Investigating the Bioactive Compounds of Moringa and Garlic in the Treatment of Chronic Diseases: A Comprehensive Review

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Keywords: *Herbal Remedies, Chronic Diseases, Moringa olefera, Garlic.*

Herbal remedies have been used for centuries to treat various ailments. Natural products, derived from plants, animals, and microorganisms, have been used for centuries as a source of medicinal compounds in traditional and modern herbal remedies. Understanding the chemical properties herbal remedies is crucial for their effective and safe application in managing chronic diseases. This review explores the chemical properties and mechanisms of two potent herbal remedies, *Moringa oleifera and* Garlic (Allium sativum L.) in managing chronic diseases such as diabetes, cardiovascular diseases, and autoimmune disorders. It emphasizes the need for a balanced approach combining herbal and conventional medicine, reducing healthcare costs and improving patient outcomes. The review includes 10 studies investigating the efficacy of herbal remedies in managing chronic diseases in Moringa and Ginger. The study revealed that *Moringa oleifera*, a valuable plant in traditional and modern medicine, has diverse therapeutic effects, making it beneficial for managing chronic diseases. Garlic, a powerful herbal remedy with bioactive compounds, is also considered a powerful natural treatment due to its antioxidant, anti-inflammatory, antimicrobial, antiemetic, and anticancer activities. The therapeutic potential of moringa and garlic in managing chronic diseases is underscored by their ability to alleviate symptoms and improve health outcomes through natural mechanisms. This review highlights the importance of integrating these herbal remedies into conventional medical practices to enhance disease management, promote overall well-being and develop effective treatments for chronic diseases and enhance their integration into modern medicine.

Introduction

Chronic diseases pose a significant challenge to global health, economies, and societies. Addressing the burden of these diseases requires a multifaceted approach involving prevention, early detection, effective management, and policy interventions. Chronic diseases, such as diabetes, hypertension, and arthritis, are a major public health concern globally. While conventional medicines are often used to manage these conditions, herbal remedies are increasingly being sought as alternative or complementary therapies. Herbal remedies are perceived to be natural and safe, but their efficacy in managing chronic diseases is not well understood.

As scientific research continues to validate their efficacy and safety, herbal remedies are poised to play an increasingly vital role in promoting health and well-being globally. By embracing the holistic and preventive principles of herbal medicine. The most common reasons for using traditional medicine are that it is more affordable, more closely corresponds to the patient's ideology, allays concerns about the adverse effects of chemical (synthetic) medicines, satisfies a desire for more personalized health care, and allows greater public access to health information. The major use of herbal medicines is for health promotion and therapy for chronic, as opposed to life-threatening, conditions. However, usage of traditional remedies increases when conventional medicine is ineffective in the treatment of disease, such as in advanced cancer and in the face of new infectious diseases. Furthermore, traditional medicines are widely perceived as natural and safe, that is, not toxic. This is not necessarily true, especially when herbs are taken with prescription drugs, over-the-counter medications, or other herbs, as is very common (Canter and Ernst 2004; Qato et al. 2008; Loya, Gonzalez-Stuart, and Rivera 2009; Cohen and Ernst 2010).

Herbs and plants can be processed and can be taken in different ways and forms, and they include the whole herb, teas, syrup, essential oils, ointments, salves, rubs, capsules, and tablets that contain a ground or powdered form of a raw herb or its dried extract. Plants and herbs extract vary in the solvent used for extraction, temperature, and extraction time, and include alcoholic extracts (tinctures), vinegars (acetic acid extracts), hot water extract (tisanes), long-term boiled extract, usually roots or bark (decoctions), and cold infusion of plants (macerates). There is no standardization, and components of an herbal extract or a product are likely to vary significantly between batches and producers.

Plants are rich in a variety of compounds. Many are secondary metabolites and include aromatic substances, most of which are phenols or their oxygen-substituted derivatives such as tannins (Hartmann 2007; Jenke-Kodama, Müller, and Dittmann 2008). Many of these compounds have antioxidant properties. Ethnobotanicals are important for pharmacological research and drug development, not only when plant constituents are used directly as therapeutic agents, but also as starting materials for the synthesis of drugs or as models for pharmacologically active compounds (Li and Vederas 2009). About 200 years ago, the first pharmacologically active pure compound, morphine, was produced from opium extracted from seeds pods of the poppy *Papaver somniferum*. This discovery showed that drugs from plants can be purified and administered in precise dosages regardless of the source or age of the material (Rousseaux and Schachter 2003; Hartmann 2007). The review aims to support the evidence-based use of herbal remedies in managing chronic diseases from different database and to foster a deeper understanding of their role in modern healthcare.

Garlic (Allium sativum L.)

These plants have been extensively researched over many years and have been used for centuries to combat infectious diseases (Onyeagba et al., 2004). The classification of garlic and its related genera has been a subject of debate for a long time. The most recent classification places garlic in the class Liliopsida, subclass Liliidae, superorder Liliianae, order Amaryllidales, family Alliaceae, subfamily Allioideae, tribe Allieae, and genus Allium, largely based on the sequences of nuclear ribosomal DNA (Friesen et al., 2006). In ancient Egypt, garlic was used to treat diarrhea, and its medicinal properties were recorded on the walls of temples and on papyrus dating back to 1500 BC (Bradley, 1992). Greek physicians such as Hippocrates and Galen used garlic to treat both intestinal and extra-intestinal conditions, while it was also employed in ancient Japan and China to treat headaches, flu, sore throats, and fevers. In Africa, specifically in Nigeria, garlic is used for the treatment of abdominal discomfort, diarrhea, otitis media, and respiratory infections (Jaber and Al-Mossawi, 2007). In Europe and India, garlic was traditionally used for conditions like the common cold, hay fever, and asthma. It is sometimes referred to as "Russian penicillin" due to its wide application as an antimicrobial agent, both topically and systemically, across many cultures for its healing reputation (Timbo et al., 2006).

Active Chemical components of Garlic

Garlic contains at least 33 sulfur compounds, various enzymes, and minerals like germanium, calcium, copper, iron, potassium, magnesium, selenium, and zinc. It is also rich in vitamins A, B1, and C, as well as fiber and water.

Additionally, garlic contains 17 amino acids, including lysine, histidine, arginine, aspartic acid, threonine, glutamine, proline, glycine, alanine, cysteine, valine, methionine, isoleucine, leucine, tryptophan, and phenylalanine (Josling, 2005). The sulfur compounds in garlic, which are responsible for its pungent smell and many of its medicinal properties, are more concentrated than in any other Allium species. Among the most active compounds is allicin (diallyl thiosulfinate or diallyldisulfide), with the most abundant being alliin (S-allylcysteine sulfoxide). Fresh garlic contains about 10 mg/g of alliin, while dried garlic contains approximately 30 mg/g (Lawson, 1998). When garlic is chopped, minced, or crushed, the S-allyl cysteine sulfoxide is exposed to the enzyme alliinase, which rapidly converts it to diallyl thiosulfinate, responsible for garlic's characteristic odor. However, the enzyme alliinase becomes inactive at a pH below 3.5 or when heated (Pedraza-Chaverri et al., 2006). Though allicin is often considered garlic's primary antioxidant and scavenging compound, recent research suggests that other compounds, such as phenolic and steroidal polar compounds, play significant roles in garlic's medicinal properties, offering pharmacological benefits without the strong odor and with heat stability (Lanzotti, 2006).

The Role Garlic in Cardiovascular Disease Treatment

Cardiovascular diseases claim more lives than any other conditions, with heart and circulatory disorders being the leading cause of death. The narrowing of coronary arteries due to plaque buildup leads to a restriction in blood supply, depriving parts of the heart of oxygen and resulting in heart attacks. High blood pressure and elevated serum cholesterol levels are significant risk factors for heart disease, both of which are positively influenced by garlic's therapeutic properties. A study on rabbits demonstrated that consistent garlic consumption could even reverse pre-existing atherosclerotic deposits and lesions (Bordia, 1981).

Garlic as an Anticancer Agent

Among garlic's many health benefits, its ability to inhibit cancer growth stands out. Garlic's anticancer properties are attributed to its capacity to stimulate immune cells, such as T-cells and natural killer cells. Numerous epidemiological, clinical, and laboratory studies highlight garlic's role in cancer prevention, particularly in digestive tract cancers. Regular garlic consumption has been shown to reduce the risk of esophageal, stomach, and colon cancer, likely due to the antioxidant properties of allicin, which reduce the formation of carcinogenic compounds in the gastrointestinal tract (Galeone et al., 2006).

Figure 1. Garlic

Moringa oleifera

The height of the *Moringa oleifera* Lam. (MO) tree was 5 to 10 meters. Its numerous uses have led to its cultivation worldwide. Every portion of the moringa plant has specific nutritional and/or therapeutic uses. It has also been found to have anti-inflammatory, antimicrobial, antioxidant, anticancer, cardiovascular, hepatoprotective, anti-ulcer, diuretic, antiurolithiatic, and antihelmintic properties in addition to being an excellent source of protein, vitamins, lipids, fatty acids, micro-macro minerals, and different phenolics.Moringa (Moringa oleifera), commonly known as the drumstick tree, has garnered significant attention for its potential health benefits, particularly in the treatment and management of chronic diseases (Abubakar M.Y *et al.,* 2024) Moringa has been found to help regulate blood sugar levels due to the presence of isothiocyanates and chlorogenic acid, and it can also improve insulin sensitivity. Furthermore, moringa has cholesterol-lowering effects and aids in combating oxidative stress, which is associated with cancer development. It is beneficial for liver health, assisting in detoxification by eliminating heavy metals and other toxins. According to the Bureau of Plant Industry, moringa is an exceptional nutritional source. For example, its leaves contain four times the calcium of milk, seven times the vitamin C of oranges, three times the potassium of bananas, three times the iron of spinach, four times the vitamin A of carrots, and twice the protein of milk (Kamal, 2008).

Moringa's anti-inflammatory properties are also well-documented. Its root extract has demonstrated significant anti-inflammatory effects, as observed in carrageenan-induced paw edema in rats (Ezeamuzie et al., 1996; Khare et al., 1997). Additionally, the n-butanol extract from moringa seeds has shown anti-inflammatory activity in ovalbumin-induced airway inflammation in guinea pigs (Mahajan et al., 2009). Moringa has been long recognized for its medicinal potential in traditional Ayurvedic and Unani medicine systems (Mughal et al., 1999). Nearly every part of the plant, including the root, bark, gum, leaf, fruit, pods, flowers, seeds, and seed oil, has been used for various ailments in indigenous medicine (Odebiyi and Sofowora, 1999).

Figure 2. Moringa

Table 1. Chemical Properties and Mechanisms of Herbal Remedies in Managing Chronic Diseases

Herb	Chemical Constituents	Chronic Diseases Managed	References
Moringa	Pterygospermin	Antibacterial and fungicidal effects	Rao *et al.,* (1946)
	Epiglobulol (Quercetin and β-sitosterol)	Antioxidant (hyperglycaemia and hyperlipidaemia)	Vats, &Gupta, (2017). Harcourt, (2017)
	Niazimicin	Anticancer	Guevaraa *et al.,* (1999)
	Alkaloid Moringine	Antiasthmatic	Agrawal & Mehta (2008)
Garlic			
	Ajoene	Antiviral	(Josling, 2001)
	Allicin	Anticancer	(Galeone et al., 2006).
	S-allyl cysteine	Antioxidant	(Torok et al., 1994)
	Allicin	Antiparasitic	(Kalyesa et al., 1975)
	Ajoene	Antifungal	Ledezma, Apitz-Castro, 2006

Results and discussion

The review discusses the potential benefits of herbal remedies in managing chronic diseases. Moringa oleifera, and garlic are potent plants with numerous bioactive compounds, is a valuable plant for treating various health conditions. Its antioxidant, anti-inflammatory, antimicrobial, anticancer, cardiovascular, and antidiabetic properties make it a valuable plant in traditional and modern medicine. Garlic is a herbal remedy, has a wide range of therapeutic properties due to its bioactive compounds. These compounds exhibit antioxidant, anti-inflammatory, antimicrobial, antiemetic, and anticancer activities, making ginger an effective natural treatment for various health conditions. Fresh and powdered garlic today, is ever-growing resistant organisms, taking of garlic extract remains a powerful antimicrobial agent.

Clearly more studies are needed to refine the use and improvement of the efficacy of this important medicinal plant.

Conclusions

Herbal remedies like *Moringa oleifera* and garlic are effective in managing chronic diseases due to their rich array of bioactive compounds. *Moringa oleifera* has antioxidant, anti-inflammatory, antimicrobial, anticancer, cardiovascular, and antidiabetic properties, making it valuable in both traditional and modern medicine. Garlic on the other hand, is highly effective due to its bioactive compounds, which exhibit significant antioxidant, anti-inflammatory, antimicrobial, antiemetic, and anticancer activities, making it a versatile and powerful natural treatment for various health conditions.

References

[1] Abubakar MY, Twan SM, Adam AB, Ahmad KB, Hylalibiya A, Kaugama AA. Exploring the Chemical Properties and Mechanismsof Herbal Remedies in Moringa, and Ginger in Managing Chronic Diseases: Review. African Journal of Biochemistry and Molecular Biology Research. 2024;1(1):193-201.

[2] Agrawal S, Mehta A. Moringa oleifera: A review of medicinal uses and its effect on bronchial asthma. International Journal of Research in Ayurveda and Pharmacy. 2008;2(5):57-63.

[3] Bordia A. Effect of garlic on blood lipids in patients with coronary heart disease. The American Journal of Clinical Nutrition 1981;34(10):2100-2103.

[4] Bradley PR. British herbal compendium. British Herbal Medicine Association. 1992.

[5] Canter PH, Ernst E. Herbal supplements for depression: A systematic review of randomized controlled clinical trials. Journal of Psychiatric Research. 2004;38(2):175-184.

[6] Cohen PA, Ernst E. Herbal medicines: Balancing benefits and risks. Drug Safety. 2010;33(7):495-497.

[7] Ezeamuzie I, Ambakederemo A, Shode F, Ekwebelem S. Antiinflammatory Effects of Moringa oleifera Root Extract. International Journal of Pharmacognosy 1996;34(3):207-212.

[8] Friesen N, Fritsch R, Blattner F. Phylogeny and New Intrageneric Classification of Allium (Alliaceae) Based on Nuclear Ribosomal DNA ITS Sequences. Aliso: A Journal of Systematic and Evolutionary Botany 2006;22(1):372-395.

[9] Galeone C, Pelucchi C, Levi F, Negri E, Franceschi S, Talamini R, Giacosa A, La Vecchia C. Onion and garlic use and human cancer. The American Journal of Clinical Nutrition 2006;84(5):1027-1032.

[10] Guevara A, Vargas C, Sakurai H, Fujiwara Y, Hashimoto K, Maoka T, Kozuka M, Ito Y, Tokuda H, Nishino H. An antitumor promoter from Moringa oleifera Lam.. Mutation Research/Genetic Toxicology and Environmental Mutagenesis 1999;440(2):181-188.

[11] Hartmann T. From waste products to ecochemicals: Fifty years research of plant secondary metabolism. Phytochemistry 2007;68(22-24):2831-2846.

[12] Jaber MA, Al-Mossawi A. Susceptibility of some multiple resistant bacteria to garlic extract. African Journal of Biotechnology, 2007;6(6):771-776.

[13] Jenke-Kodama H, Müller R, Dittmann E. Evolutionary mechanisms underlying secondary metabolite diversity. Progress in Drug Research 2008;65:119-140.

[14] Josling P. Allicin: The heart of garlic. St. Petersburg: Natural Health Solutions. 2005.

[15] Kalyesa R, Shamala TR, Appaji Rao N. Allicin: Its antimicrobial properties and role in the treatment of parasitic infections. Indian Journal of Parasitology, 1975;21(3):101-108.

[16] Lanzotti V. The analysis of onion and garlic. Journal of Chromatography A 2006;1112(1-2):3-22.

[17] Lawson L. Garlic: A Review of Its Medicinal Effects and Indicated Active Compounds. ACS Symposium Series 1998:176-209.

[18] Ledezma E, Apitz-Castro R. Ajoene: A potent antifungal compound derived from garlic. Mycopathologia, 2006;137(1):1-10.

[19] Li J, Vederas J. Drug Discovery and Natural Products: End of an Era or an Endless Frontier? Science 2009;325(5937):161-165.

[20] Loya AM, Gonzalez-Stuart A, Rivera JO. Herbal product use and potential interactions in rural patients. Complementary Therapies in Clinical Practice, 2009;15(2):98-101

[21] Mahajan SG, Mehta AA, Kulkarni PP. Evaluation of the anti-inflammatory activity of n-butanol fraction of the seeds of Moringa oleifera in experimental models. Inflammopharmacology, 2009;17(1):29-35.

[22] Mughal MH, Ali G, Srivastava PS, Iqbal M. Improvement of drumstick (Moringa pterygosperma Gaertn.) – A unique source of food and medicine through tissue culture. Hamdard Medicus, 1999;42(3):37-42.

[23] Odebiyi A, Sofowora EA. Phytochemical screening of Nigerian medicinal plants. Part II. Lloydia, 1999;41(3):234-245.

[24] Onyeagba R, Ugbogu O, Okeke C, Iroakasi O. Studies on the antimicrobial effects of garlic (Allium sativum Linn), ginger (Zingiber officinale Roscoe) and lime (Citrus aurantifolia Linn). African Journal of Biotechnology 2004;3(10):552-554.

[25] Pedraza-Chaverri J, Tapia E, Medina-Campos ON, Granados-Silvestre MA, Franco M, Torres I. Protective effects of garlic powder against oxidative stress in hypertensive rats. Life Sciences, 2006;78(19):2190-2197.

[26] Qato DM, Alexander GC, Conti RM, Johnson M, Schumm P, Lindau ST. Use of Prescription and Over-the-counter Medications and Dietary Supplements Among Older Adults in the United States. JAMA 2008;300(24):2867.

[27] Rao KNV, Mishra RN. Pterygospermin, the active antibacterial and fungicidal principle of Moringa pterygosperma. Indian Journal of Medical Research, 1946;34(1):117-126.

[28] Rousseaux C, Schachter H. Regulatory issues concerning the safety, efficacy and quality of herbal remedies. Birth Defects Research Part B: Developmental and Reproductive Toxicology 2003;68(6):505-510.

[29] Timbo B, Ross M, McCarthy P, Lin C. Dietary Supplements in a National Survey: Prevalence of Use and Reports of Adverse Events. Journal of the American Dietetic Association 2006;106(12):1966-1974.

[30] Torok D, Jones R, McClure B. S-allyl cysteine: Antioxidant properties of a sulfur compound from garlic. Free Radical Biology and Medicine, 1994;16(4):123-132.

[31] Vats S, Gupta P. A review on medicinal properties of Moringa oleifera. Journal of Medicinal Plants Studies, 2017;5(3):215-222