Review

*Mentha*: Nutritional and Health Attributes to Treat Various Ailments Including Cardiovascular Diseases

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Abstract: A poor diet, resulting in malnutrition, is a critical challenge that leads to a variety of metabolic disorders, including obesity, diabetes, and cardiovascular diseases. *Mentha* species are famous as therapeutic herbs and have long served as herbal medicine. Recently, the demand for its products, such as herbal drugs, medicines, and natural herbal formulations, has increased significantly. However, the available literature lacks a thorough overview of *Mentha* phytochemicals' effects for reducing malnutritional risks against cardiovascular diseases. In this context, we aimed to review the recent advances of *Mentha* phytochemicals and future challenges for reducing malnutritional risks in cardiovascular patients. Current studies indicated that *Mentha* species phytochemicals possess unique antimicrobial, antidiabetic, cytotoxic, and antioxidant potential, which can be used as herbal medicine directly or indirectly (such as food ingredients) and are effective in controlling and curing cardiovascular diseases. The presence of aromatic and flavor compounds of *Mentha* species greatly enhance the nutritional values of the food. Further interdisciplinary investigations are pivotal to explore main volatile compounds, synergistic actions of phytochemicals, organoleptic effects, and stability of *Mentha* sp. phytochemicals.

Keywords: phytoconstituents; herbal medicine; antidiabetic; cytotoxic; organoleptic

1. Introduction

*Mentha* is a perennial, aromatic, and curative herb which has extensive global distribution. Genus *Mentha* belongs to the family Lamiaceae and comprises 25–30 known species. *Mentha* grows vigorously at low temperatures but could undergo a wide range of environmental conditions. Normally, it can reach a height of 10 to 20 cm or more. This genus emerged from Midland countries and progressively expanded worldwide by either artificial or natural genesis [1]. They are now predominantly found in Eurasia, Australia' South Africa, and North America. According to various studies, *Mentha* plants have superabundant ingredients of phenolic compounds distinctly phenols, flavonoids, terpenes, quinines, and polysaccharides [2,3]. These phytochemicals paved the way for significant utilization in the production of pharmaceuticals food and beverage industry [1,4,5]. Numerous species of *Mentha* are used as spices and for herbal teas. Generally, every part, for instance, the leaves, stems, and roots of *Mentha*, have been used in tribal and traditional medicines [6,7]. Economically, highly important species are *Mentha aquatica* L. (*M. aquatica*), *Mentha longifolia* L. (*M. longifolia*), *Mentha × piperita* L. (*M. × piperita*), *Mentha spicata* L.
Molecules 2022, 27, 6728

(\textit{M. spicata}), and \textit{Mentha arvensis} L. (\textit{M. arvensis}). All these species possess potential phytochemicals, such as iso-menthol, iso-menthone, cineol, limonine, piperitone, carvacrol, dipentene, linalool, thujone, piperitenone oxide, and phellandrene, which play an important role in pharmacy, food, flavor, ointment, and associated industries \cite{1,8–10}. The utilization of \textit{Mentha} sp. in the food industry will provide a cost-effective and biocompatible route to control diabetes and obesity \cite{11}. Diabetes is a sort of metabolic disorder accrued due to hyperglycemia with raising of glucose levels in the blood, caused by a lack of insulin or a reduction in the insulin level \cite{12}. The extensive use and economic importance of \textit{Mentha} are due to its nutritional value and ability to replace sugar \cite{6,13,14}. The application of \textit{Mentha} phytoconstituents in food items as preservatives and additives will help to reduce the risk of diabetes and cardiovascular diseases.

The frequency of diabetes and cardiovascular diseases are increasing across the world due to diets consisting of high-fat foods and less exercise \cite{15}. The high amount of triglycerides, flavors, and synthetic preservatives in food reduces food nutritional values and leads to diabetes, obesity, and other chronic diseases \cite{16,17}. It has been reported that 30–80\% of people are at risk of diabetes and obesity due to dietary habits and lack of physical activities \cite{18}. Various approaches, such as insulin pills and the utilization of sugar-free food, are adopted to control diabetes and obesity \cite{19,20}. These approaches adversely affect patients’ nutrition status and food enjoyment and severely decline the patient’s quality of normal life. Consequently, it intensifies the utilization of natural products, such as phytoextracts and essential oils, to boost the nutritional values of food and reduce the risk of diabetes and obesity \cite{21,22}. In the last two decades, continuous efforts have been made to control metabolic disorders via natural routes, such as ingestion of dietary products. Several chemical drugs are used in food processing, but research has revealed adverse side effects, encouraging the use of active natural compounds \cite{23–26}. Plant-derived extracts, in pure form or adulterated form, provide endless opportunities as healthy and biocompatible food products \cite{27,28}. Currently, epidemiological researchers suggested many medicinal and aromatic plants for their nutritional and preservative abilities \cite{29,30}. The aqueous extracts of medicinal plants can be used in dietary products to provide plant-based food nutrition to human beings \cite{31,32}. Aqueous extracts are usually obtained from the aqueous phase through a physical process that does not influence their composition \cite{33}. However, prior to the use of these extracts at mass scale, thorough investigations, such as cytotoxicity, antioxidant, antidiabetic activities, and lipid oxidation potential, are necessary to ensure their efficacy and safety through proof-of-concept research for potential health claims \cite{34,35}. \textit{Mentha} is a medicinal and economically important plant that is regularly used for the treatment of vomiting and nausea, its antiallergic effects, its antifungal and antibacterial effects, its antidiabetic effects, the treatment of obesity, the treatment of gastrointestinal diseases, its anticarcinogenic effects, and pain relief \cite{1,36,37}.

We compiled the main characteristics of genus \textit{Mentha} extracts which should be considered as food additives and preservatives to help in diabetes and obesity control due to synthetic food additives and preservatives. In addition, we highlighted the challenges, techniques, and opportunities to improve flavor and textural properties to maintain the needs of taste and aroma of the individual. We concluded that the genus \textit{Mentha} species possess potential phytochemicals and flavoring agents, which can be used in daily diet products to improve food quality cost-effectively and sustainably. Furthermore, an investigation of other medicinal and aromatic plants should be considered, specifically their potential as food additives and dietary supplements and ability to control lethal disorders such as diabetes and obesity via daily dietary products.

2. Genus \textit{Mentha}: Morphology and Systematics

2.1. Morphology

\textit{Mentha} L. is a perennial herb, spread through long slender rhizomes. The rhizomes spread rapidly, and consequently, various populations of this species comprise a progression of clones. The rhizomes sections spread especially along wetlands and riverbanks,
resulting in vegetative multiplication and dispersal [38]. The plant has broad ovate leaves rounded or sometimes lanceolate at the base with pubescents and thick-veined leaves (Figure 1). The flowers are arranged in a large whorl with a triangular teeth calyx, and anthers exerting from the corolla. The flowers are mostly protandrous, and usually, self-pollination occurs [1,38].

![Figure 1](image_url)

**Figure 1.** Morphology of *Mentha arvensis* L. (A) Shoot structure; (B) Flower; (C) Leaves; (D) Rhizome; (E) Seed.

2.2. Systematics

*Mentha* was depicted by Carl Linnaeus from a plant specimen collected from Sweden, who named it *M. canadensis* L. Bentham pursued Linnaeus in keeping *M. canadensis* L. as a subglabrous assortment (var. glubrata Benth.) and a villose one (var. villosaBenth.) [39]. However, recent information based on physiological, anatomical, and molecular attributes have demonstrated that *Mentha* can be grouped into 42 species, hundreds of subspecies, varieties, and cultivars, and 15 hybrids [40]. The scientific classification of *Mentha* is exceptionally unpredictable and there is no consensus. *Mentha* is generally classified into five sections, i.e., *Eriodontes, Mentha, Preslia, Audibertia,* and *Pulegium* [41]. Recently, Zahra et al. [42] reported that phylogenetically, *M. arvensis, M. spicata,* and *M. × piperita* show 98% identity when using *matK* sequencing.

3. Essential Oil and the Chemical Composition of the Studied Species of *Mentha*

In a true sense, essential oils are not really oils; they are in fact volatile chemicals, produced by living organisms, and are mostly extracted by distillation [43,44]. *Mentha* species contain essential oils with different chemical compositions; for example, in *M. pulegium* L., natural compounds have been reported to account for 96.9% of the chemical profile, including oxygenated monoterpenes, monoterpenes hydrocarbons, oxygenated sesquiterpenes, and non-terpene hydrocarbons. The essential oils separated from leaves of *M. pulegium* contain carvone (56.1%), limonene (15.1%), E-caryophyllene (3.6%), oleic acid (3.2%), and 1,8-cineole (2.4%) [45]. Variations in the essential oil composition and its chemical composition were also observed in some species of *Mentha*. Major compounds in *M. × piperita* were observed, including 1-menthone, isomenthone, menthol, menthyl acetate, caryophyllene, and germacrene-D. The study reported a sufficient amount of oil composition, varying
from 0.63% germacrene-D to 51% menthol. This indicates that Mentha species contain menthol in maximum quantity [46]. Therefore, the plant has the potential to be used as a medicinal ingredient in the food industry to reduce the risk of cardiovascular diseases. The same study reported 12 essential oil compounds in M. longifolia with different concentrations of oil compounds from April to July. Another study reported pulegone (86.64%) as a major constituent from M. pulegium, possessing antioxidant, quorum sensing, antiinflammatory and antimicrobial activities, indicating that the plant has the potential to reduce the risk of cardiovascular diseases [46]. The chemical composition of Peppermint oil was reported to include oxygen-containing substances, such as menthone (20%), menthol (45–50%), and sesquiterpenes about 3% [47]. It has been reported that M. spicata contains major essential oil compounds, including oxygenated monoterpenes (approximately 67%), sesquiterpenes hydrocarbons (7.5%), monoterpen hydrocarbons (approximately 20%), oxygenated sesquiterpenes (1.2%), and other compounds (1.7%) [47]. Piperitrone (81.18%) and piperitenone oxide (94.8%) were also reported from M. spicata [47]. Detailed information of the essential oils and its composition is provided in Table 1 of some common Mentha species (Table 1). The presence of essential oils indicate that Mentha exhibit high antioxidant, antiinflammatory, and antimicrobial potential, which would help to control the risk of cardiovascular diseases by using Mentha species compounds in food products [48,49].

Table 1. Essential oil composition and biological activities of some Mentha species.

| Species Name | Essential Oil | Chemical Composition | Composition (%) | Structure | Source | Activities | Reference |
|--------------|---------------|----------------------|-----------------|----------|--------|-----------|----------|
| 1-menthone   | 7.32–18.32    | Aerial parts         | Antinflammatory, antibacterial, neuroprotective, antitaxi, and antioxidant properties | [50] |
| Isomenthone  | 0–6.75        | Aerial parts         | Antiviral, sclodial, immunomodulatory, antitumor, and antioxidant properties | [51] |
| Menthol      | 18.03–58.42   | Aerial parts         | Antitumor, neuroprotective, antitaxi, and antioxidant properties | [51] |
| Menthol acetate | 0.72–6.89   | Aerial parts         | Antimicrobial and flavoring agent | [50] |
| Caryophyllene | 0.03–1.54     | Aerial parts         | Anticancer and analgesic properties | [52] |
| Germacrene-D | 0.63–1.89     | Aerial parts         | Antioxidant and immunomodulatory effects | [53] |
Table 1. Cont.

| Species Name          | Essential Oil | Chemical Composition | Composition (%) | Structure | Source   | Activities                          | Reference |
|-----------------------|---------------|----------------------|----------------|----------|----------|-------------------------------------|-----------|
| Endo-Borneol          | Aerial parts  | 1.12-6.02            | Aerial parts   |          |          | Cytotoxicity and anticancer properties | [54]      |
| α-Terpineol           | Aerial parts  | 0-0.28               | Aerial parts   |          |          | Antioxidant and anti-COX-2 activity  | [54]      |
| Isopiperitenone       | Aerial parts  | 0.07-0.36            | Aerial parts   |          |          | Antimicrobial properties            | [55]      |
| **Monoterpenoids**    |               |                      |                |          |          |                                     |           |
| Carvacrol             | Aerial parts  | 0-1.06               | Aerial parts   |          |          | Antimicrobial and Cytotoxic properties | [54]      |
| *M. longifolia* L.    |               |                      |                |          |          |                                     |           |
| Cinerol               | Aerial parts  | 0.08-0.25            | Aerial parts   |          |          | Antimicrobial properties             | [55]      |
| Cis-α-Farnesene       | Aerial parts  | 1.03-1.97            | Aerial parts   |          |          | Antimicrobial properties             | [55]      |
| Caryophyllene         | Aerial parts  | 2.72-7.03            | Aerial parts   |          |          | Anticancer and analgesic properties  | [56]      |
| **Sesquiterpene**     |               |                      |                |          |          |                                     |           |
| Germacrene D          | Aerial parts  | 0.98-3.22            | Aerial parts   |          |          | Antioxidant and immunomodulatory effects | [56]      |
| Caryophyllene oxide   | Aerial parts  | 0.12-0.79            | Aerial parts   |          |          | Anticancer properties               | [56]      |
| Species Name | Essential Oil | Chemical Composition | Composition (%) | Structure | Source | Activities | Reference |
|--------------|---------------|----------------------|-----------------|----------|--------|------------|-----------|
| Carvone      | Aerial parts  | 56.1                 | Aerial parts    | Antimicrobial, antioxidant, diuretic, analgesic, and antiseptic properties | [57] |
| Limonene     | Aerial parts  | 15.1                 | Aerial parts    | Antimicrobial, antioxidant, diuretic, analgesic, and antiseptic properties | [57] |
| Oxygenated Monoterpenes |  |  |  |  |  |  |  |
| *M. pulegion* L. | (E)-caryophyllene | 3.6                 | Aerial parts    | Anticancer and analgesic properties | [57] |
| Oleic acid   | Aerial parts  | 3.2                  | Aerial parts    | Antioxidant and antimicrobial properties | [58] |
| 1,8-cineole  | Aerial parts  | 2.4                  | Aerial parts    | Antimicrobial, antioxidant, diuretic, analgesic, and antiseptic properties | [57] |
| Monoterpane  | Pulegone      | 54.3                 | Aerial parts    | Antioxidant and antimicrobial properties | [58] |
| Menthol      | Leaf          | 30.35                | Leaf            | Antiseptic, antibacterial properties, antioxidant, antimicrobial, anticancer, and antiinflammatory activities | [59] |
| Menthone     | Leaf          | 20.50                | Leaf            | Antiseptic, antibacterial properties, antioxidant, antimicrobial, anticancer, and antiinflammatory activities | [59] |
| *M. arvensis* L. |  |  |  |  |  |  |  |
| β-pinenene   | Leaf          | 7.28                 | Leaf            | Antimicrobial properties | [53] |
| α-terpineol  | Leaf          | 7.08                 | Leaf            | Antiproliferative activity | [60] |
### Table 1. Cont.

| Species Name   | Essential Oil         | Chemical Composition | Composition (%) | Structure | Source | Activities                                      | Reference |
|----------------|-----------------------|----------------------|-----------------|-----------|--------|------------------------------------------------|----------|
| α-pinene       |                       |                      | 6.35            | Leaf      |         | Antiproliferative activity                      | [60]     |
| Menthofuran    |                       |                      | 5.85            | Leaf      |         | Antioxidant, antimicrobial, cytotoxic, analgesic | [61]     |
| *M. pulegium* L. | Iso-menthone          |                      | 4.53            | Leaf      |         | Antiviral, scolicidal, immunomodulatory, antitumor, and antioxidant properties | [51]     |
| Neo-menthol    |                       |                      | 4.36            | Leaf      |         | Antioxidant properties and antimicrobial activity | [51]     |
| Menthy acetate |                       |                      | 3.26            | Leaf      |         | Antimicrobial properties and flavoring agent     | [50]     |
| Terpenoids     | Carvone               |                      | 58.22           | Leaf      |         | Antimicrobial, antioxidant, diuretic, analgesic, and antiseptic properties | [57]     |
| *M. spicata* L. | Oxygenated Monoterpenes | Limonene             | 19.54           | Leaf      |         | Antimicrobial, antioxidant, diuretic, analgesic, and antiseptic properties | [57]     |
| Terpenoids     | Carvone               |                      | 64.31           | Leaf      |         | Antimicrobial, antioxidant, diuretic, analgesic, and antiseptic properties | [57]     |
| Myrcenol      |                       |                      | 5.88            | Leaf      |         | Antioxidants, antifungal, and flavoring agents  | [48]     |
| *M. suaveolens* L. | Monoterpenoid       | Terpineol            | 5.61            | Leaf      |         | Antimutagenic potency                           | [62]     |
| Pulegone       |                       |                      | 3.81            | Whole plant |       | Antibacterial and antifungal properties         | [63]     |
### Table 1. Cont.

| Species Name | Essential Oil                  | Chemical Composition | Composition (%) | Structure | Source | Activities                                           | Reference |
|--------------|--------------------------------|----------------------|-----------------|----------|--------|-----------------------------------------------------|-----------|
| *M. suaveolens* L. | Oxygenated Monoterpenes        | Limonene             | 1.24            | Leaf     |         | Antidiabetic, antioxidant, and antibacterial properties | [64]      |
| *M. aquatica* L. | Monoterpe | Pulegone              | 39.36           | Leaves   |         | Antioxidant and antibacterial properties             | [65]      |
| *M. viridis* L. | Oxygenated Monoterpenes        | 1.8-Cineole          | 11.82           | Leaves   |         | Antioxidant, antidiabetic, dermatoprotective, antidermatophyte, and antibacterial properties | [3]       |
|              |                                 | Terpinen-4-ol        | 08.72           | Leaves   |         | Antioxidant, antidiabetic, dermatoprotective, antidermatophyte, and antibacterial properties | [3]       |

Note: The structures were obtained from [https://pubchem.ncbi.nlm.nih.gov/](https://pubchem.ncbi.nlm.nih.gov/) (Accessed on 15 August 2022).

The essential oils of *Mentha* are using in aromatherapy. Many food and beverages industries are using *Mentha* as food additive and flavoring agent. Due to aromatic compounds and secondary metabolites, fresh or dried leaves of *Mentha* are used in chewing tobacco, confectionaries, analgesic balm, perfumes, candies, and the tobacco industry [66]. Some researchers found potential antidiabetic effects of *Mentha* [67,68]. The use of *Mentha* in food industry will open new avenues for epidemiologists to control diabetes and cardiovascular diseases.

### 4. Health Benefits of *Mentha*

*Mentha* is a much desired and demanded herb due to its medicinal and therapeutic use. The use of *Mentha* species has been reported in China since the rule of Ming [69]. *Mentha* became an official item of Materia medical in London Pharmacopeia [70]. In the 18th century, it was commonly used as a medicinal herb [71,72]. Various health benefits of *Mentha* species have been reported [50,64]. *Mentha* species have shown analgesic activity during in vivo experiments on mice [61]. *Mentha* species showed antibacterial and antifungal activities against different bacterial and fungal strains [73]. *Mentha* species have traditionally used against various diseases and have the potential to be used for cardiovascular diseases [68]. Several studies have indicated that *Mentha* species contain free radical species and nonradical species, e.g., hydrogen peroxide, which is harmful for molecules of...
microbes, such as proteins, lipids, nucleic acids, and carbohydrates. Extracts and essential oils of *Mentha* species have shown several health benefits (Figure 2) [74,75].



![Figure 2](image-url)  
Figure 2. Traditional therapeutic uses of some species of *Mentha* against a variety of ailments.

Some studies found that mint enable lungs surfactants to filter the air and perform better pulmonary action. Methanol from the mint stimulates respiratory muscle strength and increases the end tidal oxygen rate in the human body [76,77]. *Mentha* plants contain constituents with cytotoxic properties, and could be used in developing anticancer agents; for example, *M. longifolia*, *M. arvensis*, and *M. × piperita* were found to possess cytotoxic activity against breast cancer in humans [78,79] and human laryngeal epidermoid carcinoma [80]. The direct application of *Mentha* on the skin shows excellent analgesic activity, producing a cooling effect on the skin. Mint oil stimulates blood receptors on the skin and expands blood vessels, resulting in a cold sensation and relaxation [69]. *Mentha* sp. possesses various secondary metabolites which are useful against different disorders (Table 1). These can be used in the food industry to reduce malnutritional risks in diabetic and cardiovascular patients.

5. Biological Activities of *Mentha*

A detailed survey of the biological activities of *Mentha* is a prerequisite to explore its potential for the treatment of diseases.

5.1. Antimicrobial Activity of *Mentha*

*Mentha* exhibits a strong antimicrobial potential, which is why it is considered as one of the most industrially, medicinally, and economically important plant genera. *Mentha* has shown a significant antibacterial resistance against the epidemic bacterium Chlamydia. Additionally, *Mentha* helps fight pneumoniae associated with respiratory disease [81]. A study conducted by Hussain et al. [82] reported a strong antibacterial potential of various *Mentha* species. Another study found *Mentha* extracts to have an effective inhibition activity against various strains of bacteria, including *Pseudomonas aeruginosa*, *Shigella flexineri*, *Klebsella pneumoniae*, and *Staphylococcus aureus* (do Nascimento, Rodrigues, Campos, & da Costa, 2009). Mimica-Dukić et al. [83] isolated secondary metabolites from *Mentha* and tested them against *Escherichia coli* and *Shigella sonnei*; they showed significant antibacterial activity. Furthermore, using *Candida albicans* and *Trichophyton tonsurans*, studies have shown that *Mentha* extracts have strong antifungal properties. Another study by López et al. [84] reported the potential of *Mentha* extracts against *Rhizopus tolinifera*. Apart from this, various species of *Mentha* have been shown to possess potential antimicrobial activity.
against resistant pathogens (Table 2), indicating that metabolites of Mentha species are highly active against pathogenic organisms. The antimicrobial mechanism of Mentha extracts involves the production of antioxidant agents which disrupt the microbial membrane, and subsequently, damage the cellular organelles. The strong antimicrobial potential of Mentha extracts proved it as a highly essential preservative in the food industry. Further studies are required to find which kinds of extracts and which elements are important for the production of health-oriented food.

Table 2. Antimicrobial activity of some Mentha species.

| Species Name | Sample Used | Microorganisms | Activities | References |
|--------------|-------------|----------------|------------|------------|
| M. aquatica L. | Essential oil | Staphylococcus aureus, Escherichia coli, Bacillus sp., and Candida sp. | Showed activity against S. aureus, E. coli, and Bacillus sp., but no result against Candida sp. | [65] |
| M. arvensis L. | Ethanol extract | Acinetobacter baumannii | Results showed 34.5 mm inhibition use at 100 µg/mL | [85] |
| M. viride L. | Essential oil, pulegone, isomenthone and menthone was used | S. aureus, S. caprae, Enterococcus faecalis, E. faecium, E. hirae, E. coli, Salmonella braenderup, S. typhimurium, S. choleraesuis, Klebsiella pneumonia, Acinetobacter baumannii, Pseudomonas aeruginosa, and Listeria monocytogenes strains | Showed variation in activity against Gram positive and Gram-negative strains, but overall inhibition activity was significant as compared to control | [86] |
| M. arvensis var. piperascens Malavi. ex Holmes | Essential oil | Salmonella enteritidis, E. coli, Clostridium Perfringens, Campylobacter jejuni, and Salmonella species | Significant antibacterial activity against all strains specifically Salmonella species and C. jejuni (inhibition zones more than 40 mm) | [87] |
| M. × piperita L. | Essential oil | Aeromonas spp. | High antibacterial activity was shown by the essential oils, ranging from 1.250 to 16.67 µL/mL | [88] |
| M. × pulegium L. | Essential oil, pulegone, carvone Menthol, and piperitenone oxide | S. aureus, E. coli, B. subtillis, Aspergillus flavus, Alternaria solani, Aspergillus niger, Alternaria alternata, Rhizopus solani, Fusarium solani, and Rhizopus sp. | Among these, menthol showed high antimicrobial activity, with the inhibition zone ranging from 19–33 mm | [82] |
| M. × rotundifolia | Essential oils | E. coli, K. pneumonia, Salmonella typhimurium, Staphylococcus epidermidis, Streptococcus mutans, P. aeroginosa, and S. aureus | Average activity was recorded from between 10–15 mm inhibition zone against different strains, but essential oil showed an inhibition zone of more than 15 mm against S. epidermidis | [89] |
| M. × × villosa Huds., M. × × × Huds., and M. aquatica were tested. The overall results showed extraordinary antioxidant activity, but M. aquatica showed the highest antioxidant potential, with an IC50 value of 7.50 µg/mL. | Methanol extract | E. coli | Potential activity against E. coli | [90] |
| M. × × × Huds., and M. aquatica were tested. The overall results showed extraordinary antioxidant activity, but M. aquatica showed the highest antioxidant potential, with an IC50 value of 7.50 µg/mL. | Ethanol extract | S. aureus | Significant activity was observed as compared to control | [91] |
| M. × × × Huds., and M. aquatica were tested. The overall results showed extraordinary antioxidant activity, but M. aquatica showed the highest antioxidant potential, with an IC50 value of 7.50 µg/mL. | Ethanol extract | Aspergillus fumigatus, C. albicans, Fusarium spp., and Rhodotorula sp. | Revealed sufficient inhibition against molds and yeasts, ranging from 40 mm to 70 mm | [92] |

5.2. Antioxidant Activity of Mentha

The antioxidant activity of the plants and its extracts is of great importance in fundamental science and applied science. Various species of Mentha have shown significant antioxidant activity both in vitro and in vivo. One study reported on the antioxidant activity of M. longifolia oil, with an IC50 value of 0.659 mL/mL of solution [93]. The antioxidant activity of the five Mentha species, including M. longifolia, M. × piperita, M. spicata, M. rotundifolia, and M. pulegium, was tested by diphenylpicrylhydrazyl (DPPH) and 2,2’-azinobis (3 ethylbenzothiazoline 6 sulfonic acid) radical (ABTS+). This study revealed that M. × piperita exhibits the most strongest DPPH scavenging activity [94]. The methanolic extracts of six Mentha species, which included M. villosa Huds., M. arvensis, M. pulegium, M. × piperita, M. rotundifolia (L) Huds., and M. aquatica, were tested. The overall results showed extraordinary antioxidant activity, but M. aquatica showed the highest antioxidant potential, with an IC50 value of 7.50 µg/mL [95]. Ethanolic extract of M. pulegium improved the catalase, glutathione, and peroxidase level after induced toxicity of CCl4 intraperitoneal injection in rats [96]. Another study reported on the antioxidant potential of M. × piperita by examining various extracts, such as chloroform, ethanol, and aqueous and essential oils,
showing 73 to 91% antioxidant capacity at 734 nm and 70.3 to 92.6% free radical scavenging activity [66]. These findings suggest that species of Mentha exhibit significant antioxidant potential, and therefore, they are ideal sources for the medicine and food industry to fight cardiovascular diseases.

5.3. Antidiabetic Activity of Mentha

Diabetes is one of the main factors of cardiovascular diseases. Therefore, potential resources of a natural origin are required to help in the reduction of diabetic and cardiovascular diseases. Mentha oils and extracts exhibit a strong antidiabetic potential, as reported by several researchers. The essential oil of M. viridis was assessed by the inhibition of α-glucosidase and α-amylase. The results showed that essential oils of M. viridis exhibit IC$_{50}$ = 101.72 ± 1.86 µg/mL inhibitory potential against α-amylase and IC$_{50}$ = 86.93 ± 2.43 µg/mL against α-glucosidase [3]. Antidiabetic activity of M. arvensis L. was determined by in vitro and in vivo experiments in rats. The methanolic extract of M. arvensis revealed more than 50% α-amylase and more than 68% α-glucosidase inhibition. Additionally, in rats, significant postprandial hyperglycemia inhibition was observed [97]. Essential oils of M. suaveolens were found to be very active against α-glucosidase and α-amylase, indicating an inhibitory potential of IC$_{50}$ 141.16 ± 0.2 and 94.30 ± 0.06 µg/mL, respectively [64]. Bayani et al. [98] reported on the antidiabetic effect of aqueous extract prepared from M. spicata leaves. The LD$_{50}$ of the extract was more than 1500 mg/kg. The application of the extract showed a significant reduction in cholesterol, low density lipoprotein cholesterol, and triglyceride in diabetic rats as compared to commercially available antidiabetic drug (glibenclamide), indicating that the plant extract possesses a high antidiabetic activity. Thus, it is clear that the use Mentha species directly or indirectly can help to reduce the risk of diabetes, and ultimately, reduce the risk of cardiovascular diseases.

Based on the literature review, further research is required to screen Mentha sp. against specific diseases. Additionally, the search for medicinally important compounds in Mentha extracts is also necessary if Mentha is to be used as a source of producing and preserving health-oriented food to control diabetes and cardiovascular diseases.

6. Cardioprotective Potential of Mentha by Its Antiinflammatory Effect

The Mentha species that exhibit effective antioxidant compounds (Polyphenolic) play an important role in reducing the risk of cardiovascular diseases by the suppression of inflammation. One of the species of Mentha genus, M. arvensis, has shown a cardioprotective potential via inhibition of inflammation [99]. Another species, M. × piperita, revealed antiinflammatory activity against chronic and acute inflammation [100]. The mechanism involves suppression of tumor necrosis factor-alpha (TNF-α), fibroblast growth factor-2 (FGF-2), and vascular endothelial growth factor (VEGF) [101]. As cardiovascular patients have high inflammation, the inflammatory activity of M. × piperita may be responsible for reducing risks of cardiovascular diseases. The cardiovascular effects of M. × piperita were also reported by Badal et al. [102]. Another species of Mentha genus, M. pulegium, plays role in the reduction of IL-6, TNF-α, and MCP-1 secretion in murine RAW 264.7 macrophages [103,104]. Moreover, other biological properties, such as the antioxidant, cytotoxic, antidiabetic, and antimicrobial potential of Mentha, also improve the cardioprotective potential of Mentha. Adding Mentha compounds and extracts in food products can facilitate the design of functional foods possessing beneficial health effects.

**Mechanism of Active Compounds with Cardioprotective Effects**

Mentha plants possess a variety of bioactive compounds with cardioprotective and other medicinal properties, among them carvacrol, rosmarinic acid, quercetin, baicalein, and apigenin. These compounds have cardioprotective effects by regulating numerous molecules, such as growth factors, enzymes, kinases, inflammatory molecules, transcriptional factors, apoptosis, etc. (Figure 3). Menthol from M. arvensis exhibits activity against ischemic heart disease [105]. Phenolic compound quercetin extracted from the leaves of
M. pulegium was reported to have cardioprotective effects [106]. Similarly, Pulegone and menthofuran isolated from M. longifolia and M. aquatica possess antiinflammatory effects, which eventually help in reducing the risk of different diseases in the body [107]. Studies also revealed various functions of Mentha species exhibiting cardioprotective effects, decreased toxicity, antiarrhythmic effects, heart rate normalization, and antihypersensitive effects (Table 3) [108–111].

Figure 3. Mode of action of phytochemicals in cardioprotection. This figure was created with https://app.diagrams.net/ (accessed on 15 August 2022).

Carvacrol is a phytochemical, also reported from Mentha longifolia, which exhibits a cardioprotective effect through various mechanisms. It suppresses the myocardial ischemic damage in rats of acute myocardial infarction. The compound reduces the infarct size and myocardial enzymes, such as lactate dehydrogenase, creatine kinase, and cardiac troponin T [105]. Carvacrol also increases activities of antioxidant enzymes, including glutathione peroxidase, glutathione, and superoxide dismutase, and reduces malondialdehydes, which facilitates heart protection from lethal disorders [116]. Baicalein promotes the downregulation of the phosphorylation of MAPK and focal adhesion kinase activities regulated by thrombin in endothelial cells, leading to cardioprotection [116]. Quercetin also showed in vitro and in vivo cardioprotection activities. It inhibits MAPK and focal adhesion kinase activities regulated by thrombin in endothelial cells, leading to cardioprotection [116]. Baicalein promotes the downregulation of the phosphorylation of Ca2+/calmodulin-dependent protein kinase II (CaMKII) with the expression of Na+/Ca2+ exchangers (NCX1), which leads to protection from cardiovascular disorders [117]. Mentha species possess numerous bioactive compounds that facilitate cardioprotection from lethal disorders (Table 2). The isolation and applications of these bioactive compounds can...
facilitate the food industry in the production of functional foods that can protect from cardiovascular disorders.

Table 3. Cardioprotecting effects of active constituents of *Mentha* species.

| Species Name               | Compounds                     | Cardioprotecting Effect                  | References   |
|----------------------------|-------------------------------|-----------------------------------------|--------------|
| *Mentha arvensis* L.       | Phenolic compounds, Menthol   | Ischemic heart disease                  | [105]        |
| *Mentha x piperita* L.     | Aqueous extract               | Antiinflammatory                        | [100]        |
| *Mentha pulegium* L.       | Phenolic compounds, Quercitin | Cardioprotective effects                | [106]        |
| *Mentha aquatica* L.       | Menthofuran                   | Antiinflammatory                        | [107]        |
|                           | D-carvone                     | Decrease toxicity                       | [118]        |
| *Mentha canadensis* L.     | Menthol                       | Reduce lipid peroxidation               | [119]        |
|                           | Menthone                      | Reversible cardiac depression           | [119]        |
| *Mentha cardiaca* J. Gerard ex Baker | Carvone                 | Decrease toxicity                       | [118]        |
| *Mentha cervina* L.        | Pulegone                      | Antiinflammatory effect                 | [108]        |
| *Mentha diemenica* Spreng. | Pulegone                      | Antiinflammatory                        | [108]        |
| *Mentha longifolia* L.     | Menthone                      | Reverse cardiac depression              | [119]        |
|                           | Pulegone                      | Antiinflammatory                        | [108]        |
|                           | Piperitone                    | Induce changes in mean aortic pressure  | [110]        |
|                           |                               | and heart rate                          |              |
| *Mentha pulegium* L.       | Pulegone                      | Suppress the NLRP3 inflammasome         | [120]        |
|                           | Piperitone                    | Normalize heart rate                    | [110]        |
|                           | Carvone                       | Antioxidant                             | [121]        |
| *Mentha spicata* L.        | Cis-carveol                   | Antihypersensitive, Antioxidant         | [122]        |
|                           | Piperitenone                  | Antiinflammatory                        | [111]        |
|                           | Limonene                      | Antiarrhythmic properties               | [109]        |

7. Utility of *Mentha* in Food Industry

*Mentha* is a widely cultivated crop, and several species are used in industry. Currently, phytochemicals of *Mentha* plants are used to improve the flavor in food beverages. Mint has different flavors and is the third most demanded flavor on the world food market [123].

*Mentha* oils are commonly connected with flavors used in chewing gums and dental pastes; however, they have many other flavors, which are used in the food industry, ranging from candies, dairy products, sauces, and alcoholic and nonalcoholic beverages [124]. *Mentha* plants are also used to preserve, improve the quality, and extend the life of food.

The peppermint flavor of *Mentha* is basically menthol. Menthol causes a cooling effect in the oral cavity and activates cold-sensitive receptors [125]. This molecule also has a sensation of bitterness, so it stimulates both taste and aroma receptors. It releases its minty flavor to food products and other daily life essentials, e.g., tooth paste and mouth fresheners, causing a physiological cooling effect [126]. The essential oils of *Mentha* are used in aromatherapy. Many food and beverages industries use fermented *Mentha* as a flavoring agent. Due to aromatic compounds and secondary metabolites, fresh or dried leaves of *Mentha* are used in the chewing tobacco, confectionaries, analgesic balm, perfumes, candies,
and tobacco industries [127]. Large-scale cultivation, isolation, and characterizations can facilitate the food industry to utilize Mentha extracts for different purposes (Figure 4). However, there are still significant knowledge gaps, especially regarding the differing potential of the various composition extracts of different plants; these gaps should be filled to ensure cost effective, compatible ways for the production of foods that include Mentha. It is important to compare extracts of Mentha with other aromatic and medicinal plant extracts, in order to determine which plant extracts are significant for the herbal medicine industry and nutraceutical industries.

![Figure 4](image-url)

**Figure 4.** Large-scale cultivation, isolation, and characterizations of Mentha phytoconstituents to reduce the malnutritional risks of cardiovascular diseases. This figure was created with Microsoft PowerPoint (accessed on 15 August 2022).

8. Current Challenges and Implementations

Many mint derivatives and their active compounds have been approved by the European commission and the United States Food and Drug Administration for their proposed use as flavoring agents in food products. Plant extracts have numerous intrinsic and extrinsic challenges, which has hindered their applications in the food industry [128,129]. The exiguity of raw materials, chemotypic diversity, inconsistent efficacy, unexplored molecular mechanism of action, adverse effects on food taste, low water solubility, high cost, and threat to biodiversity loss are some leading challenges to Mentha use in the food industry [130]. Moreover, plant collection and identification are difficult due to the close resemblance of different Mentha species, in addition to the deficiency in the quality assessment of raw materials. Moreover, there is a scarcity in the quantity of extracts from the raw materials of Mentha for industrial applications. After mixing with a food matrix, i.e., fat, protein, carbohydrates, salt contents, pH, moisture, etc., together with extrinsic factors (temperature, gaseous composition, and microbial diversity), the antimicrobial potential of Mentha extracts is reduced [131]. The excessive aroma present in plant extracts may negatively influence the organoleptic properties (flavor, color, taste, and texture) of food items, leading to a reduction in consumer demand [132]. Due to the abovementioned challenges, the interest in plant-based preservatives has been gradually declining in the past decade.

9. Conclusions and Future Perspective

Mentha species and their compounds have long been used in folk medicines and as flavoring agents. The plants and their extracts are used against digestive, nausea, fevers, headache, tumors, and skin diseases. Numerous essential oils and phytochemicals
are reported from Mentha species, which possess different biological activities. These essential oils and their antioxidant, antidiabetic, and antimicrobial potential demonstrate that Mentha species could be an extraordinary source for the prevention of cardiovascular diseases. In order to utilize plant extracts to their complete application, there are several avenues that must be explored further. First, future research should focus on the modes of action of the natural compounds present in the extracts. Second, the metabolic pathways which help keep the food taste and aroma alive should be identified. These are important research questions to explore the core substances necessary for the control of diabetes and cardiovascular diseases via Mentha species compounds in food or in medicine. Advances in the research of medicinal plants will help in determining the quantity and quality of plant extracts required as food additives and preservatives against a specific disease. A final future potential for Mentha extracts does not lie in their potential medicinal values directly, but in their possible use as synergist compounds and processing mechanisms. The applications of natural antidiabetic and cardioprotective agents are likely to grow steadily in the future because of consumer demand for food containing naturally derived preservatives with good taste and aroma, such as Mentha.

Author Contributions: Conceptualization, methodology, data collection, S.S., F.U., M.Y., S.A. and A.A.; data analysis, writing—original draft, W.Z. and W.Z.; writing—review and editing, A.A., S.A., W.Z. and S.S.; supervision and monitoring W.Z. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: We are thankful to department of Biotechnology Mohi-ud-Din Islamia University, Nerian Sharif, AJ&K, Pakistan for providing basic facilities.

Conflicts of Interest: The authors declare no conflict of interest.

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