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A Review on Antimicrobial and Cardioprotective Activities of Allium Sativum

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ABSTRACT:-

Allium sativum (garlic) is one of the oldest medicinal plants known for its diverse biological activities. Across ancient, traditional, and modern medicine systems, garlic has been widely utilized for infections, inflammatory disorders, metabolic diseases, and cardiovascular ailments. Garlic contains a variety of organosulfur compounds-most notably allicin, ajoene, diallyl sulfides, and S-allylcysteine-that contribute to its potent antimicrobial and cardioprotective activities. These compounds exhibit broad-spectrum antimicrobial effects against bacteria, fungi, viruses, and parasites through mechanisms including cell membrane disruption, inhibition of nucleic acid synthesis, and interference with metabolic pathways. In cardiovascular health, garlic demonstrates antihyperlipidemic, antihypertensive, antithrombotic, antioxidant, and vasodilatory properties. Scientific studies report significant reductions in LDL cholesterol, total lipids, blood pressure, and platelet aggregation with garlic supplementation. This review provides a comprehensive analysis of the phytochemical constituents, pharmacognostic characteristics, antimicrobial mechanism of action, cardioprotective properties, and clinical evidence supporting the therapeutic applications of Allium sativum. Its safety profile, limitations, standardization challenges, and future prospects in drug development are also highlighted. Garlic remains a promising natural therapeutic agent with substantial clinical relevance in infectious diseases and cardiovascular disorders.

Keywords:- Allium sativum; allicin; dially sulfide

INTR0DUCTION:-

Medicinal plants have played a vital role in healthcare since ancient times, and Allium sativum (garlic) stands among the most extensively used natural remedies. Belonging to the family Amaryllidaceae, garlic has been traditionally utilized as a culinary spice and therapeutic agent in Ayurveda, Traditional Chinese Medicine (TCM), and Egyptian medicine for over 5000 years. The plant's therapeutic potential is attributed primarily to its organosulfur compounds, which show strong antimicrobial and cardioprotective actions.

In modern pharmacology, garlic has gained scientific validation for its wide range of biological activities such as antibacterial, antifungal, antiviral, antiparasitic, antihyperlipidemic, antihypertensive, antithrombotic, anti-inflammatory, and antioxidant effects. With the global burden of antibiotic resistance and rising cardiovascular diseases, garlic emerges as a promising plant-based therapeutic.

This review aims to present an updated and comprehensive overview of the antimicrobial and cardioprotective properties of Allium sativum, supported by mechanistic insights, preclinical and clinical studies, and evidence-based applications.

2. BOTANICAL & PHARMACOGNOSTIC PROFILE OF ALLIUM SATIVUM

2.1 Botanical Description

- Scientific name: Allium sativum
- Family: Amaryllidaceae
- Common names: Garlic (English), Lahsun (Hindi), Lasun (Marathi), Vellulli (Telugu)
- Morphological features
- Bulb: Compound bulb with 6-20 cloves
- Leaves: Linear, flat, long
- Flowers: White to purple
- Odor: Characteristic pungent smell due to allicin

2.2 Macroscopical Characteristics

- Bulb covered with papery white or purple tunic
- Cloves arranged around a central axis

- Strong pungent odor when crushed
- Taste: Acrid

2.3 Microscopical Characteristics

- Epidermal cells with paracytic stomata
- Vascular bundles scattered
- Oil droplets present
- Fibrovascular tissues prominent

3. PHYTOCHEMISTRY OF GARLIC

Garlic contains >100 bioactive constituents.

Key Organosulfur Compounds

Compound	Properties
Allicin	Major antimicrobial agent, unstable, formed by alliinase
Ajoene	Antithrombotic, antifungal
Diallyl disulfide (DADS)	Anticancer, antimicrobial
Diallyl trisulfide (DATS)	Cardioprotective
S-allylcysteine (SAC)	Antioxidant, stable, found in aged garlic

Other Phytochemicals

- Flavonoids (quercetin, kaempferol)
- Saponins
- Amino acids
- Vitamins (C, B6)
- Minerals (selenium, manganese)

4. ANTIMICROBIAL ACTIVITIES OF ALLIUM SATIVUM

Garlic exhibits broad-spectrum antimicrobial

Activity against:

- Gram-positive bacteria (e.g., Staphylococcus aureus)
- Gram-negative bacteria (e.g., E. coli, Pseudomonas aeruginosa)
- Fungi (e.g., Candida albicans)
- Viruses (e.g., influenza, herpes viruses)
- Parasites (e.g., Giardia, Entamoeba)

4.1 Mechanisms of Antimicrobial Action

A. Against Bacteria

1. Cell membrane disruption

Allicin reacts with thiol groups on bacterial proteins.

2. Inhibition of DNA & RNA synthesis

3. Blocking lipid synthesis

4. Inhibition of bacterial enzyme activity (e.g., RNA polymerase)

B. Against Fungi

Ajoene inhibits phospholipid biosynthesis

Allicin damages fungal membranes

C. Antiviral Activity

Inhibits viral entry

Blocks viral replication enzymes

Boosts immune response

D. Antiparasitic Action

Induces oxidative stress in parasites

Inhibits cysteine proteases

Flowchart: Mechanism of Antimicrobial Action

Allium sativum

↓

Organosulfur compounds (Allicin, Ajoene)

↓

Targets microbial proteins and enzymes

↓

• Membrane disruption

• Inhibition of DNA/RNA synthesis

• Interference with energy metabolism

↓

Microorganism death or inhibited growth

5. CARDIOPROTECTIVE ACTIVITIES OF ALLIUM SATIVUM

Cardiovascular diseases (CVDs) are leading causes of global mortality. Garlic shows strong therapeutic potential in multiple areas:

5.1 Antihyperlipidemic Activity

Garlic reduces:

- Total cholesterol
- LDL cholesterol
- Triglycerides
- VLDL

Mechanisms:

- Inhibition of HMG-CoA reductase
- Enhanced bile acid excretion
- Reduced lipid peroxidation

5.2 Antihypertensive Activity

- Garlic lowers blood pressure through:
- Nitric oxide (NO) mediated vasodilation
- Inhibition of angiotensin-converting enzyme (ACE)
- Reduced arterial stiffness

5.3 Antithrombotic Activity

- Ajoene reduces:
- Platelet aggregation
- Fibrin formation
- Risk of clot formation
- Garlic inhibits thromboxane synthesis reduces clotting tendency.

5.4 Antioxidant Activity

- Garlic enhances antioxidant enzymes:
- SOD
- Catalase
- Glutathione

Reduces oxidative stress protects heart tissues.

5.5 Anti-inflammatory Action

- Inhibition of inflammatory markers:
- TNF-a
- IL-6
- CRP
- This contributes to protection against atherosclerosis.

6. CLINICAL STUDIES ON GARLIC

Hyperlipidemia

- 29 clinical trials show 10-15% reduction in cholesterol with raw or aged garlic extract.

Hypertension

- Garlic significantly lowers systolic BP by 5-10 mmHg in patients with mild-moderate hypertension.

Infections

- One randomized study showed 63% reduction in common cold occurrence with garlic supplementation.

7. SAFETY PROFILE

- Generally safe; mild side effects:
- Gastric irritation
- Breath and body odor
- Allergic dermatitis (rare)

Contraindications

- Before surgery (due to antithrombotic effect)

8. FUTURE PROSPECTS

- Development of stable allicin formulations
- Nano-garlic particles for enhanced delivery
- Combination therapies with antibiotics
- Garlic-derived cardiovascular drugs

9. CONCLUSION

Allium sativum is a potent medicinal plant with scientifically validated antimicrobial and cardioprotective activities. The presence of organosulfur compounds such as allicin, ajoene, and diallyl sulfides contributes to its therapeutic potential. Garlic demonstrates bactericidal, fungicidal, antiviral, and antiparasitic actions through multiple molecular mechanisms. It also provides cardioprotective effects by lowering lipid levels, reducing blood pressure, inhibiting platelet aggregation, and preventing oxidative stress.

Clinical studies strongly support its efficacy in cardiovascular diseases and infectious conditions.

Garlic remains an important natural therapeutic candidate with promising applications in modern phytomedicine and pharmacognosy

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