiotensin converting enzyme, thereby lowering hypertension Garlic can also protect the heart. Garlic has been shown to increase Na+/K+-ATPase protein levels and reduce cardiac hypertrophy and remodeling induced by isoproterenol in rats In short, numerous studies have found that garlic exhibits protective cardiovascular effects and can alleviate hypertension, hyperlipidemia, and heart disease (36). Garlic has a significant effect on "lowing blood pressure, prevention of atherosclerosis, reduction of serum cholesterol and triglyceride inhibition of platelet aggregation and increasing fibrinolytic activity(37) Raw garlic, garlic oil, and garlic-derived polysulfides, all of which have H2S-generating capability, have been shown to have an impact on cardiac structure and function (38)

Anticancer activity

A number of researchers have shown the inhibitory effectof garlic on tumor growth using various cancer cell lines. Chinese researchers using gastric cancer cell lines have shown that fresh garlic extract and diallyl trisulfide were more potent than 5-fluorouracil or mitomycin C in killing these cancer cells(39) garlic-derived sulfur compounds, especially allyl sulfides, are known to be responsible for the anticarcinogenicity of garlic(40) In addition, garlic and its organic allyl sulfides can inhibit the generation of nitrosamines, a kind of carcinogen produced during cooking and storage. Moreover, garlic allyl sulfides can block DNA alkylation, which is an early step in nitrosamine carcinogenesis(41) Raw garlic extract was found to be the most effective and highly specific anticancer drug when compared with 33 raw vegetable extracts against different cancer cells without affecting thenon-cancerous cells(42). Previous studies have shown that organic or aqueous garlic extracts efficiently inhibit chemically induced mutagenicity in bacteria, such as Salmonella typhimurium and Escherichia coli .In addition to blocking the effects of extracellular mutagens, garlic is also a highly effective antioxidant. Compounds from garlic can also block several signaling pathways involved in cell migration and the differentiation of tumor cells(43)

Antithrombotic:

We have studied the antithrombotic potential of garlic, and identified methyl allyl trisulfide (MATS) from garlic oil as the most active principle for inhibition of platelet aggregation both in vitro and in vivo The other sulfur compounds in garlic oil, e.g., dimethyl trisulfide and diallyl trisulfide,were also inhibitory toward platelet aggregation(44) A number of studies have suggested the possible use of garlic as an antithrombotic agent The father of Ayurvedic medicine claimed that garlic maintains the fluidity of blood and strengthens the heart(45)

Other uses :

As an antiseptic, its use has long been recognized. In the late war it was widely employed for the control of suppuration of wounds. It was externally applied in ointments and lotions, and as an antiseptic, to disperse hard swellings, also pounded and employed as a poultice for scrofulous sores. It is said to prevent anthrax in cattle, being largely used for the purpose. Both juice and milk of garlic are still used as a vermifuge (46)

Extraction techniques of functional components

The harshes technique is steam distillation, that is the boiling of garlic followed by the extraction of compounds from condensed steam; it yields diallyl disulfide, apart from this, dimethyl-, methyl allyl suffides, dimethyl-, dipropyl- allyl propyl- and methyl allyldisulfides, dimethyl-, diallyl- and methylallyl trisulfides, methylpropyl trisulfide, diallyl thi-sulfinate, and sulfur dioxide are also formed Garlic oil obtained by steam distillation has been shown to possess biological properties(47) A range of techniques have been reported for extraction of phenolics from garlic. A simple extraction technique of maceration wasapplied to extract phenolics at ambient temperature . An open-end-funnel-shaped percolator for concentrate dextracts was also studied previously Likewise, continuous high-temperature extraction ,i.e.Soxhlet, was applied for phenolics extraction. An advanced technique of ultrasonication, using the concept of a cavitation mechanism, was applied to determine the phenolics content in garlic(48)

Garlic as Neutraceuticals

The term neutraceuticals was coined from nutrition and pharmaceutical by Stephen defelice in 1989 neutraceutical is defined as a substance that is food or a part of food and provides medical or health benefits including the prevention and treatment of diseases(49) Garlic and its preparations have been widely recognized as agents for prevention and treatment of cardiovascular and othermetabolic diseases, atherosclerosis, hyperlipidemia, thrombosis, hypertension and diabetes(50)

Side effects of garlic

Oral intake of garlic is safe , upon oral consumption garlic causes bad breadth, burning sensation mouth ,heatburn ,nausea, vomiting, diarrhoea(51) Hypersensitivity to garlic has been described as a cause of contact dermatitis and occupational asthma and rhinitis.(52)

Drug interactions of garlic

1) Isoniazid with Garlic: Garlic decreases the absorbed levels of isoniazid in body. Therefore, taking garlic with isoniazid reduces the effectiveness of drug.

2) Medications used for HIV/AIDS [Non-Nucleoside Reverse Transcriptase Inhibitors (NNRTIs)] with Garlic: Some medications used for HIV/AIDS, e.g., nevirapine, delavirdine, and efavirenz, are broken d own by the body. Garlic increases this breakdown process. Therefore, taking garlic with these medications reduces their effectiveness.

3) Saquinavir with Garlic: Saquinavir is broken down by the body. Garlic potentiates this breakdown process. Therefore, ta king garlic with saquinavir decreases the effectiveness of drug.

4) Birth Control Pills (Contraceptive Drugs) with Garlic: Some estrogen -containing birth control pills, e.g., ethinyl estradiol and , ethinyl estradiol and norethindrone, etc., are broken down by the body. Garlic can increase this breakdown process. Therefore, taking garlic with such medications reduce their effectiveness.

5) Cyclosporine with Garlic: Cyclosporine is broken down by the body. Garlic can potentiate this breakdown proces s. Therefore, taking garlic with cyclosporine decreases the effectiveness of drug.

6) Medications Changed by the with Garlic: Certain drugs are converted and broken down by the liver, e.g., acetaminophen, chlorzoxazone, ethanol, theophylline, and anaesthetic drugs during surgery like enflurane, halothane, and methoxyflurane. Garlic oil can decrease how fast the liver breaks down these medications. It also affects the metabolism of the medications that are converted by the liver. Therefore, taking garlic oil with such medications either potentiates their action or elevates their side effects.

7) Medications Changed by the Liver with Garlic: Certain drugs are con verted and broken down by the liver, e.g., lovastatin, ketoconazole, itraconazole, fexofenadine, triazolam, etc. Garlic can increase how fast the liver breaks down these medications. Therefore, taking garlic with such medications reduces their effectiveness.

8) Medications that Slow Blood Clotting (Anticoagulant/Antiplatelet Drugs) with Garlic: Some medications delay blood clotting, e.g., aspirin, clopidogrel, diclofenac, ibuprofen, naproxen, dalteparin, enoxaparin, heparin, warfarin, etc. Garlic also delays blood clotting. Therefore, taking garlic with such medications can increase the chances of bruising and bleeding.

9) Warfarin with Garlic: Warfarin slows down blood clotting process. Garlic can potentiate the effectiveness of warfarin. Therefore, taking garlic with warfarin can increase the chances of bruising and bleeding due to slow clotting (53)

Result/conclusion:

This review focused on the chemical constituent & pharmacological activities of garlic (allium sativum). Sulfur-containing compounds such as alliin, allicin, ajoenes, vinyldithiins, and sulfides, are the main constituents isolated from A. sativum extracts. Garlic is also well-known to have immunomodulatory and anti-inflammatory activities. Thus, proper consideration should be taken when using garlic as a medicine for the treatment of different diseases. This review may be useful to increase our knowledge of garlic therapeutic effects and improve our future experimental and clinical research plans

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