

Pharmacological effects of traditional herbal plant garlic (*Allium sativum*): A review

Paudel KR

Keshab Raj Paudel, Assistant Professor, Department of Pharmacology, Kathmandu Medical College Teaching Hospital, Kathmandu Nepal

ABSTRACT

This study aimed to review the different pharmacological effects of garlic. Garlic, *Allium sativum*, is a herbal plant which has been used in different food preparations since long time. Many studies have shown that allicin is the main compound in garlic which is generated from alliin with the help of alliinase enzyme and is responsible for many pharmacological effects. Different studies have shown that garlic has pharmacological effects such as antihypertensive, antihypercholesterolaemic, antiplatelet, hypoglycaemic, cardioprotective, antimicrobial, antineoplastic, etc. However, studies in the literature have some conflicting findings and meta-analyses are also slightly different for different effects. Despite these findings, most of the studies, including meta-analyses, have shown significant antihypertensive and hypolipidaemic effects of garlic. Based on the data in the literature, regular dietary consumption of raw garlic, two to four grams, equivalent to one clove of garlic, or 600-900 mg garlic powder per day, if not contraindicated, may be effective for different beneficial pharmacological effects.

Key words: Allicin, Alliin, *Allium sativum*, Garlic.

INTRODUCTION

Allium sativum, commonly known as garlic, is used as one of common components of foods and condiments¹. Many reports in the literature have shown that *A. sativum* has variety of pharmacological activities such as antihypertensive, antihypercholesterolaemic, cardioprotective, antiplatelet, hypoglycaemic, antimicrobial, antineoplastic, etc. though all the data in the different researches are not concordant with each other. Garlic contains alliin, allicin, diallyl disulphide, S-allylcysteine and diallyl trisulfide organosulfur compounds and allicin is responsible for characteristic garlic odour^{1,2-5}. Out of these compounds, allicin is the most studied compound responsible for the different types of pharmacological effects². Alliin is the precursor of allicin which is produced by the action of alliinase enzyme. This enzyme may be deactivated by gastric juice. So, enteric coated tablets of garlic are recommended for the therapeutic uses to inhibit the gastric inactivation of enzyme so that generation of allicin from alliin is

not affected⁶. Allicin is hydrophobic and crosses the biological barrier easily and undergoes metabolic pathway instantly to produce different pharmacological effects⁷.

METHODS

Cochrane library, MEDLINE/PUBMED central through HINARI and open access journals were searched for garlic Allicin, Alliin and *Allium sativum* for the published data in the period of 1990 to 2014. Besides, related chapter in the text books were also consulted. Studies with relevant and significant findings were included in the study. Depending upon the different studies, the formulation of the garlic was different such as enteric coated tablets, dried garlic powder, standardized dehydrated garlic preparation and raw garlic. Dose of the formulation and duration of study differed from study to study.

BODY

There is no unanimous consensus *vis a vis* effective ingredient in the garlic for various pharmacological effects. However, many garlic researchers believe that allicin is the major ingredient which is responsible for various potential clinical effects⁸. Investigations are underway to clearly delineate the exact mechanism of action of *A sativum*. Similarly, some studies have

Address for correspondence

Dr. Keshab Raj Paudel
Assistant Professor
Department of Pharmacology
Kathmandu Medical College and Teaching Hospital,
Kathmandu, Nepal
E-mail: keshabpaudel@gmail.com

tried to explore the metabolic pathways for various pharmacological activities which are as follows: Allicin may decrease oxidative stress (by decreasing reactive oxygen species and stimulating the production of glutathione⁷, increase nitric oxide bioavailability and hydrogen sulfide production, decrease angiotensin converting enzyme activity, expression of nuclear factor kappa-light-chain-enhancer of activated B cells (NF- κ B which plays key role in immune response to different stimuli) and the proliferation of vascular smooth muscle cells which are associated with pathogenesis (mainly atherosclerosis) of hypertension⁹. Organosulfur compounds from garlic are converted by red blood cells into hydrogen sulfide which dilates vascular smooth muscle cells and decrease total peripheral resistance³. Garlic also shows antiplatelet effects which is due to inhibition of thromboxane synthesis and fibrinolytic activity⁶. Antioxidant and tumour growth inhibition may be responsible for the antineoplastic growth of garlic⁴. Hypoglycaemic effect of garlic is due to the presence of volatile organosulfur compounds like alliin, allicin, diallyl disulfide, diallyl trisulfide, diallyl sulfide, S-allyl cysteine, ajoene and allyl mercaptan⁵. A randomised controlled clinical trial on pro-inflammatory cytokines has shown that tissue necrosis factor alfa (TNF α) has decreased significantly in garlic treated group pre and post measurement in postmenopausal osteoporotic females though there was no significant effect on interleukin-1 (IL-1) and interleukin-6 (IL-6) which, along with TNF α are involved in post-menopausal osteoporosis¹⁰.

EFFECTS OF GARLIC

Antihypertensive effect

Meta-analysis by Reinhart et al showed that garlic reduced blood pressure only in those patients with elevated systolic blood pressure. It reduced systolic blood pressure by 16.3 mm Hg (95% confidence interval 6.2 to 26.5) and diastolic blood pressure by 9.3 mm Hg (95% confidence interval 5.3 to 13.3) compared to placebo¹¹.

Hypolipidaemic effect

Based on animal data, Allicin decreased blood cholesterol and triglycerides and caused a significant reduction in the hepatic cholesterol storage¹². Meta-analyses based on clinical trials suggest that regardless of garlic preparation and compared to placebo garlic reduces total blood cholesterol (7.2 mg/dl, 95% CI: 1.2-13.5) and low density cholesterol (6.2 mg/dl, 95% CI: 0.77-11.6) levels though there are variations in the findings⁸. However, another meta-analysis of 29 clinical trials shows that garlic reduces total cholesterol (TC) and

triglyceride (TG) levels only marginally (TC- 3.42 mg/dl, range 1.08-5.94 mg/dl and TG- 1.98mg/dl, range 1.08-3.42 mg/dl), though significantly, without significant effect on low density and high density lipoproteins¹³.

Antiplatelet effect

Studies have shown that there is significant reduction in platelet aggregation after garlic treatment^{7,8}. Garlic also reduces epinephrine induced platelet aggregation¹⁴. Patients taking oral anticoagulants like warfarin may experience increased bleeding episodes. It is advisable to stop garlic administration one week prior to any surgical intervention.

Hypoglycaemic effect

Short term clinical trials have shown significant reduction in the blood glucose level in non-diabetic persons compared to placebo⁸. Other reports on human studies have also shown the hypoglycemic effects of garlic. The antidiabetic effects of garlic are mainly due to the volatile sulfur compounds. Garlic has been shown to be effective in reducing insulin resistance as well⁵.

Cardioprotective effect

When compared to garlic treated group and placebo group, in garlic treated group 11 deaths and 15 reinfarctions were noted in 222 prior myocardial infarction patients in a three year study whereas 20 deaths and 22 reinfarctions in 210 placebo treated patients⁸. Garlic reduces norepinephrine induced cardiomyopathy¹⁵ and reverses atherosclerosis¹⁶. Studies have shown allicin provides cardio-protective activity by causing vasodilatation and decreasing different pathogenicities of coronary artery disease, including cardiac hypertrophy, angiogenesis, platelet aggregation, hyperlipidaemia and hyperglycaemia^{7,17}. Cardioprotective effect of garlic may be the combined beneficial effects of vasodilatory, antihypertensive, hypolipidaemic, antiplatelet, antioxidant activities and inhibition of noradrenaline induced cardiomyopathy^{7,8,18-20}.

Effect on peripheral vascular disease

Significant increase in pain-free walking distance (relieve of intermittent claudication) has been reported after the administration of garlic extracts in different clinical trials⁸. However, long-term study is required for the clinical relevance of garlic in peripheral vascular diseases²¹.

Antimicrobial effect

Compared to flucunazole, allicin reduced the bio-film of *Candida albicans* significantly in the experimental set up by inhibiting the gene hyphal wall protein 1 (HWP1-is a adhesive glycoprotein present on the

surface of *Candida albicans*) which is responsible for the aggregation of organism to form biofilm. Allicin also causes membrane disruption to inhibit the growth of the fungus²². Allicin showed an antifungal activity against mycoses-causing dermatophytes with similar activity to ketoconazole²³. Oral pathogens involved in the pathogenesis of dental caries and periodontitis such as *Streptococcus mutans*, *S. sobrinus*, *Actinomyces oris*, *Aggregatibacter actinomycetemcomitans* and *Fusobacterium nucleatum* are also inhibited by allicin²⁴.

Antineoplastic effect

Animal studies have shown that garlic inhibits procarcinogens for esophageal, stomach, colon, lung and breast cancer. Human clinical and epidemiological studies have also the evidence of chemoprotective effects of garlic^{4,6}.

Effect on post-menopausal osteoporosis

Garlic may decrease postmenopausal osteoporosis in the females by modulating proinflammatory cytokins IL-1, IL-6 and TNF- α . However, more research is required¹⁰.

Neuroprotective effect

Data on animal study have shown that allicin may cause neuroprotection in ischaemia reperfusion injury to the spinal cord by improving mitochondrial function²⁵.

Effect against common cold

One clinical trial has shown that regular garlic intake may decrease the prevalence of common cold. However, this finding is inconclusive and needs more studies²⁶.

SIDE EFFECTS

Characteristic garlic smell has been reported (28%- garlic group versus 12%- placebo group) more commonly by

different studies^{8,21}. Other side effects include body odour, abdominal pain, anorexia, flatulence and allergic reactions though they are not statistically significant^{6,8}.

DOSAGE AND ADMINISTRATION

Various methods and different forms of garlic preparation may result in the significant difference in the garlic ingredients in the final composition. At low gastric pH, alliinase enzyme which is required to produce allicin from alliin gets denaturated and becomes inactive so the allicin generation is affected⁸. For this reason, enteric-coated garlic preparations are suggested. However, dried garlic powders in which content of allicin is standardised are recommended in the dose range of 600-900 mg per day which is equivalent to one clove of raw garlic (2-4 gm)^{6,15}.

PRECAUTION

It is better to avoid raw dietary garlic in take by the patients who are under anticoagulant and/or antiplatelet therapy (warfarin, aspirin, clopidogrel, ticlopidine, etc). It is recommended that persons who are under either garlic supplement or high dietary raw garlic consumption avoid garlic intake one week before any surgical intervention^{6,8}.

CONCLUSION

Garlic has variety of beneficial pharmacological effects such as antihypertensive, hypolipidaemic, antiplatelet, hypoglycaemic, cardioprotective, antineoplastic, antimicrobial activities, etc. Dietary inclusion of one clove of garlic per day may help get benefitted from various effects of garlic.

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