مجلة الدراسات التربوية والعلمية - كلية التربية - الجامعة العراقية
العدد الحادي والعشرون - المجلد الرابع - علوم الحياة - آيار 2023 م
doi.org/10.52866/esj.2021.04.21.16

Review article: An overview on garlic plant (*Allium sativum* L.)

Alaa M. Hasan* , Sura Muayad Abdul Majeed
Department of Biology/ College of Science/University of Baghdad/ Baghdad, Iraq.
*E-mail of Corresponding author: alaa.m.h@uobaghdad.edu.iq

Abstract:

This review article concentrated on the therapeutic properties one of the most important plants and the probability of using some of them as a source of natural drugs to treat many important diseases. The light was spotted on garlic because it's considered as an abundant source of useful ingredients, allowing the possibility of benefiting from them as alternative sources in the development of the pharmaceutical industry. Over many experiments, garlic has been shown its ability to control the spread of large groups of microorganisms that cause many important diseases that affect humans, such as the genera of bacteria, fungi and viruses due to presence of antimicrobial, antioxidant, antiviral and antifungal properties in such an important plant.

Key words: Organosulfur compounds, medicinal plants, garlic, allicin, anti-microbial activity.

مراجعة المقالة: نظرة عامة على نبات الثوم (*Allium sativum* L.)

مستخلص:

ركزت هذه المقالة الاستعراضية على الخصائص العلاجية من أهم النباتات واحتمالية استخدام بعضها كمصدر للأدوية الطبيعية لعلاج العديد من الأمراض الهامة. تم رصد الضوء على الثوم لأنه يعتبر مصدرًا وفيرًا للمكونات المفيدة، مما يتيح إمكانية الاستفادة منها كمصادر بديلة في تطوير صناعة الأدوية.

من خلال العديد من التجارب، أثبت الثوم قدرته على التحكم في انتشار مجموعات كبيرة من الكائنات الحية الدقيقة التي تسبب العديد من الأمراض المهمة التي تصيب الإنسان، مثل أجناس البكتيريا والفطريات والفيروسات لوجود خصائص مضادة للميكروبات ومضادات الأكسدة ومضادة للفيروسات ومضادة للفطريات. في مثل هذا النبات المهم.

Introduction:

Medicinal plants have an important and essential defensive ability for their survival and survival against various predators. This feature is summarized by the fact that these plants produce secondary metabolic compounds of defensive importance, and store them in their different parts (seeds, leaves, flowers, ...). It is possible to benefit from these compounds and materials to treat many diseases that negatively affect the vital functions of humans [1].

Many phytochemicals have a positive effect on the health level of humans if used for long periods, as it has been found that they can be used effectively to treat many diseases that affect humans. Over the past century, more than thirteen thousand plant species have been used worldwide as traditional or local remedies specific to the culture of each region [2]. In general, there is weakness in the adoption of special systems for the legislation of traditional medicine in many countries of the world. Therefore, the World Health Organization seeks to encourage the safe use of many treatments or medicines. On the other hand, plants of medicinal importance are exposed to many challenges, such as climatic fluctuations and changing their natural habitats on the one hand, and the possibility of their availability and meeting the needs of the market on the other hand [3].

The typical taste, smell and flavor in raw/ freshly cut garlic belongs to allicin, a sulfur-containing natural compound which has plenty of biological properties [4]. Garlic (*Allium sativum*) is one of the species of the onion genus, *Allium*. other close relatives are onion, shallot, leek, and chive [5]. Garlic is considered a local crop to Central Asia and northeastern Iran, on another hand China, India, South Korea, Egypt and the United State are at the forefront of the world in terms of garlic production [6]. Garlic is one of the oldest and most common spices in the world, as its use by humans dates back thousands of years [4,7].

It was known to the ancient Egyptians, who used it as a flavoring for food and as a traditional remedy [8], (Figure,1).

Figure-1: Fresh and powder salt of garlic (*Allium sativum*)

Description of garlic plant:

Garlic is a flowering bulbous plant belonging to the family Amaryllidaceae. The plant grows to a height of 1.2 meters. It is a hermaphrodite plant that produces both female and male flowers together. These flowers are pollinated by insects, moths and butterflies [9- 10] (Figure, 2).

Figure- 2: *Allium sativum* bulbous plant

Garlic nutrients:

Fresh raw garlic bulbs consist of water, carbohydrate (starch, sucrose, glucose, fructose), protein, amino acids, dietary fiber, fatty acids (palmitic acid, oleic acid, linoleic acid, linolenic acid), trace minerals and more than 34 sulfur-containing compounds [11-13].

Chemical compositions and bioactive compounds in garlic:

Among many edible plants/ plant parts, garlic has a wide spectrum of chemical compounds with biological activity, the most important are organosulfur compounds, such as diallyl thiosulfonate (allicin), diallyl sulfide (DAS), diallyl disulfide (DADS), diallyl trisulfide (DATS), E/Z-ajoene, S-allyl-cysteine (SAC), and S-allyl-cysteine sulfoxide (alliin) [14- 15]. It is noteworthy, that organosulfur compounds are better digested if people consume fresh garlic when compared to eating cooked garlic [16].

As for phytochemicals, in general they include polyphenols, sulfur-containing compounds (Thiosulphinates such as allicin, allylmethyl-, methylallyl- and trans-1-propenyl-thiosulfinate), benzenoids, fatty acyls, glycerophospholipids, heteroaromatic compounds, indoles, phenols (-resorcylic acid, pyrogallol, gallic acid, rutin, protocatechuic acid and quercetin), lipids, pyrrolizidines, steroid derivatives quinolines, tetrahydrofuran's, saponins and polysaccharides [17, 12, 18].

Cultivation of garlic:

Garlic is one of the plants that is easy to grow, as it is grown throughout the year in areas with a temperate climate. The hard-necked garlic and the soft-necked garlic are among the most sensitive species to the length of the daily period compared to other types and strains of garlic. For garlic with a hard neck, the appropriate environment for it is an environment with a cold climate, and this is reflected in its shape and growth, as the cloves are

rather large in size. As for garlic with a soft neck, its preferred environment is one with a warm tropical climate, which leads to the production of small, compact cloves [19].

In cold climates, garlic cloves are planted for propagation during the autumn season before the time of freezing and cooling of the soil, about six weeks after that, the output is harvested for the period from before the end of spring until the beginning of summer. In order to obtain the best results, these cloves must be planted at a certain depth in the soil in order to avoid climate fluctuations that could infect the crop with fungal diseases [20].

Garlic can be grown through sexual reproduction, but it is preferable to plant it and propagate it asexually for the ease of the process by planting its cloves in soil or plastic pots, as mentioned previously [21] (Figure, 3). Garlic plants are planted close to each other, either in the designated soil or suitable pots for the growth and maturity of the bulbs. With regard to the types of soil suitable for growing garlic, it was found that it grows well in both dry and loose soils, in addition to well-drained soil with the importance of being exposed to the sun continuously. In order to achieve a better production of garlic, it is preferable to choose large bulbs to separate the lobes intended for cultivation from them. At the same level, large bulbs are obtained by planting the lobes in their designated place and the necessity to leave sufficient distances between them. At last, it is preferable that the soil designated for the cultivation of this crop be rich in organic matter, despite the possibility of growing it in regular soil due to its tolerance of soil conditions and different pH levels [21-22].

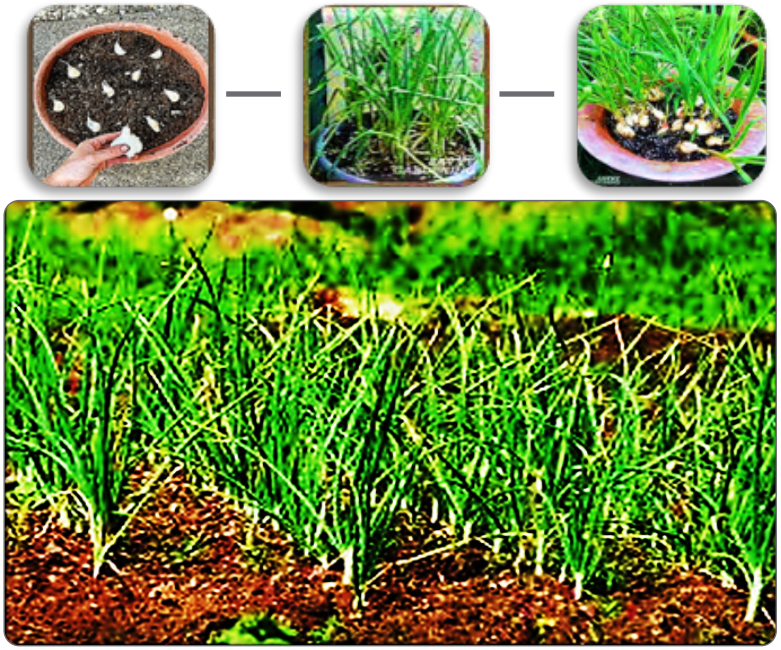

Figure- 3: Stages of growing garlic plant by planting individual cloves in pots and ground.

Uses and properties of garlic:

Garlic is used in several forms both *In Vitro* and *In Vivo* as illustrated by literatures. For instance, as:

Anti-microbial activities

For its antimicrobial activity, garlic was used as treatment for bacterial infections worldwide since long time ago. Garlic exhibits a significant domain of antibacterial features like bactericidal, antibiofilm and antitoxic efficacy versus enormous scope of bacterial species included strains resistant to many antibiotics thanks to the presence of organic sulfur compounds [23]. For this purpose, garlic has been used in several forms as stated in the research reviews, it could use as hydro alcoholic garlic extract [24], water, ethanol, hexane, acetone, diethyl ether garlic extract [25], aqueous garlic extract [26], garlic with DMSO extract and silver nano particles [27].

[28-29] mentioned the benefit of using fresh garlic extract or garlic paste as a natural anti-bacterial agent for many bacterial infections caused by pathogenic intestinal bacteria such as E. *coli, Salmonella* species, *Shigella* species, *Vibrio* species, *Campylobacter* species, *L. monocytogenes, Enterobacter*, and *Enterococcus* species, *S. aureus*, *Streptococcus* species, and *C. difficile*. They suggested that garlic consumption could positively reduce or even prevent food poisoning.

Anti-oxidant activities

Several studies have come to an important conclusion that garlic has powerful antioxidant properties. [30] studied the efficiency and concentrations of antioxidants in raw or fresh, cooked and fried garlic, explaining that fresh garlic has the highest percentages of antioxidants because it has many compounds such as: 1,1-diphenyl-2-picrilhydrazyl (DPPH) radical scavenging assay, 2,2'-Azino-bis (3-ethyl-benzothiazoline-6-sulfonic acid) (ABTS) radical scavenging assay, and ferric ion reducing antioxidant power (FRAP) assay). for its antioxidant activity, it could use as lyophilized garlic powder [30-31].

Furthermore, [32] Compared between both aged and fresh garlic in terms of having the strongest properties of antioxidants, and it turns out that aged garlic has more antioxidant activity thanks to the presence of DPPH, ABTS, FRAP, H2O2 scavenging, and Fe2+ chelating assays. With regard to the same context, some studies indicated a significant increase in the concentrations and effectiveness of antioxidants as follows, increasing the concentrations of antioxidants to their highest levels in black garlic when exposed to heat in the first 3 weeks of starting the process [33], moreover, it has been observed that the effectiveness of antioxidants improves when garlic paste is exposed to pressure increment [34].

Antifungal activities

for its antifungal activity as garlic paste [35], as an essential's oil [36], garlic powder [37]. For its antiviral activity, it was used as fresh garlic extract (juice), polar fraction and garlic associated compound [38], oil using hydro-

distillation [39], aqueous and alcoholic garlic extract [40].

Anti-inflammatory and anti-cancer activities

In the field of an anti-inflammatory activity, garlic was used as garlic tablets (300 mg) of aqueous garlic extract powder [41]. For anticancer activity, allicin standard extract was used [42].

The garlic plant is distinguished when compared with the rest of the onion family by containing high concentrations of primary reaction products, which gives it the lead in terms of strength of effectiveness. As for clinical studies, studies have shown that consuming garlic on a regular basis led to lowering cholesterol, blood pressure and blood sugar levels, in addition to prohibition of cancer and arteriosclerosis, and oral cavity as well. Therefore, garlic is known to possess many properties of medicinal and therapeutic benefit, as it can be used as an anti-inflammatory, antioxidant, antibacterial, antiviral, antifungal and antimutagenic properties [43- 44].

Among other *Allium* species, garlic has a typical pungent flavor due to the presence of allicin compound which is responsible for the slight burning sensation in the mouth that resulting from chewing or biting raw garlic. Allicin is activated when the odorless alliin molecule is exposed to the alliinase enzyme, and when it is produced, it is unstable or weakly stable, as allicin decomposes within a few hours if it is left uncooked at normal temperatures (room temperature). On contrast, if it is exposed to a high temperature during cooking, it decomposes within a few seconds, but if allicin is subjected to a reduction process, it gives many compounds such as ajoene, dithiins, and allyl methyl trisulfide [45- 46].

Anti-viral activities

The latest studies reported that garlic, in particular organic sulfur compounds, has anti-viral activity against many pathogenic viruses that affect humans, animals and plants by one of several methods like damaging viral receptors and inhibiting the synthesis of viral nucleic acid [47]. Preclinical investigations of garlic extract on both *In Vivo* and *In Vitro* has shown inhibitory activity against many respiratory viruses such as flu infections [48], gastrointestinal infections [49], viral plant infections [50].

Conclusion:

Due to increment in the emergence of the negative effects of many drugs on the human health level and the increase in cases of resistance towards many bacterial, fungal and other diseases, the global trend has been urged in recent years to encourage the consumption of medicines and therapeutic products of herbal origin, as they are safer on the consumer's health level, and one of the most important of these plants is garlic Which is easy to use in several forms, as it may be used as oil or powder, packed in capsules, or it may be eaten in its raw form.

In general, consuming garlic in its raw form is safe for everyone, espe-

cially for people who love natural and unprocessed products, but it is preferable to use it in reasonable quantities due to its strong smell. It is expected that some doctors will include garlic as a treatment for certain diseases in their prescriptions for patients, if specialists in the pharmaceutical industry can formulate it as stable treatments based on the scientific results resulting from many researches and studies interested in clarifying the therapeutic properties of this plant.

References:

1. Yudharaj P, Shankar M, Sowjanya R, Sireesha B, Ashok Naik E, Jasmine P R. Importance and Uses of Medicinal Plants - An Overview. International Journal of Preclinical and Pharmaceutical Research 2016; 7 (2): 67-73.
2. Tapsell LC, Hemphill I, Cobiac L. Health benefits of herbs and spices: the past, the present, the future. Med. J. Aust 2006; 185 (4): S4- 24.
3. Ahn K. The worldwide trend of using botanical drugs and strategies for developing global drugs. BMB Reports 2017; 50 (3): 111-116.
4. Borlinghaus J, Frank A, Martin C H G, Ifeanyi D N, Alan J S. Allicin: Chemistry and Biological Properties. Molecules 2014; 19 (8): 12591-12618.
5. Block E. Garlic and Other Alliums: The Lore and the Science. Royal Society of Chemistry 2010.
6. Rehman R, Saif S, Hanif M A, Riaz M. Elsevier B. V; Amsterdam: Medicinal plants of South Asia. (Chapter 23) - Garlic 2019.
7. Kewscience. Plants of the World Online; Royal Botanic Gardens, Kew, England 2017.
8. Garlic. National Center for Complementary and Integrative Health, US National Institutes of Health 2016.
9. Meredith T J, Drucker A. Growing Garlic from True Seed. Blogspot: Garlic Analecta 2014.
10. Sasi M, Sandeep K, Manoj K, Sandhya T, Uma P, Yamini T, et al. Garlic (*Allium sativum* L.) Bioactives and Its Role in Alleviating Oral Pathologies. Antioxidants 2021; 10: 1847.
11. Nutrition facts for raw garlic, USDA National Nutrient Database, version SR-21. Condé Nast. 2014.
12. Shang A, Cao SY, Xu XY, Gan RY, Tang GY, Corke H, et al. Bioactive Compounds and Biological Functions of Garlic (Allium sativum L.). Foods 2019; 8: 246.
13. Zhang Y, Liu X, Ruan J, Zhuang X, Zhang X, Li Z. Phytochemicals of garlic: Promising candidates for cancer therapy. Biomed. Pharmacother 2020: 123, 109730.
14. Kodera Y, Ushijima M, Amano H, Suzuki J, Matsutomo T. Chemical and biological properties of S-1-propenyl-l-cysteine in aged garlic extract. Molecules 2017; 22: 570.
15. Mansingh D P, Dalpati N, Sali V K, Vasanthi A H R, Alliin the precursor of allicin in garlic extract mitigates proliferation of gastric adenocarcinoma cells by modulating apoptosis. Pharmacogn. Mag 2018: 14,

S84- S91.

16. Torres-Palazzolo C, Ramirez D, Locatelli D, Manucha W, Castro C, Camargo A. Bioaccessibility and permeability of bioactive compounds in raw and cooked garlic. J. Food Compos. Anal. 2018; 70: 49- 53.
17. Wang YC, Guan M, Zhao X, Li X L, Effects of garlic polysaccharide on alcoholic liver fibrosis and intestinal microflora in mice. Pharm. Biol 2018; 56, 325- 332.
18. Ceccanti C, Rocchetti G, Lucini L, Giuberti G, Landi M, Biagiotti S, et al. Comparative phytochemical profile ofthe elephant garlic (Allium ampeloprasum var. holmense) and the common garlic (Allium sativum) from the Val di Chiana area (Tuscany, Italy) before and after in vitro gastrointestinal digestion. Food Chem 2021; 338: 128011.
19. The Royal Horticultural Society. London, UK 2017.
20. Tortorello M. 2010. The Cult of the Cloves. The New York Times. Available at https:// www.nytimes.com/2010/09/30/ garden/30garden.html.
21. Salunkhe D K, Kadam S S, Eds. 1998. Handbook of Vegetable Science and Technology: Production, Compostion, Storage, and Processing. Marcel Dekker. p. 397.
22. Rosen C, Roger B, Vince F, Bill H, Jim P, Cindy T. et al. Growing garlic in Minnesota. University of Minnesota Extension 2016.
23. Bhatwalkar S B, Rajesh M, Suresh B N K, Jamila Khatoon A, Patrick G, Rajaneesh A. Antibacterial Propt erties of Organosulfur Compounds of Garlic (*Allium sativum*), Front Microbiol 2021; 12: 613077.
24. Borhan-Mojabi K, Sharifi M, Karagah T. Efficacy of different concentrations of garlic extract in reduction of oral salivary microorganisms. Arch. Iran. Med 2012; 15: 99- 101.
25. Bin C, Al-Dhabi N A, Esmail G A, Arokiyaraj S, Arasu M V. Potential effect of Allium sativum bulb for the treatment of biofilm forming clinical pathogens recovered from periodontal and dental caries. Saudi J. Biol. Sci 2020; 27:1428- 1434.
26. Bakhshi M, Taheri J.B, Basir SS, Tanik A, Pahlevan R. Comparison of Therapeutic effect of aqueous extract of garlic and nystatin mouthwash in denture stomatistis. *Gerodontology* 2012; 29; 680- 684.
27. Abdelkader HS, Alayafi A A, Ahmed H E, Bin Osail R A. The Antibacterial Activity of Nanosilver Coupled Edible Plant Extracts Against Streptococcus mutans, the Cause of Dental Caries. J. Pharm. Res. Int 2021; 33: 167- 186.
28. Jain I, Jain P, Bisht D, Sharma A, Srivastava B, Gupta N. Comparative evaluation of antibacterial efficacy of six indian plant extracts against streptococcus mutans. J. Clin. Diagn. Res 2015a; 9: ZC50- ZC53.
29. Roshan N, Riley T V, Hammer K A. Antimicrobial activity of natural products against Clostridium difficile in vitro. J. Appl. Microbiol 2017; 123: 92- 103.

30. Locatelli D A, Nazareno M A, Fusari C M, Camargo A B. Cooked garlic and antioxidant activity: Correlation with organosulfur compound composition. Food Chem 2017; 220: 219-224.
31. Feng Y, Xu B, Yagoub A E A, Ma H, Sun Y, Xu X, et al. Role of drying techniques on physical, rehydration, flavor, bioactive compounds and antioxidant characteristics of garlic. Food Chem 2021; 343: 128404.
32. Jang H J, Lee H J, Yoon D K, Ji D S, Kim J H, Lee C H. Antioxidant and antimicrobial activities of fresh garlic and aged garlic by-products extracted with different solvents. Food Sci. Biotechnol 2018; 27: 219-225.
33. Zhang Z S, Lei M M, Liu R, Gao Y F, Xu MY, Zhang M. Evaluation of alliin, saccharide contents and antioxidant activities of black garlic during thermal processing. J. Food Biochem. 2015; 39: 39- 47.
34. Hiramatsu K, Tsuneyoshi T, Ogawa T, Morihara N. Aged garlic extract enhances heme oxygenase-1 and glutamate-cysteine ligase modifier subunit expression via the nuclear factor erythroid 2-related factor 2-antioxidant response element signaling pathway in human endothelial cells. Nutr. Res 2016; 36: 143-149.
35. Fattahi H F, Alirezaei S, Goodarzi H, Khalesi M A. Investigation of antifungal effect of aqueous extract of garlic on Candida albicans (Invitro). J. Res. Dent. Sci 2019; 16: 20-26.
36. Asai D, Nakashima H. Pathogenic Viruses Commonly Present in the Oral Cavity and Relevant Antiviral Compounds Derived from Natural Products. Medicines 2018; 5: 120.
37. Tamai I A, Pakbin B, Fasaei B N. Genetic diversity and antifungal susceptibility of Candida albicans isolates from Iranian HIV-infected patients with oral candidiasis. BMC Res. Notes 2021; 14: 1- 7.
38. Ban J O, Oh J H, Kim T M, Kim D J, Jeong H S, Han S B, et al. Anti-inflammatory and arthritic effects of thiacremonone, a novel sulfur-compound isolated from garlic via inhibition of NF-κB. Arthritis Res. Ther. 2009; 11: 1- 13.
39. Ohtani M, Nishimura T. The preventive and therapeutic application of garlic and other plant ingredients in the treatment of periodontal diseases. Exp. Ther. Med 2020; 19: 1507- 1510.
40. Kim H K. Garlic supplementation ameliorates UV-induced photoaging in hairless mice by regulating antioxidative activity and MMPs expression. Molecules 2016; 21: 70.
41. Li Z, Le W, Cui Z. A novel therapeutic anticancer property of raw garlic extract via injection but not ingestion. Cell Death Discov 2018; 4: 1- 10.
42. Alamir A H, Patil S. Allicin Could Potentially Alleviate Oral Cancer Pain by Inhibiting "Pain Me-diators" TNF-, IL-8, and Endothelin. Curr. Is-

sues Mol. Biol 2021; 43: 187- 196.
43. Kumar M, Prakash S, Kumari N, Pundir A, Punia S, Saurabh V, et al. Beneficial role of antioxidant secondary metabolites from medicinal plants in maintaining oral health. Antioxidants 2021; 10:1061.
44. Ahmad T A, El-Sayed B A, El-Sayed L H. Development of immunization trials against Eimeria spp. Trials Vaccinol 2016; 5: 38- 47.
45. Neeraj S, Sushila K, Neeraj D, Milind P, Minakshi P. Garlic: A Pungent wonder from nature. Int. Res. J. Phamacy 2014; 5: 523- 529.
46. Yun H M, Ban J O, Park K R, Lee C K, Jeong H S, Han S B, et al. Potential therapeutic effects of functionally active compounds isolated from garlic. Pharmacol. Ther 2014; 142: 183- 195.
47. Rouf R, Shaikh J U, Dipto K S, Muhammad T I, Eunus S A, Jamil A S et al. Antiviral potential of garlic (Allium sativum) and its organosulfur compounds: A systematic update of pre-clinical and clinical data. Trends Food Sci Technol 2020; 104: 219- 234.
48. Choi H -J. Chemical constituents of essential oils possessing anti-influenza A/WS/33 virus activity. Osong Public Health and Research Perspectives 2018; 9(6): 348-353.
49. Al-Ballawi Z, Redhwan N, Ali M. In-vitro studies of some medicinal plants extracts for antiviral activity against rotavirus. IOSR Journal of Pharmacy and Biological Sciences 2017; 12:53- 58.
50. Wang X Y, Zhang C W, Huang W T, Yue J, Dou J J, Wang L Y, Cheng YQ. Crude garlic extract significantly inhibits replication of grapevine viruses. Plant Pathology 2020; 69 (1):149- 158.