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Allium Sativum-Boon to the Herbal World

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ABSTRACT

Background: For many years, people have utilized Allium Sativum as a spice, culinary addition, and natural cure for several common illnesses, such as earaches, burns, wounds, baldness, migraines, chest colds, dog bites, and insect stings. It is believed that minerals, protein, fixed oil, thiamine, ascorbic acid, and allin are responsible for the therapeutic benefits of Allium Sativum.

Purpose: This review covers the pharmacology, pharmacognosy, pharma chemistry, and other therapeutic aspects of this plant. Aside from its antibacterial, antioxidant, and anticancer qualities, allicin is a helpful treatment for cardiovascular disorders. To lessen reactive oxygen species (ROS), the antioxidant allicin inhibits the enzymes that oxidise NADPH. By engaging with various peroxidases, it can also directly lower the concentrations of various ROS within cells. As an inhibitor of cholinesterase, butyrylcholinesterase (BuChE), and autism spectrum disorder (ASD), it treats these disorders. Furthermore, it aids in the preservation of neurotransmitter balance in individuals with ADHD and attention deficit hyperactivity disorder.

Methods: Recent literature has been surveyed from PUBMED, Google Scholar, etc. like search engines, for summarizing detailed on-going on the phytochemical properties, biological activities, marketed formulations, patents and therapeutic potential of Allium Sativum (garlic). The search strategy included keywords such as "Allium Sativum," "allicin," "garlic therapeutic properties," "neuroinflammation," "antioxidant activity," "phytochemicals," "marketed formulations, " "patents, " and "drug delivery systems."

Results: Allium Sativum offers broad therapeutic benefits, including antibacterial, antioxidant, and cardiovascular protection, making it a valuable natural remedy for various health conditions.

Conclusion: Allicin therapy can lessen the effects of metal-induced neurotoxicity in addition to enhancing cognitive function in neurologically ill individuals. Moreover, it may pass across cell membranes with ease. This molecule can oxidise the links that keep cysteine residues in proteins together and the thiol groups in glutathione. It is physiologically active. Aside from its antibacterial, antioxidant, and anticancer qualities, allicin is a helpful treatment for cardiovascular disorders. To lessen reactive oxygen species (ROS), the antioxidant allicin inhibits the enzymes that oxidize NADPH. By engaging with various peroxidases, it can also directly lower the concentrations of various ROS within cells. As an inhibitor of cholinesterase, butyrylcholinesterase (BuChE), and autism spectrum disorder (ASD), it treats these disorders.

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1. Introduction

One of the earliest recognised uses of medicinal herbs by humans is for healing purposes. Most nations rely on conventional medications to treat a sizable fraction of their citizens, and more than 75% of people worldwide receive their main medical treatment from them. Many people view traditional medicines as a great alternative to modern treatments because of its accessibility, cost, and environmental friendliness. Given their low cost, high efficacy, and lack of side effects, several Indian plants are considered advantageous as medicinal agents. A plant known as *Allium Sativum* Linn. Garlic is one of the earliest plants to be domesticated and is frequently used as a flavouring and spice in culinary applications. The most

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researched plant when it comes to medicine is garlic. It is listed as an efficient remedy for several ailments, including headaches, heart problems, bites, worms, and tumours, in 22 medicinal formulations (Batiha *et al*., 2020). Chemically speaking, it is composed of a wide variety of materials, including fibre, proteins, lipids, carbohydrates, minerals, and organosulfur compounds. It has potential biological properties that include radioprotective, hepatoprotective, cardioprotective, anti-inflammatory, antioxidant, antidiabetic, anti-cancer, antibacterial, antifungal, antiparasitic, and diuretic due to the wide variety of phytochemicals that are contained in it (Reddy *et al*., 2022; Dhankhar *et al*., 2023). Countless studies on garlic that have been published in a variety of journals, books, papers, and publications have been carefully examined and presented by this review project. In addition to details on Unani, Ayurvedic, and pharmacognostic practices, this also contains information on phytochemistry, biological activity, chemical modification, dosage forms, side effects, clinical and toxicological research, and descriptions of plants. They had a thorough examination. One of the Alliaceae family's staples in human diets from ancient times is garlic or *Allium Sativum*. Free amino acids, essential oils, sulphur compounds, vitamins, and minerals are all abundant in it. Garlic has sulfur-containing molecules, particularly polysulphides, according to preliminary research on its biochemistry. The bioactive component known as allicin, which contains sulphur and gives garlic its unique scent. Its chemical makeup and moa against the development of bacteria have been investigated. Alliinase breaks down the non-proteinaceous amino acid alliin, to produce allicin. Allicin, a reactive sulphur species, acts as an oxidising agent inside cells, oxidising glutathione and protein cysteine residues' thiols (Jikah & Edo, 2023). Table 1 shows the botanical classification of garlic.

Table 1: Botanical Classification of Garlic

Kingdom	**Plantae**
Clade	Angiosperms
Clade	Monocots
Order	Asparagales
Family	Amaryllidaceae
Subfamily	Allioideae
Genus	Allium
Species	A. sativum

Allicin has several applications in medicine. It has been used as an antibacterial agent to combat several infections, such as Helicobacter pylori, Candida albicans, Bacillus species, and Staphylococcus aureus. Allicin inhibits the activity of numerous enzymes due to its interaction with cysteine residues. By reducing triglycerides and low-density cholesterol in the human body, this substance improves health. Allicin is an oxidant, but in tiny quantities and under physiological circumstances, it also helps the body produce antioxidant enzymes and prevents low-density plasma lipids from oxidizing (Batiha *et al*., 2020; Mittal *et al*., 2023). In addition, it inhibits the body's production of cholesterol, reducing the possibility of plaque accumulation and artery blockage. Up to 90% of the time, a small dose of allicin (0.4 mM) may decrease platelet aggregation when compared to an aspirin concentration of the same size. These features indicate that allicin is a highly effective cardiovascular disease preventative. Glutathione and allicin degrade rapidly, releasing hydrogen sulfide (H2S). Blood pressure is regulated by the gaseous signaling molecule H2S. In addition, it regulates blood pressure reduction, artery dilatation, and smooth muscle relaxation. Allicin's antihypertensive, antioxidant, and cardioprotective effects have been linked to the NF-E2-related factor-2 (Nrf2) inhibitor KEAP1 and the down-regulation of the angiotensin II type 1 receptor (Chatterjee *et al*., 2023). The nutritional value per 100g (3.5 oz) of raw garlic is shown in Table 2.

Table 2: Nutritional Value per 100g (3.5 oz) of Raw Garlic

Energy	**623 kJ (149 kcal)**
Carbohydrates	33.06 g
Sugars	1.00g
Dietary fiber	2.1 g
Fat	0.5 g
Protein	6.39 g
beta-carotene	5 µg (0%)
Thiamine (Vit. B1)	0.2 mg (17%)
Riboflavin (Vit. B2)	0.11 mg (9%)
Niacin (Vit. B3)	0.7 mg (5%)
Pantothenic acid (B5)	0.596 mg (12%)
Vitamin B6	1.235 mg (95%)
Folate (Vit. B9)	3 µg (1%)
Vitamin C	31.2 mg (38%)
Vitamin B6	1.235 mg (95%)
Vitamin B6	1.235 mg (95%)
Folate (Vit. B9)	3 µg (1%)
Vitamin C	31.2 mg (38%)
Calcium	181 mg (18%)
Iron	1.7 mg (13%)
Magnesium	25 mg (7%)
Phosphorus	153 mg (22%)
Potassium	401 mg (9%)
Sodium	17 mg (1%)
Zinc	1.16 mg (12%)
Manganese	1.672 mg
Selenium	14.2 µg
Selenium	14.2 Mg

1.1. History of Allium Sativum

Garlic grows in Central Asia's mountainous regions. Spanish and Portuguese sailed it to the western hemisphere when it landed in China. In Europe, Asia, and Africa, spice has been a common addition. The Ancient Egyptians were aware of it and had used it historically for both culinary and medicinal purposes. Both the Bible and the Talmud mention garlic. Garlic was recommended by Hippocrates, Galen, Pliny the Elder, and Dioscorides as a remedy for a wide range of ailments, such as parasites, respiratory issues, poor digestion, and low vitality (Dhall *et al*., 2023). AD 510 is the earliest known date of its use in China. During World Wars I and II, troops received garlic as a gangrene preventive treatment. Throughout the early 1900s, treatment for phthisis, or pulmonary tuberculosis, was sometimes used. The medicinal qualities of A. sativum have been well-known for almost a millennia. Chinese people used it as a natural cure for three millennia. Egyptians, Romans, and Greeks all used it to heal wounds. It saw usage in both World Wars I and II due to its antibacterial qualities. Historical records indicate that use of garlic as food dates back to ancient Egyptians. During the construction of the pyramids, A. sativum was specifically fed to the working class to increase their stamina and output. Athletes in Greece received it before the Olympics to help them perform better. Throughout history, the ruling classes did not really love A. sativum, whereas lesser groups tended to consume it. Its very strong odor also made entry into sacred temples extremely restricted. A. sativum was advised by ancient Chinese culture to help with digestion and respiration. Since it's a popular spice, it was suggested to take it in moderation every day. It was widely used in combination treatment by Chinese physicians to alleviate headache, sadness, melancholy, tiredness, and insomnia.

1.2. Botanical Description

Allium Sativum, which is commonly referred to as hard neck and soft neck garlic. The prophylls that make up the clove, an underground bulb joined by a basal plate and enveloped in a membrane, are the same for both types. The plant consists of several sections, including a bulb, leaves, flowers, fruits, and seeds. Round in form, bulbs can contain up to fifteen small cloves, or bulblets, inside. Cloves and bulbs are covered with a papery white or pinkish tunic. Sword-shaped and varying in length from four to twelve, the leaves are attached to a stem that is submerged beneath the surface. Flowers are held in dense, spherical clusters on spikes, or flower stalks. A long-beaked pair of enclosing bracts surrounds the budding flower head; these bracts ultimately become papery and split apart to show the blossoms. Every single flower stalk begins at one location. Six about 3mm long perianth segments, composed of sepals and petals, are present in the greenish-white or pinkish blooms. Small clove-like seeds called bulbils are often dispersed throughout the blooms. Fruits usually mature too fast to be fertilized. Usually, seeds are grown under laboratory conditions rather than in the wild. Table 3 shows specified adult dose of garlic and its derivatives.

Table 3: Specified Adult Dose of Garlic and its Derivatives

Categories	Dose	Specification
Whole garlic	2 - 4 grams per day	As a food supplement
Clove Oil	0.03 - 0.12 mL, 3 times daily	----------
Fluid extract 4 mL	Daily	1:1 w/v
Tincture 20 mL	Daily	1:5 w/v
Aged garlic extract	600 - 1,200 mg, daily in divided doses	----------
Tablets of freeze-dried garlic	200 mg, 2 tablets 3 times Daily	Products found standardized to contain 10 – 12 mg/Gm alliin and 4,000 mcg of total allicin potential (TAP).

1.3. Pharmacognostic Description

The following is a description of the herb's macroscopic and microscopic study:

1.3.1. Macroscopically

With three to five pale, papery, membraneous scales around eight to twenty cloves, garlic is a subglobular, complicated, greyish-white bulb. Cloves feature tiny, sub-cylindrical outgrowths on the top surface and numerous thin, wiry roots on the bottom, supported by a flattened, spherical, woody main stem. Each ovoid clove has three or four sides, and is surrounded by a pair of papery scale leaves; the inner leaf is pink and sticky, and it separates easily from the solid part of the clove. There is a loose, white leaf on the outside. Two pale, meaty scales are surrounded by papery scale leaves. In comparison to the outside, the inner one is smaller and thinner. Allium flavour and scent are quite strong. It has an alliaceous, lingering flavour.

1.3.2. Microscopically

Each of the many concentric bullets that make up the cloves is made up of ground tissue, an outer scale, an epidermis, and a layer of epidermal cells at the bottom. Two or three

layers of rectangular cells with increasingly sloping end walls make up dried scales. The calcium oxalate crystals in these cells are rhomboid. The single layer of rectangular to cubical cells that make up the top epidermal cells close to the scale layer are interspersed with many vascular bundles that have alternating xylem and phloem patterns. Compared to the cells in the upper epidermis, the cells in the lower epidermis are smaller and have a cubic shape.

1.3.3. Powdered Microscopy

There were slices of parenchymatous cells in the garlic. Rhomboid calcium oxalate crystals and starch grains are seen within the cells. There are also apparent pieces of a vessel. Using an array of chemical reagents, histopathological analyses of garlic powder have been conducted. It changes colour from light brown to dark brown according to whether it is treated with nitric acid or strong sulfuric acid. Using an atomic absorption spectrophotometer, an elemental analysis revealed that garlic ash contains elements iron, copper, nickel, manganese, zinc, sodium, potassium, calcium, and magnesium. Plant phytochemistry: *Allium Sativum* Linn. Garlic was examined chemically, and the results showed that it included sulfur-containing chemicals, pectin, colouring, enzymes, carbohydrates, and vitamins. Garlic's primary components, sulphur compounds, give the plant its smell, scent, and biological properties (Knowles, 2001).

- Carbohydrate Analysis: In garlic bulbs that were studied, the carbohydrates included dextrin, sucrose, starch, and reducing sugars. Sulfuric acid hydrolysis yields the soluble carbohydrates fructose and mannose.
- Amino Acids Analysis: Garlic has three main amino acids: lysine, histidine, and cysteine. Other amino acids that have been proposed to be present include valine, aspartic acid, leucine, methionine, phenylalanine, proline, serine, threonine, tryptophan, and aspartic acid (Yang *et al.*, 2010). All amino acids are included in bublis, except tryptophan and valine.
- Lipid Components Analysis: Garlic has 0.6% of the total fat content, according to lipid analysis. Research on fractionation using column chromatography revealed the presence of phospholipids, glycolipids, and neutral lipids. Fatty acids such as palmitic, oleic, linoleic, linolenic, capric, lauric, myristic, and stearic acids are present in both total and fractionated lipids (Rahim *et al.*, 2023).
- Nutrient Composition of Garlic: Together with carbohydrates, lipids, and proteins, it contains minerals including calcium, phosphorus, iron, manganese, magnesium, and zinc (Otunola *et al.*, 2010). There were reports for phytic acid, tannins, uronic acids, and total fibre. It has been noted that throughout the growth of garlic bulbs, the amount of certain nutrients was higher in the roots and tops, while it was lower in the tops. The ratio of reducing and non-reducing carbohydrates and proteins in the bulb is higher than in the other plant organs.
- Ionic Components of Garlic: Fluorine and iodine, at respective amounts of 0.88 and 5.0 ppm, are also present. The amount of calcium, phosphorus, and fluoride in raw food was quantified and reported. Additionally, quantitative data on the bulb's phosphate, calcium, and oxalic acid were provided.
- Analysis of Garlic Skin: Proteins, unsaponifiable fats, total sterols, lignin, pectin, arabinose, xylose, rhamnose, glucose, and galactose were all present in garlic skin. Moo-, di-, tri-, and tetra-galacturonic acids, as well as trace amounts of arabinose and rhamnose, were detected by chromatographic examination of the pectin's acid hydrolysate.
- Sulfur Compound: *Allium Sativum*'s flavour, fragrance, and most its biological effects are caused by these primary chemical ingredients. The main sulphur constituents in an undamaged garlic clove are glutamylcysteines (Borlinghaus *et al.*, 2021). Alliin is created by their hydrolysis. Allicin is produced swiftly when alliin and the enzyme alliinase interact. When garlic is crushed by chewing, chopping, etc., the process is 97% complete in 30 seconds. Of the thiosulfate found in *Allium Sativum*, diallyl forms such as allicin makeup about 70–80% of the mixture. Ajoene, hydrogen sulphide, and diallyl sulphide are among sulphur compounds that are rapidly produced while oxidising allicin, which is also extremely unstable. One of the main organo-sulfur compounds found in garlic is allicin, which is created by crushing its precursor alliin. Secondary reactions and enzymatic activity also result in the formation of several additional compounds. In the investigation of odourless garlic powder, the thermal stability of allinase and the enzymatic regeneration of flavour were used to examine the necessity of allinase for the production of allicin from allin. Research on the stability of allicin and alliin in garlic extracts and dried garlic powder kept at different temperatures found that allicin's antibacterial activity in the aqueous extract of garlic was lost during storage. Alliin may be kept for a very long period in both dehydrated garlic powder and aqueous extract form. The Ayurvedic description of *Allium Sativum* Linn is shown in Table 4.

Table 4: An Explanation of *Allium Sativum* Linn. in Ayurveda

Sanskrit name	Rasona
Synonyms	Yavanesta, Mahausadha, Ugragandha, and Lasuna

Properties	Rasa: Madhura, Lavana, tikta, kasaya, katu Guna: Sara, guru, tiksna, picchila, and nigdha
Action	Vatakaphahararasayana, Varnakara, Pacana, Medhya, Bharmahararasayana, Balya, Varaha, and Medhya
Therapeutic uses	Kuksisula, vibandha, gulma, kusta, krmi, sopha, arsa, analasada, bhagna, hrdroga, aruci, jirnajwara, kuksisula, and sosa

2. Biosynthesis, Properties, and Action Mechanism of Allicin

The source of allicin is the amino acid alliin, which is not present in proteins. Cysteine and glutamic acid combine to form glutamylcysteine, which is subsequently combined with glycine to form glutathione (Nadeem *et al*., 2021). Tests using radiolabelling were used to get this data. Many opposing pathways for the production of alliin have been discussed, and arguments have been made for and against them. Nucleophilic substitution produces allyl perthiol and S-allylglutathione (SAG) at the α-carbon after glutathione and di-2-propenyl disulfide (DADS) combine. It has been demonstrated that using strong antioxidant SAG can reduce the hepatic toxicity of carbon tetrachloride (CCl4). Cysteinylglycinase and γ-glutamyl transpeptidase help convert S-allylglutathione to S-allylcysteine (SAC) once glutamate and glycine are lost. One molecule with anti-inflammatory and antioxidant qualities is SAC, which scavenges reactive oxygen species (ROS). It is further converted into alliin, which possesses various important physiological properties. Hyperglycemia conditions are reduced, and glutathione and catalase production are increased. Garlic varieties differ in their levels of alliin; dried garlic powder may have as much as 1% of alliin in it. Insulin sensitivity and glucose metabolism are both enhanced by alliin. Its use has been shown to reduce blood cholesterol and prevent heart attacks (Suleria *et al*., 2015).

2.1. Allicin as an Antioxidant

Because of their superiority as therapeutic agents against oxidative stress, natural compounds have a lower side effect profile compared to manufactured medications. Allicin has been identified as an antioxidant that occurs naturally. The three major mechanisms by which allicin exhibits antioxidant properties are hydroxyl radical inhibition, superoxide, and nitric oxide (NO) (Chan *et al*., 2013). ROS are very unpredictable molecules that cause tissue destruction and oxidative stress when they accumulate inside cells. One of the primary producers of reactive oxygen species, which induce oxidative stress and inflammation in cells, is believed to be the complex family of enzymes known as nicotinamide adenine dinucleotide phosphate oxidases, or NOXs. This is only one instance of an enzymatic process that raises the risk of oxidative stress in cells. All NOX family enzymes have conserved sites for binding FAD and NADPH, with the exception of NOX5. Six transmembrane domains comprise each enzyme. The third and fifth transmembrane domain haem-binding sites are connected to the electron transporter that employs cytoplasmic NADPH as the electron donor.

3. Pharmacognostic Aspects of *Allium Sativum*

Originally from Central Asia, garlic is a perennial herb that is now planted all over the world. It has a maximum height of two feet. The compound bulb of this plant is the portion utilized for medicinal purposes (Zafar *et al*., 2023). There are four to twenty cloves per bulb, and each clove weighs around one gram. Different types of garlic supplements may have varying impacts on the body, such as fresh, dried, aged, or garlic oil.

3.1. Pharmachemistry of Allium Sativum

Originally, the advantages of garlic and its unique scent were attributed to the component allicin. Garlic also contains additional molecules, such as sulfur-containing compounds, which may help prevent cancer, decrease cholesterol, and combat heart disease (Amagase, 2006). A mixture of aliphatic mono and polysulfides is present in the bulb, along with diallyldisulfide oxide and allicin. A recent study suggests that fresh homogenized garlic extract may include prostaglandins A2 and F1-4.

3.2. Pharmacological Aspects of Allium Sativum

Due to its high antioxidant content, garlic may help prevent the onset of certain diseases, including cancer and heart disease, as well as the aging process. Free radicals are particles that can harm DNA and cell membranes (Capasso, 2013). Free radicals are neutralized by antioxidants, which may also lessen or maybe stop some of the long-term harm they cause. There are a wide variety of garlic varieties available that may be advantageous. Garlic supplements are made from whole fresh garlic, dried or freeze-dried garlic, garlic oil, and aged garlic extracts. The amount of active compounds in garlic varies depending on the kind. Use of standardized garlic products is therefore crucial to get the most advantages.

3.3. Pharmaceutical Aspects of Allium Sativum

The best supplements made from garlic powder contain qualities similar to those of fresh cloves. But whereas steam-distilled oils were 35% more active than fresh cloves, oil-macerates were just 12% more active (Cardelle-Cobas *et al.*, 2009). The European Scientific Cooperative on Phytotherapy states that 3-5 mg of fresh garlic clove or 500–1000 mg of garlic powder is the daily recommended dose of allicin, or 6–10 mg of alliin. Products varied by around 30–40 times in the levels of certain garlic components. The Centre for Science in the Public Interest found that, aside from consuming raw, fresh garlic, purchasing garlic powder from the spice cupboard and placing oneself into a gelatin capsule is the "best buy" when it comes to acquiring the most allicin for one's money.

3.4. Economical Aspects of Allium Sativum

Despite being planted all over the world, China is the nation that produces the most garlic, accounting for nearly 77% of global production from its annual plantings of 10.5 million metric tons (23 billion pounds). The United States, where every state grows garlic but Alaska, came in sixth place (1.4%), followed by South Korea (2.1%), India (4.1%), Egypt (1.6%), and Russia (1.6%). Numerous domestic and foreign enterprises manufacture and trade garlic and its derivatives on the worldwide market. Due to the fact that this is available in both raw and processed forms, it is economically advantageous as it provides access to work opportunities for a greater portion of the world population.

4. Medicinal Perspectives of *Allium Sativum*

Any formulation's development is based on two fundamental concepts: the viability of the product and its logical use (Rai *et al.*, 2018). When the medicinal benefits of a pharmaceutical product outweigh its negative effects economic and otherwise it is seen as a blessing. Any pharmaceutical preparation's larger multifunctional approach offers selection and diversification possibilities (Figure 1).

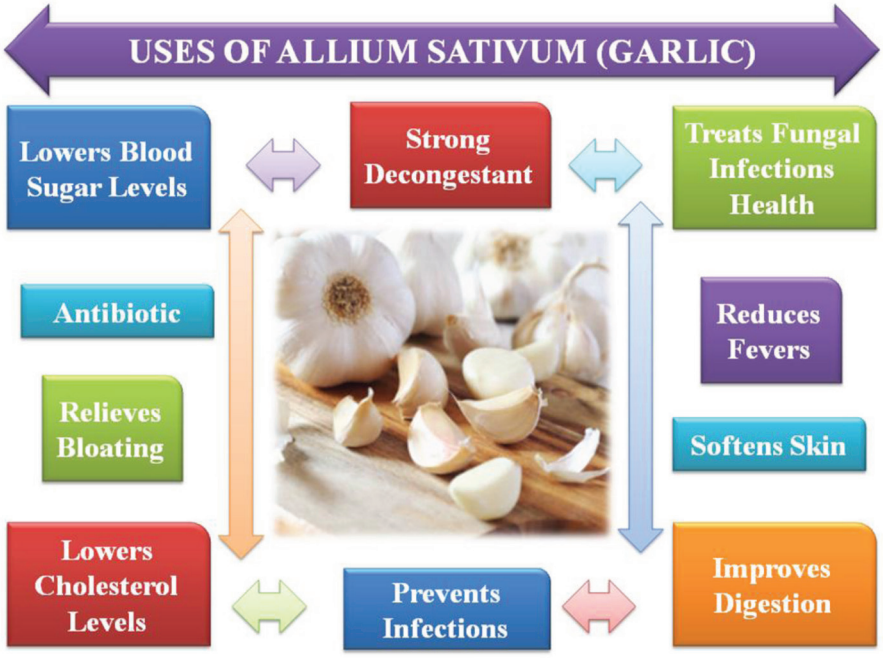

Figure 1: Medicinal Uses of *Allium Sativum*

4.1. Antilipemic (Cholesterol Lowering)

Garlic has been shown to reduce cholesterol in over 35 human trials. Garlic may lower mean blood cholesterol levels and boost fibrinolytic activity, according to case studies and controlled trials involving healthy individuals given supplements and diets high in cholesterol (Brewster & Rabinowitch, 2022). For a month, 40 individuals with elevated blood cholesterol were randomised to take capsules containing either fish oil (1800 mg of EPA and 1200 mg of DHA) or garlic powder (1200 mg) as a placebo. A single blind, placebo-controlled crossover design was used for experiment. Supplementing with garlic decreased low-density lipoprotein (LDL) levels by 10%, triglycerides by 34%, cholesterol by 11%, and risk of high-density lipoprotein (HDL) cholesterol by 19%.

4.2. Anti-Atherosclerotic I

Garlic supplements dramatically decreased the amount of fat in pre-existing fatty plaques and the aortic lesions in hypercholesterolemic rabbits. Aqueous solutions of dried garlic powder containing allicin and ajoene significantly inhibited the growth of smooth muscle cells from atherosclerotic aortic plaques in culture (Kindernay *et al.*, 2023).

4.3. Antihypertensive

Three significant reductions in systolic blood pressure (SBP) and four significant reductions in diastolic blood pressure (DBP) were seen in seven placebo-controlled clinical studies with KwaiÒ garlic powder supplementation. Compared to placebo, overall pooled mean difference in SBP change was 5-7% higher with garlic treatment. The corresponding decline in DBP was somewhat less for individuals who got the garlic therapy. A single dosage of 2400 mg of dried garlic was given in one of these studies, and the hypotensive effect started in five hours and lasted for almost fourteen. In a four-year clinical investigation that involved individuals with atherosclerosis, taking 900 mg of standardised garlic powder daily resulted in a 7% ($P<0.05$) reduction in blood pressure. Garlic extracts reduce hypertension in both rats and dogs. Garlic extracts administered intravenously to rabbits resulted in a dose-dependent diuretic-natriuretic response and a progressive reduction in heart rate; however, no discernible alteration in arterial blood pressure was noted.

4.4. Antimicrobial

Garlic powder and oil formulations have not been demonstrated to have considerable antibacterial action, despite allicin's antimicrobial activities against a range of bacteria, fungi, viruses, and parasites in vitro (Prajapati *et al.*, 2021). Garlic and its sulfur-containing components have been proven to have antiviral activity against a variety of viruses, including Influenza B, Parainfluenza virus, Vaccinia virus, Vesicular Stomatitis virus, Human Immunodeficiency Virus, and Human Rhinovirus. Garlic extract suppressed the human cytomegalovirus in tissue. In addition to influenza immunisations, supplementing mice with garlic protected against influenza infections. Gram-negative bacteria, including Serratia, Citrobacter, Enterobacter, Pseudomonas, and Proteus species, were shown to be affected by crude garlic extracts. Salmonella typhimurium 36 was susceptible to the antimicrobial effects of allicin, which were mostly caused by RNA synthesis. The aged garlic extracts exhibited dose-dependent antimicrobial activity at 2-4 mg per mL against three distinct reference strains of Helicobacter pylori; however, extracts' bactericidal or inhibitory action against Helicobacter pylori was diminished upon heat treatment. When used with omeprazole, a proton pump inhibitor, garlic has demonstrated further synergistic benefits against H. pylori. Histoplasma capsulatum, Candida albicans, Cryptococcus neoformans, Trichophyton, and other yeasts and fungi have all been shown to be susceptible to the fungicidal effects of allicin. When combined with amphotericin B47, dialyl trisulfide had synergistic fungicidal effects and demonstrated antifungal activity against C. neoformans. Garlic is suggested as a therapy for systemic and vaginal yeast infections by a number of naturopaths and herbalists due to its strong in vitro suppression of yeast. Major intestinal parasites in humans, including Giardia lamblia, Ascaris lumbricoides, and Entamoeba histolytica, are also inhibited by allicin (Josling, 2003).

4.5. Spasmolytic and Hepatoprotectant

Garlic administration prevented hepatotoxic exposure (such as doxorubicin, galactosamine, and carbon tetrachloride)-related damage shown in histology and biochemistry. Rats and toads treated with garlic before surgery did not develop liver tumours brought on by aflatoxin or chemicals. Dallyl sulphur compounds and aged garlic prevented acute chemically induced hepatotoxicity in rats. Over course of eighteen months, self-medication with powdered garlic showed good outcomes for a patient with severe hepatopulmonary illness who declined liver transplantation and did not react to somatostatin therapy. Despite its longstanding use, there are no studies evaluating efficacy of garlic in reducing gastrointestinal spasms.

4.6. Hypoglycemic

Research on the hypoglycemic effects of garlic is lacking, and what little that is available often yields contradictory findings. This study examines the hypoglycemic effects of garlic extracts in combination with water or a range of various organic solvents on oral glucose tolerance in both normal and alloxan-induced diabetic rabbits. There have also been reports of garlic oil's hypoglycemic effects on diabetics and animals. However, no human study has shown that garlic possesses hypoglycemic or anti-diabetic properties. Large doses of garlic may lower hyperglycemia, according to animal studies. (Wang *et al.*, 2017)

4.7. Hematologic

Domethacin, dipyridamole, and prostacyclin all had an anti-aggregatory effect that was enhanced when combined with ajoene (Lecompte *et al.*, 2019). Garlic taken orally also prevented platelets from aggregating. 5-hydroxytryptamine-induced platelet aggregation was completely inhibited in

a different investigation involving platelets from healthy individuals who had eaten four raw cloves of garlic. When animals were given a fatal dosage of collagen or arachidonic acid after first being prepared with garlic, the amount of damage to their liver and lung tissues was significantly less than in the cases of animals that were not prepped with garlic, according to histopathological analysis. Supplementing with 600–800 mg of garlic per day has been shown in case series in randomised, controlled trials involving both healthy individuals and those with vascular disease to reduce platelet aggregation and promote fibrinolysis. This effect is likely due to supplement's ability to interfere with the production of thromboxane. Garlic supplements had no discernible impact on serum thromboxane concentrations or platelet aggregation in a trial including 14 males with normal blood pressure.

4.8. Emmenagogue/ Abortifacient

There are no epidemiological studies indicating a link between garlic consumption and miscarriage, despite the herb's extensive historical usage as an abortifacient. Garlic stimulates rat uteri in one in vitro study, however, there are no findings from research involving humans or animals indicating that regular use of garlic poses risks to expectant mothers or their developing foetuses (Dorrigiv *et al*., 2020).

4.9. Immunostimulant

Human peripheral blood lymphocytes treated both NK-resistant M14 and NK-sensitive K562 cell lines with cytotoxic levels that were markedly increased by aged garlic extract (Adaki *et al*., 2014). Concurrent therapy with interleukin 2 (IL-2) improved this effect synergistically, indicating that garlic extracts are an effective immunostimulant. After being incubated with alliin, TNF-alpha and IL-1beta production both markedly increased, and the proliferation of peripheral blood mononuclear cells (PBMCs) induced by pokeweed mitogen was also enhanced. On the other hand, the production of IL-6 and Con-A-induced cell proliferation decreased, IL-2, superoxide anion production, and PHA-induced cell proliferation, however, did not alter.

4.10. Antineoplastic

Garlic contains diallyl sulphide and glutathione-S-transferase, at least two anti-carcinogenic substances. At dosages needed to have antiviral effects, components of garlic, especially allicin, are cytotoxic to HeLa and Vero cell lines (Sasi *et al*., 2021). In human promyeloleukemic cells, ajoene causes apoptosis. S-allyl cysteine pretreated head & neck squamous cell cancer cell lines greatly enhanced cisplatin's cytotoxic effects but showed no cytotoxic effects when administered on its own. Diets high in garlic may lower the chance of developing many types of solid tumours, according to a number of epidemiologic studies.

4.11. Antioxidant

Whole garlic & aged garlic extract have long been known to have antioxidant effects, and they also increase blood levels of glutathione peroxidase and catalase (Ansary, 2022). In rat liver microsomes undergoing lipid peroxidation, garlic extract in a dose-dependent way prevented formation of thiobarbituric acid reactive chemicals in cell membranes. An aqueous extract demonstrating antioxidant activity comparable to thirty nanomoles of ascorbic acid and/or three hundred and sixty micromoles of alpha-tocopherol was obtained from one milligram of a garlic preparation (KwaiO). In a randomised, placebo-controlled cross-over trial, ten volunteers who took 600 mg of a standardised garlic powder formulation (KwaiO tablets) daily showed a significant (34%) reduction in susceptibility to lipoprotein oxidation in response to garlic supplementation.

5. Biological/ Pharmacological Activities

Due to the presence of alkyl sulphides, garlic has garnered increased interest for its biological properties (Bhatwalkar *et al*., 2021). Garlic has been utilised as a medication to treat a variety of illnesses and ailments because of its biologically active ingredient, allicin, and its derivative.

5.1. Antiviral Activity

Vaccincinia virus, vesicular stomatitis virus, herpes simplex virus types 1 and 2, influenza B, para influenza virus type 3, coxsackie virus species, human immunodeficiency virus type 1, and human rhinovirus type 2 are just a few of the viruses against which garlic has shown a strong antiviral effect. Allicin, methyl allyl thiosulfinate, ajoene, & allyl methyl thiosulfinate are the ingredients that showed antiviral activity. Garlic was discovered to have a significant antiviral effect against common cold virus in a double-blind placebo-controlled experiment. Garlic has been shown in several lab tests to be useful in treating both herpes simplex and influenza B viruses (Perera *et al*., 2021).

5.2. Anti-cancer Activity

The anticancer properties of garlic have been investigated. The capacity of garlic extracts to stop the growth of cancer cells exists when sulphurous components found in garlic are combined with recognised tumour promoters. Garlic and garlic oil have anticancer properties. When administered topically to adult female Swiss albino mice that were

randomly bred and from two distinct substrains, during start phase of BaP induced skin carcinogenesis, the frequency of tumor-bearing animals decreased. discovered that garlic is utilised to prevent lung cancer as well as colon, rectal, stomach, breast, prostate, and bladder cancers. It was found that garlic's organosulfur components work by stopping malignant cells in their tracks. It was discovered that ajoene caused the creation of peroxide, which caused malignant cells to undergo apoptosis. Examining research on animals and cells, it was shown that eating garlic inversely correlated with the existence of malignant cells, indicating that garlic may have anticancer properties (Alkreathy, 2020).

5.3. Antibacterial Activity

Garlic's antimicrobial qualities are often attributed to allicin. Allicin has a well-established capacity to modify and inhibit sulfhydryl enzymes. Allicin is absent from raw garlic. It develops rapidly due to the enzyme alleinase. Since it reacts quickly with free thiol groups via thiol-disulphide exchange, interaction with thiol-containing enzymes, such as cysteine proteases and alcohol dehydrogenases, is thought to be the main mechanism of its antimicrobial activity. Since these enzymes are often essential for bacterial feeding and metabolism, it has been suggested that allicin resistance develops 1000 times more slowly than resistance to other antibiotics (Hussein *et al*., 2017).

5.4. Antifungal Activity

Garlic was shown to suppress development of fungal infections just as well as ketoconazole in tests against Aspergillus, Cryptococcus, Malassezia furfur, and other types of Candida. How to treat the uncommon and fatal brain fungal disease known as Cryptococcus meningitis using intravenous garlic. In study, Chinese evaluated effectiveness of garlic against traditional medical treatment, which included the use of the extremely dangerous medication amphotericin B. Garlic given intravenously proved to be more effective than the drug and dangerous at any dosage, the study found. One study found that mice fed liquid garlic extract had much fewer Candida colonies. Warts, ringworm, and skin parasites can all be cured by topically using garlic oil.

5.5. Antiprotozoal Activity

Research has shown that garlic has antiprotozoal properties. In addition to their anti-oxidant and anti-cancer qualities, they affect the immune system and cardiovascular systems. It has long been known that treating intestinal parasites with garlic may be advantageous. Garlic extract has shown efficacy against many protozoa, including Opalina ranarum, Opalinadimidicita, Balantidium entozoon, Entamoeba histolytica, Trypanosoma, Leishmania, Leptomonas, and Crithidia.

5.6. Antiparasitic Activity

An alcoholic extract made from crushed garlic cloves has been used as a medicinal therapy for digestive disorders. Major intestinal parasites of humans, including Giardia lamblia, Ascaris lumbricoides, and Entamoeba histolytica, are inhibited by allicin. The virulence of Entamoeba histolytica trophozoites was 90% decreased by allicin at lower dosages, according to research on the antiparasitic efficacy of allicin against Entamoeba histological (Bhattacharyya, 2021).

5.7. Molluscicidal Activity

In vitro and in vivo, allicin, a molluscicidal component of garlic, inhibited the activities of acetylcholinesterase, lactic dehydrogenase, and alkaline phosphatase when exposed to Lymnaea acuminata. The research discovered that Lymnaea acuminata nerve tissue showed increased succinic dehydrogenase activity when treated in vivo. Nonetheless, succinic dehydrogenase activity was mostly unchanged after in vitro exposure. Based on the kinetics of their inhibition, allicin inhibited LDH, alkaline phosphatase, and AChE in a competitive and an uncompetitive manner, respectively (Singh *et al*., 1996).

5.8. Insecticidal Effect

Excellent insecticidal activity was demonstrated by the different garlic extracts against the following: A. sierrensis, Culexpeus, Aedes aegypti, Larvae of Culicines, Anopheles, and Musca domestic. Among these are Trogoderma granarium, Simukium indicum, Culex fatigans, Dysdercus cingulatus, Anopheles stephensi, Pentalonia nigronervosa f. caladii, and Aproarema modicella.

5.9. Anthelmintic Activity

The garlic clove extract exhibited nematicidal action against Meloidogyne incognita, whereas garlic extract from bulbs showed modest in vitro activity against human Ascaris lumbricoides.

5.10. Anti- Diabetic Activity

The majority of studies have demonstrated that giving diabetic rats, mice, and rabbits garlic lowers their blood glucose levels. examined the effects of administering an oral dosage of garlic extract to rats during a 14-day period that had both normal and streptozotocin-induced diabetes. The blood glucose, triglyceride, total cholesterol, urea,

uric acid, and creatinine levels were monitored during this time. The blood insulin levels of diabetic rats given garlic extract were much greater than those of normal rats, and they also showed significant reductions in creatinine, aspartate aminotransferase, alanine aminotransferase, urea, uric acid, total cholesterol, triglycerides, and serum glucose (Helal *et al*., 2015). When given orally to fasted rabbits, the dried garlic cloves' ethyl ether extract was found to have a hypoglycemic impact. report on allicin's hypoglycemic impact on rabbits. When taken orally in rabbits with moderate alloxan-diabetes, allicin, which is derived from garlic, had hypoglycemic effects similar to those of tolbutamide (Hosseini & Hosseinzadeh, 2015).

5.11. Antihypertensive Activity

Garlic extracts have anti-hypertensive properties and significantly lower both systolic and diastolic blood pressure (DBP), according to the study. Numerous epidemiological research indicate that garlic (*Allium Sativum*) and a few of its bioactive constituents may have an antihypertensive effect. The goal of this research is to provide a thorough examination of the molecular, biochemical, and cellular processes underlying the antihypertensive properties of garlic and its bioactive constituents, with a focus on S-allyl cysteine and allicin (Gioxari *et al.,* 2023).

5.12. Anti-inflammatory Effect

Among the most commonly used is garlic (*Allium Sativum*). These compounds have anti-inflammatory, anti-cancerigenic, and cardioprotective properties when extracted and isolated. They also show a wide range of positive effects against microbial infections. Because IL-10 deregulation and decreased IL-12 production are two of the ways that garlic extract reduces inflammation in inflammatory bowel disease (IBD). This prevents IL-12 from binding to its receptor on T and NK cells, which inhibits the production of IFN-y.

5.13. Hypolipidemic Effect

Garlic has been shown to have hypolipidemic properties in both humans and animals. These studies show that garlic can reduce blood cholesterol levels in several ways, including garlic juice, aqueous extract, ethanolic extract, and essential oil fraction (Hussein *et al*., 2017). Garlic's hypocholesterolemic effects in normal rats have been studied. Onion was the control medication that was utilized. One clove of garlic and its alcoholic extract were given orally once a day for seven days at doses equivalent to 5 and 10 grams of crude drug per kilogram of body weight, respectively, for the onion (Khan *et al*., 2022). The combined effect of garlic & ginger in a biochemical study on adult male rats has been reported. The study included four groups: normal, garlic-fed, ginger-fed, and combination-fed. Except for the normal group, all three groups' blood cholesterol levels significantly decreased, with the combination of ginger and garlic showing an even greater reduction (Menon *et al*., 2021). In rats given an atherogenic diet, the essential oil's hypocholesterolemic impact was documented, as was the residue left behind after the essential oil was removed and the defatted garlic powder contained. The study demonstrated that reducing serum and hepatic cholesterol levels is caused by essential oil and defatted garlic powder. The investigation also found that the polysulphides found in essential oils are what had the lipid-lowering impact. In house rats and white rats, the hypolipidemic effect of AL-6, a crystalline fraction produced from A. satium, was found. Triglycerides, non-esterified fatty acids, phospholipids, and total cholesterol were all significantly lower in the rats. Myocardial necrosis can be prevented by garlic juice and essential oil (Spano *et al*., 2022).

5.14. Diuretic and Digestive Activity

It is claimed that garlic helps flush out bodily fluids and serves as a diuretic. For rheumatism, gout, arthritis, hidropesia, and edema, it could be a very helpful resource. Through pancreas, gall bladder, and liver stimulation, it facilitates digestion.

5.15. Hematological Effects

It examined the impact of giving rabbits a 1 g capsule of whole dehydrated garlic on a few hematological markers. Based on the study's findings, the hemogram did not significantly alter. However, in rabbits, it somewhat lowered the bleeding time and WBC level.

5.16. Chemical Modifications

It is altering the shape of garlic results in a reaction between the unstable sulfur compounds, which changes the active chemical ingredients. It is noteworthy that these alterations in chemistry have the potential to modify the compounds' bioavailability. Although garlic is currently cooked, dried, and aged rather than utilized raw as it was in the past, hydrogen sulfide, which is exclusively found in freshly crushed garlic, is believed to offer significant cardioprotective advantages as a vasodilator. If garlic is subjected to high temperatures during the dehydration process, alliinase becomes inactive and may not react with alliin to generate allicin. Garlic may also be aged by extracting and condensing its key components after soaking it in a solution of aqueous ethanol. S-Allylcystein (SAC), the most stable component of garlic, is the main molecule that remains when allicin is dissolved in oils; ajoene is also present (Akone *et al*., 2020).

6. Clinical Studies

The scientific community showed tremendous interest in garlic's hypolipidemic properties, particularly between 1970 and 1990. Several national institutions used garlic or its essential oil in clinical research on healthy, normal volunteers. Clinical investigations on the effects of garlic, its product on heart disease, hypoglycemia, antirheumatic activity, and fibrinolytic activity are also being conducted.

6.1. Toxicological Studies

For ten days, rats given garlic extract intragastrically (2 milliliters per 100 g body weight) showed substantial increases in urea and aspartate aminotransferase in their blood, as well as inhibition of alkaline phosphatase. The histological abnormalities were seen in the liver. It was discovered that administering garlic oil during a 24-hour fast proved fatal. Garlic extract and fresh garlic juice have been shown to cause comparable allergic sensitivities on housewives' fingers in the form of contact dermatitis.

6.2. Adverse Effects of Garlic

The primary side effect frequently linked to garlic consumption is breath odor. Two more serious side effects include nausea and vomiting. Garlic bulb juice is highly concentrated and can have a powerful emetic effect if taken in excess of the recommended acute dosage. Applying topically might result in allergy and garlic burns. Immunoglobulin E (IgE) mediated hypersensitivity reactions from the skin have been linked to rare garlic allergies, which are caused by the protein allinase. Unexpected hematomas in the spine or epidural area, linked to platelet dysfunction brought on by consuming too much garlic. Ratio An acute dosage of up to 30 g per day is similar to 2 to 5 cloves**/**day, or 500 mg fresh per day.

7. Marketed Formulations

Some have marketed ayurvedic preparations of *Allium Sativum* Linn. These are also some of its images: 500 milligrams of garlic is the Ayurvedic plant. Table 5 and 6 show the marketed formulations of garlic & selected companies associated with garlic and garlic-based products, along with Table 7 which shows the patent data of *Allium Sativum*.

Table 5: Market Preparations of Garlic

Name of Pharmaceutical Preparation	
Allium Plus	Horse Radish and Garlic Tablets
Artifact	Keli-Med
Arterase	Kincare
Asgoviscum N	Kreislauf-Kapseln
Bleib Junger	Procold
Brewers Yeast with Garlic	Preston
Cold-Eeze	Protol
Discmigon	Proyeast
Dynamol	Silybum Complex
Echinacea ACE Plus Zinc	Omegacelle
Esten	Vitalyt
Garlic and Horseradish + C Complex	Gelovitall
Garlic and Horseradish Complex 1000	Ginkovit
Gartech	Hanoartin

Table 6: Selected List of Companies Associated with Garlic and Garlic-Based Products

Countries	**Manufacturers/Traders/Suppliers**
India	Denree World Incorporation, Satikuwar Exports Private Limited, Gemini
Malaysia	Ebony Wonder sdn. Bhd.
Vietnam	Viemts joint stock company, Vietgo joint stock company
South Korea	K.Y.Cdigital Nomad Co. Ltd.
Japan	Toyo Suppli Co. Ltd., Green Tex Co. Ltd., Kaburagien Co. Ltd.
Pakistan	Khurshid Trading Co. (private) Limited
Thailand	Nine and King Co., Ltd.
Australia	Vvrs Australia Pty Ltd., Sumabe Holdings Pty Ltd., Vitaimpex

New Zealand	New Zealand Health Food Co. Ltd., Fresh Fruits Co. Ltd., Deep Blue Health
Northern Mariana Islands	Guangxi Linshifubang Trade Co., Ltd.
United Kingdom	Kolli International Trading Limited, Rav Industries Ltd.
Spain	Easyfish S.L., basic allium S.L.
Turkey	Manu agro supplies, Arkil Alp Trades
Netherlands	Bloemimex BV, Victoria Mondial
Cyprus	Al Ali traders
France	Maison Aux Mille Saveurs
Germany	Nwenzak S.kayap investment (nski)
Switzerland	phytolites gmbh
Portugal	Sousa Antunes
Egypt	Arkanza international trade, lashein for import, export, and commercial agencies, and for manufacturing, packaging, and exporting agricultural and food products.
United Arab Emirates	Al-Hikma FZCO, Al-Nooran General Trading Llc
Yemen	Alkirshi for Trading Co., Okaz Trading & Marketing

Table 7: List of Patents

Sr. No.	Patent No.	Title	Description
1	WO/2020/067867	Agricultural pesticide containing *Allium Sativum* and Heliopsis longipes extracts	In order to manage and/or eradicate pest insects and mites in crops grown in greenhouses and/or fields in general, present invention relates to a pesticide composition based on natural extracts. As a pesticide, it has a synergistic effect and 100% overall effectiveness. This combination consists of 20%–80% *Allium Sativum* (20–80%), a natural extract of Heliopsis longipes (20–80%), and 18–10% surfactant.
2	WO/2015/174817	Enhanced synergistic composition, manufacturing process, and use of *Allium Sativum* natural extract with synthetic pesticide components for pest insect control and/or eradication	The invention controls and/or eliminates nuisance insects by using a more potent synergistic combination. a) 20% to 80% natural extract of *Allium Sativum*; b) at least one synthetic insecticide ingredient chosen from groups I, II, and III and/or combinations of the same; c) 18% to 10% surfactant; and d) 8% to 1% diluent, making up 100% of the composition. In terms of controlling pest insects, the aforementioned elements have increased efficacy and had a longer-lasting impact in these percentages. They ensure control of adults, nymphs, larvae, and eggs, particularly in adults, by changing behaviour and reproduction. This is because garlic (*Allium Sativum*) extract uses its fundamental properties to alter the behaviour or physiology of insects, especially the hyperexcitation effect on the nervous system, which boosts the efficacy of synthetic chemical compounds. The aqueous extract of garlic (*Allium Sativum*) is made by maceration and combined with the other ingredients in the tank or directly in the field in the ratios determined by the formulation to ensure the eradication of pest insects that harm crops.

3	WO/2021/230894	Enhancing foam stability using *Allium Sativum* oil	Foaming fluid composition and methods for enhanced oil recovery are provided with enhanced foaming properties. The foaming composition may include a surfactant and *Allium Sativum* oil, whereas *Allium Sativum* oil may be included in an amount ranging from 20 to 75 vol% with respect to the total volume of the surfactant and the *Allium Sativum* oil. Methods of enhancing the recovery of oil from an oil-containing formation are also provided. Methods may include injecting a foaming composition into the oil-containing formation, where the foaming composition may include a surfactant and *Allium Sativum* oil. Methods may also include the foaming composition that includes *Allium Sativum* oil in an amount ranging from 20 to 75 vol% with respect to the total volume of the surfactant and the *Allium Sativum* oil.
4	WO/2018/134236	Interspecific hybrid plant resulting from a cross between an Allium ampeloprasum plant with an *Allium Sativum* plant	The latest invention is a hybrid of a leek and a garlic plant. By crossing an *Allium Sativum* plant with an Allium ampeloprasum plant, the innovation produces interspecific hybrid plants. The interspecific hybrid plants created when an *Allium Sativum* plant crosses with an Allium ampeloprasum plant are the specific subject of this invention. Because they include nuclear genetic information from both *Allium Sativum* and Allium ampeloprasum plants, these plants are able to generate seeds. The plants must also be available, bought, or descended from an interspecific hybrid plant that has been deposited under accession number NCIMB 42564, and they must have at least 250 mg/kg of allicin, as measured by measuring the white region of their leaf sheets.
5	WO/2003/035085	*Allium Sativum* bulb absolutes and therapeutic or cosmetic uses	The invention focusses on the absolutes of *Allium Sativum* bulbs, their composition, and their application in medicine and cosmetics, particularly in the treatment of obesity, cellulite, and localised excess skin fat.
6	WO/2023/128987	Inhibitory effects of standardized extracts of *Allium Sativum* l. Onions on cox-1, cox-2, and lox enzymes	The present invention relates to a standardized extract of *Allium Sativum* onions over allicin for use as an anti-inflammatory agent.
7	WO/2004/069262	Herbal composition comprising commiphora mukul, *Allium Sativum*, and curcuma longa	The present invention relates to a herbal chemical utilised to treat and/or prevent hyperlipidaemia, hypertension, atherosclerosis, and hypercholesterolaemia in animals. Extracts from Curcuma longa, Communiphora mukul, and *Allium Sativum* combine to form the formulation.
8	2019008594	Planta hibrida interespecifica que resulta de un cruce entre una planta de allium ampeloprasum con una planta de *Allium Sativum*.	The current innovation concerns a cross between a garlic plant and a leek. Interspecific hybrid plants that are produced by crossing an *Allium Sativum* plant with an Allium ampeloprasum plant are subject of the invention. The invention specifically concerns interspecific hybrid plants that are produced by crossing an Allium ampeloprasum plant with an *Allium Sativum* plant. These plants must be able to produce seeds and contain nuclear genomic material from both the Allium ampeloprasum and *Allium Sativum* plants. Additionally, the plants must contain at least 250 mg/kg of allicin, as measured in white portion of their leaf sheets, and they must be obtainable, obtained, or derived from an interspecific hybrid plant that has been deposited under accession number NCIMB 48644.
9	1020160127188	Anti-inflammatory cosmetic composition comprising *Allium Sativum* l. Stem extract	The present invention relates to a composition comprising an *Allium Sativum* L. Stem extract as an active ingredient and, more specifically, to an anti-inflammatory composition comprising an *Allium Sativum* L. Stem extract. COPYRIGHT KIPO 2016

10	1020200013304	Anti-aging composition comprising alliumsativum l. Root extract	Present invention relates to a composition for preventing skin aging, comprising an *Allium Sativum* L. Root extract. The composition comprising an *Allium Sativum* L. Root extract as an active ingredient of present invention has a high total phenol content, excellent DPPH and ABTS free radical scavenging activity, excellent collagenase and elastase inhibitory activity, a collagen biosynthetic effect, and a wound healing effect, and thus can be advantageously used as a composition for alleviating and preventing skin aging. In addition, the *Allium Sativum* L. Root extract of the present invention has no cytotoxicity or skin side effects and thus can be safely used in cosmetic, pharmaceutical, & food compositions. COPYRIGHT KIPO 2020
11	WO/2022/250641	Formulations prepared from *Allium Sativum* l. Methanol Extract and their effect on osteoarthritis	The invention relates to the microemulsion formulations comprising *Allium Sativum* L. Methanol extract containing at least 0.45% allicin as the active ingredient and the effects of said formulations on osteoarthritis.
12	MX/a/2009/002081	An description of the use and acquisition of a botanical repellent that uses *Allium Sativum* and humic acid to fight off plague insects	The present invention refers to a botanical repellent composition for fighting against plague insects, which comprises from about 75% to about 92% of garlic extract (*Allium Sativum*), humic acids, and from about 25% to about 8% of diluents. Preferably, the composition comprises 87% of garlic aqueous extract, humic acids, and 13% of water. Said percentages guarantee a control higher than 70% against adults, higher than 60% against nymphs, and higher than 60% against whitefly eggs (Benicia tabaci) in squash (Cucúrbita pepo). The garlic extract is obtained by the maceration method so as to have a concentration degree of 87%, which allows a suitable percentage to be obtained against plague insects affecting crops.
13	WO/2020/245479	Prebiotic composition for the preventative treatment of intestinal infections in livestock	Present invention relates to three formulations for stimulating intestinal microbiota of mammals, particularly livestock, and is characterized in that it comprises prebiotics extracted from beetroot, from milk and from *Allium Sativum*, and extracts of medicinal plants. The three formulations of the invention are suitable for the preventative treatment of intestinal infections such as clostridiosis, intestinal parasitosis, cryptosporidiosis and coccidiosis, as well as infections caused by some types of E. Coli bacteria, and metabolic diseases such as pre-eclampsia. In addition, the formulations of the invention are administered in different phases of an animal's development, from pregnancy to the end of its reproductive and productive life.
14	WO/2004/089385	An ayurvedic nutritional preparation	An ayurvedic meal composition that lowers the risk of heart problems and improves cardiac muscle tonicity is the subject of the invention. The Anacardiaceae plants Zingiber Officinale Rosc and *Allium Sativum* Linn are the two main suppliers of nuts. Before the nuts are used to create oil, the irritants and poisons are eliminated or rendered inactive. Zingiber Officinale Rosc extracts, *Allium Sativum* Linn extracts, and the filtered nut oil extract make up the mixture.
15	WO/2013/088225	Copper, glucose, and selenium salts found in sulfur-rich plant bulbs resulted in a watery extract with antifungal, anticancer, and antidermatitis (including autoimmune dermatitis) properties.	A compound comprising garlic, preferably *Allium Sativum*, and supplemented with selenium, copper salts, and sugars, preferably glucose, said compound having an apoptotic, cytotoxic or cytostatic action against tumor cells.
16	WO/2016/025010	A novel combination of broad-spectrum antiviral drugs to treat and prevent viral infections	In order to treat and prevent viral infections caused by filoviruses (Ebola Virus & Marburg Virus) and retroviruses (HIV-1 and HIV-2) the current invention focusses on using tetracycline (doxycycline, minocycline, tetracycline, or other derivatives) in combination with fresh or aged bulbs or garlic (*Allium Sativum*) extract (tablets, capsules, mixtures)

			in a pharmaceutical drug composition that contains a tetracycline anti-infective agent (doxycycline, minocycline, tetracycline, or other derivatives). Both medications have potent antiviral properties, and when combined, they have a synergistic therapeutic effect that is far more effective than when taken separately against retroviruses (HIV-1 and HIV-2) and filoviruses (Ebola).
17	WO/2023/154884	Natural product compositions for management of cholesterol levels	The composition includes extracts from Trigonella foenum-graecum, Camellia sinensis, and Commiphora mukul. The mixture may also include extracts from *Allium Sativum*, Cinnamomum verum, and Zingiber officinale. Composition may include Commiphora mukul extract at about 24%-36% by weight of the total composition, the *Allium Sativum* extract at about 20%-30% by weight of the total composition, the Camellia sinensis extract at about 12%-18% by weight of the total composition, the Trigonella foenum-graecum extract at about 12%-18% by weight of the total composition, the Zingiber officinale extract at about 8%-12% by weight of the total composition, and the Cinnamomum verum extract at about 4%-6% by weight of the total composition. The disclosure further provides methods of treating hyperlipidemia using the disclosed compositions.
18	IN2927CH2013A	Topical remedy for wound healing using Morinda tinctoria and *Allium Sativum*	The topical solutions for wound healing that include Morinda tinctoria, lime, and *Allium Sativum* are the subject of the present invention.
19	EP0923937A2	A herbal formulation useful as a therapeutic and cosmetic application for the treatment of general skin disorders	For both medical and cosmetic purposes, the invention offers a herbal formulation to treat common skin disorders. The formulation consists of at least two plant extracts, either in the form of powder, oil, or mixtures of these extracts. The plant extracts chosen from this group included the following: gum olibanum powder in its natural form (4–7%), gum olibanum resinoid or its organic extract (3–8%), resinoid-free gum olibanum meal (5–10 weight percent), Tridax procumbens water extract (3–6%), its methanolic extract (4–6%), *Allium Sativum* oilhexane extract (1–3%), dried aloe vera juice (2–6%), and gum olibanum powder in its natural form (4–6%). Furthermore, any drug that has wound-heature and anti-inflammatory qualities may be optional. Preservatives (0.05–0.3 weight percent), a humectant (1–1 weight percent), a base containing aqueous cream or a gel containing carbopol (1–4 weight percent), emulsifying ointment (20–40 weight percent), diclofenac sodium (1-3 weight percent), salicyclic acid (1–4 weight percent), piroxicam (1–2 weight percent), and water to make 100 weight percent were among the medications taken into consideration.
20	WO2024127434A1	A polyherbal formulation for immunomodulatory action	The polyherbal formulation comprising Padmapatra (Innula racemose), Bhargi (Clerodundrum serratum), Shati (Curcuma zedoaria), Pippali (Piper longum), black pepper (Piper nigrum), talispatra (Abies webbiana), Vacha (Acorus Calamus), Yastimadhu (Glycyrrhiza glabra), Arka Patriin (Calotropis gigantean), Garlic (*Allium Sativum*), Shatavari (Asparagus racemosus), Haridra (Curcuma Longa), Amlaki (Phyllanthus embilica), Shonti (Zingiber officinale), Karavella (Momordica charantia), Haritaki (Terminalia chebula), Guduchi (Tinospora cordifolia), Ashwagandha (Withania somnifera), Kanchanaar (Bauhinia variegata), Punarnava (Boerhavia diffusa), Moshli (Chlorophytum borivilianum), Nagarmustak (Cyperus rotundus), Udumbara (Ficus racemosa), Shobanjan (Moringa oleifera), Mundi (Sphaeranthus indicus), Shilajit (Asphaltum punjabianum), and Guggulu (Commiphora wightii) mixed in a suitable proportion with suitable excipients. Present invention relates to a method for preparing a polyherbal formulation for reducing the risk of various hypersensitivity reactions (type1, type2, type3, and type4 reactions).

8. Conclusion

Allium Sativum demonstrates its remarkable qualities and is a great asset to the herbal community. The medication's beneficial and non-beneficial properties outweigh its drawbacks. Its unique scent may be advantageous as well. Hardly a single illness category remains where this plant has not made an appearance. Furthermore, the market for this miraculous substance is growing at a startling rate. The perspective of consumers regarding the correlation between diet and illness will determine the future of *Allium Sativum*. When crushed garlic cloves are subjected to enzyme-catalyzed processes, a volatile chemical known as allicin is created from amino acids. By increasing CAT, SOD, GPX, and numerous other peroxidases while inhibiting the production of ROS-producing NOX enzymes, allicin administration can lower ROS. In the treatment of psychiatric disorders like ASD and ADHD as well as neurodegenerative illnesses like AD and PD, allicin has been discovered to be a helpful natural chemical against neuroinflammation. It can enhance the cognitive functioning of people with neurological disorders and safeguard neurons and the nervous system. To determine allicin's therapeutic effectiveness, however, clinical research is necessary. This review focuses on *Allium Sativum* Linn's phytochemicals and their biological activity.

9. Future Prospectives

Allium Sativum, also known as garlic, is one of the most promising therapeutic agents for the future since the interest of consumers in natural health care is on the rise. With the active compound allicin, it has shown impressive potential in reducing oxidative stress and neuroinflammation, placing it in the possibility of being used for neurodegenerative conditions such as Alzheimer's and Parkinson's diseases, psychiatric disorders such as ASD, and ADHD. It was publicized that garlic has medicinal use in traditional medicine, which has not been supported by enough high-quality clinical trials to record the therapeutic benefits in humans. Future work should focus on standardization of the range of garlic extracts for a consistent allicin content, optimal dosing, and long-term safety. In fact, the more scientific evidence is developed, *Allium Sativum* could increasingly contribute to managing various diseases and could be used in the various fields of therapy. Its increasing popularity, spurring from the global emergence of natural remedies, makes research not only necessary but also important to unlock its full prescription in modern medicine.

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It is an original article and has neither been sent elsewhere nor published anywhere.

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