



EFFECTIVENESS OF BLACK GARLIC EXTRACT AGAINST VARIOUS ORGANS: A REVIEW

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ABSTRACT

*Black garlic is a fermented form of garlic (*Allium sativum*) which is obtained by heating (60-90 ° C) and humidity of 70-90% for a certain period of time. Black garlic, which is rich in functional compounds, is certainly very beneficial, especially for several organs in the body, such as cardiovascular, respiratory, hepatobiliary, kidney, gastrointestinal tract organs, and others. The study used is a literature review study using in vitro, in silico research articles and literature review articles. The results showed that the effectiveness of black garlic extract was mainly attributed to its antioxidant, immunomodulatory, anti-inflammatory, digestive system protective, hepatoprotective, cardiovascular protection, neuroprotective, and nephroprotective compounds.*

Keywords: *allium sativum, black garlic, organs*

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Black garlic is a fermented form of garlic (*Allium sativum*) which is obtained by heating (60-90 ° C) and humidity of 70-90% for a certain period of time. Black garlic, which is rich in functional compounds, is certainly very beneficial, especially for several organs in the body, such as cardiovascular, respiratory, hepatobiliary, kidney, gastrointestinal tract organs, and others. The study used is a literature review study using in vitro, in silico research articles and literature review articles. The results showed that the effectiveness of black garlic extract was mainly attributed to its antioxidant, immunomodulatory, anti-inflammatory, digestive system protective, hepatoprotective, cardiovascular protection, neuroprotective, and nephroprotective compounds.

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Introduction

The use of onion plants as an additional flavoring and herbal medicine has been around for a long time. Due to the many



benefits of the compounds in onions, there are antioxidant, immunomodulatory, antimicrobial, antibacterial, anti-inflammatory, and others (1). One type of

onion used to consumed by residents of Japan, South Korea, and Thailand since ancient times is black onion, while other countries have only started consuming black garlic in the last ten years (2).

Black garlic is a fermented form of garlic (*Allium sativum*) which is obtained by heating (60-90 C) and humidity of 70-90% for a certain period (3.4). This fermentation process causes changes in the color, smell, and taste of black garlic (5). Black garlic does not have a strong odor like garlic and has a sweet and sour taste because during the fermentation of black garlic, reducing sugars are formed consisting of 57.14% fructose, 7.62% sucrose, and 6.78% glucose. The sour taste in black garlic occurs because during the onion fermentation process carboxylic acid is formed, and the pH decreases from PH 6.25 to PH 4.25 (6).

Black garlic, which is rich in functional compounds very beneficial, especially for several organs in the human body like cardiovascular, respiratory, hepatobiliary, kidney, gastrointestinal tract, and others. Therefore, the author is interested in discussing it in this literature review study. This literature review study aims to determine the effectiveness of black garlic extract (black garlic) on several organs.

Method

The study used is a literature review study using in vitro, in silico research articles, and literature review articles. The articles used are English and Indonesian from national and international journals, which are full text. Articles were searched using keywords and accessed from Google Scholar, PubMed, and NCBI last ten years.

Results

Based on the search results by typing keywords with settings for the last ten years, found--journals. The articles are then selected based on the language, the comprehensiveness, and the suitability of the journal topics. Used -- journals with 1 -- key journals which are relevant to this literature review study.

a. Against Diseases of the Genitourinary Tract

The effectiveness of black garlic has shown an interesting capacity to relieve symptoms associated with various genitourinary diseases. Few studies have investigated the role of aged garlic extract in the treatment of kidney disorders, specifically those caused by glomerular, tubulointerstitial, or infectious pathologies. In the case of diabetic nephropathy, aged garlic extract significantly decreased urine albumin level, blood urea nitrogen content,

and increased urine urea nitrogen content in diabetic rats. The protective effect of aged garlic extract on diabetic nephropathy may be due to its anti-glycation and hypolipidemic effects (7). Albrakati et al. (8) studied the effects of aged black garlic extract (ABGE) on chronic kidney disease and found that aged garlic extract rescued ethephon-induced kidney damage through activation of nuclear erythroid-associated factor 2 and inhibition of inflammation and apoptotic responses (8). Furthermore, Tae Won et al., 2019 (9) tested the effectiveness of aged black garlic extract against Wistar rats that experienced acute kidney failure and had injected with colistin 10 mg/kg body weight per 30 minutes for six consecutive days. In this experiment, the sample was divided into two groups, namely the group that was given black garlic extract and the group that was not. The results showed that the samples given black garlic extract experienced an improvement in kidney function, as evidenced by a decrease in blood urea nitrogen (BUN) and serum creatinine. Histologically, the kidneys of rats that were not treated with black garlic extract experienced extensive tubular damage, and necrosis, while improvements were found in the kidney cells of rats that were treated with black garlic extract.

b. Against Liver Disease

Many substances, including components of food, drugs, alcohol, and pollutants, can cause acute and/or chronic liver diseases, such as liver fibrosis, non-alcoholic liver disease, non-alcoholic steatohepatitis, and even cirrhosis. Black garlic has been investigated extensively for its hepatoprotective properties. In Wistar rats with CCl₄-induced liver injury, administration of black garlic extract was found to exhibit a hepatoprotective effect based on protection against oxidative damage. SOD and GSH-Px levels decreased with increasing levels of alanine transaminase (ALT), aspartate transaminase (AST), lactate dehydrogenase, and alkaline phosphatase (ALP)(12). In another study, Tsai et al. (13) demonstrated that administration of SAC-enriched and polysaccharide-enriched black garlic extract into ICR mice inhibited CCl₄-induced liver injury by inhibiting lipid peroxidation and inflammation. Shin et al. (14) reported that administration of aged black garlic extract decreased AST and ALT levels in the liver of Sprague-Dawley rats treated with CCl₄ and D-galactosamine, consequently protecting the liver. The hepatoprotective effect of fermented garlic extract was also confirmed in two different studies conducted by Jiang et al. (15) and Chung et al. (16) in which

administration of a fermented BG extract into C57BL/6 mice modulated glycometabolism, lipometabolism, oxidative stress, and inflammation. Therefore, black garlic extract can help to prevent oxidative stress and cholesterol-related liver disorders, by reducing levels of AST, ALT, ALP, total cholesterol, LDL-C, and melondialdehit, while also increasing SOD, GSH-Px, and CAT. , GPx, and GR (17).

c. Against Diseases of the Heart and Blood Vessels

Systolic blood pressure (SBP) of 140 mm Hg or more and diastolic blood pressure (DBP) 90 mm Hg or higher, or both, is considered arterial hypertension. Several risk factors are associated with the development of arterial hypertension. Recent studies have shown that arterial stiffness precedes hypertension as well as causes an increase in SBP (18). In most cases, suffering from a disease such as hypertension leads to premature death. On the other hand, the renin-angiotensin system (RAS) is a group of related hormones that work together to regulate blood pressure, cardiovascular, and kidney function. It is documented that RAS dysregulation can be associated with arterial hypertension, cardiovascular, and renal disease (19). Based on the classic concept of the RAS

pathway for arterial hypertension, renin cleaves the substrate, angiotensinogen, to make the inactive peptide angiotensin I, which is then converted to angiotensin II by endothelial angiotensin-converting enzyme (ACE). This is the most extensive activation of angiotensin II by ACE that occurs in the lungs. Angiotensin II acts as a vasoconstrictor and stimulates aldosterone production from the adrenal glands, resulting in sodium retention and increased blood pressure (19). Many studies show the potential effect of black garlic on reducing arterial hypertension and inhibiting ACE. One of them is Ried et al. (20) conducted a clinical trial on 88 patients with uncontrolled hypertension. After 12 weeks of the study, the findings showed that black garlic extracts significantly reduced mean blood pressure along with arterial stiffness, mean artery pressure (MAP), central blood pressure, central pulse pressure, pulse wave velocity, and pressure augmentation. Administration of 12-week-old garlic extract to 49 participants with uncontrolled arterial hypertension was also found to be effective in reducing blood pressure and has the potential to improve inflammation, arterial stiffness, and improve gut microbial profile (21).

Another disorder that often occurs in blood vessels and of course will have an impact on heart function is atherosclerosis. Atherosclerosis occurs as a result of the interaction of fats, cholesterol, and other substances in the cellular components of the artery walls. These deposits are called plaques. Over time, this plaque can eventually narrow or completely clog arteries, causing whole-body complications (22). Black garlic extract exerted an anti-atherogenic effect in cholesterol-fed rabbits by reducing the development of lipid accumulation, blood vessel wall cholesterol accumulation, and development of fibro-fatty plaques as well as decreasing the development of coronary artery calcification (CAC) (23).

In a randomized double-blind placebo-controlled trial, black garlic extract significantly inhibited the development of CAC, decreased IL-6 glucose levels, and blood pressure of patients with an increased risk of cardiovascular events after consuming 2400 mg/day of aged black garlic extract for one year (24). Another randomized clinical trial showed that the combination of aged garlic extract and coenzyme Q10 could suppress the development of CAC and significantly decrease the levels of reactive carbonaceous proteins (25).

d. Against Diseases of the Nerves

In one study, Jeong and colleagues found that aged garlic extract could ameliorate A-induced neurotoxicity in PC12 mice by exhibiting 2,20-azino-bis (3-ethylbenzthiazoline-6-sulphonic acid) diammonium salt radical activity, inhibiting malondialdehyde, and reduces the accumulation of intracellular ROS (26).

Garlic can also prevent cognitive decline by protecting neurons from A-induced neurotoxicity, and apoptosis, thereby avoiding neuronal death caused by ischemia or reperfusion and increasing memory retention and learning ability. In context, Wichai et al.(27) conducted a dose-dependent study of aged garlic extract on A-induced neurotoxicity rats for 8 weeks. The authors found that aged garlic extract increased SOD, GPx activity, and decreased malondialdehyde levels. So these findings suggest that aged garlic extract improves cognitive dysfunction through antioxidant effects. Interestingly, another study proposed a possible mechanism, by which aged garlic extract impaired working memory via modification of cholinergic neurons, vesicular glutamate transporter 1, and glutamate decarboxylase in A-induced rat hippocampus (28).

On the other hand, Parkinson's disease (PD) is the second most common age-related neurodegenerative disease with unclear etiology. Oxidative stress and inflammatory disease play an important role in the onset and development of Parkinson's. Garlic and its compounds have been shown to protect cells from apoptosis, mitochondrial dysfunction, inflammation, and oxidative stress. Very limited studies have demonstrated the effect of BG on Parkinson's disease. One study of the effect of SAC on 1-methyl-4-parkinsonism induced phenylpyridinium (MPP+) oxidative stress in C57BL/6J mice. SAC (125 mg/kg i.p.) administered to rats for 17 days significantly improved MPP+-induced lipid peroxidation, ROS production, decreased dopamine in the striatum, and increased deficit locomotion (29). However, there is a need for more animal studies and clinical trials to confirm the therapeutic effects of black garlic on Parkinson's disease.

Conclusion

Based on a review of the results several clinical trials, that have been carried out by many researchers, it can be said that black garlic extract has provided strong evidence, to support the therapy of consuming black garlic in various preparations for the treatment of several diseases in the human

body. The therapeutic effect of black garlic extract is mainly due to its antioxidant, immunomodulatory, anti-inflammatory, digestive system protective, hepatoprotective, cardiovascular protection, neuroprotective, and nephroprotective compounds. The effectiveness of black garlic extract helps to be mediated by the regulation of several molecular signals. However, in most cases, the mechanism by which it creates is unknown due to the complexity of the disturbance. However, there are very few and inconsistent results from human studies, suspected due to the variance in the black garlic preparation, the unknown active substance, its bioavailability, and the small sample size.

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