

Phytotherapy for *Bacillus cereus*: A review of the most important medicinal plants of Iran effective on *B. cereus*

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ASBSTRACT

Infectious diseases are spreading day-to-day with excessive health care costs. *Bacillus cereus* is a known causative agent of foodborne diseases. Because of emergence of antibiotic resistance, it is necessary to develop nature- and plant-based antibiotics. Many of the medicinal plants are highly able to fight bacterial and fungal pathogens in humans. Scientists are interested in using these plants to treat infections because these plants cause much fewer side effects than chemical drugs. This review article reported the native medicinal plants effective on *B. cereus*. The findings indicate that *Eucalyptus camaldulensis* Dehnh, *Zataria multiflora*, *Mentha pulegium*, *Artemisia persica*, *Cuminum cyminum*, *Cordia myxa* L., *Scrophularia striata*, *Mentha longifolia*, *Rosmarinus officinalis*, and *Lavandula sp.* are effective on *B. cereus*. Because these plants have antimicrobial effects according to traditional medicine, their anti-*B. cereus* effects have been confirmed in scientific investigations, and their compounds have already been identified in phytochemical investigations, their effective compounds can be used to produce nature-based, anti-*B. cereus* antibiotics.

KEY WORDS: *Bacillus cereus*, Medicinal plants, Herb, Antibacterial, Iran.

1. INTRODUCTION

Infectious diseases are particularly important. These diseases are spreading day- to-day with excessive health care costs (Khoramrooz, 2012; Nakhjavani, 2013; Kalantari, 2007). *Bacillus cereus* exists in soil and plants and has been known as a causative agent of foodborne diseases for over 40 years. *B. cereus* can develop two types of poisoning, one with vomiting and another with diarrhea, due to two different anthrotoxins produced by this bacterium (Kramer, 1989). Usually, *B. cereus* can grow at 10-15°C and can grow appropriately at 28-35°C. However, a variety of cool *B. cereus* that are able to grow at temperatures below 5°C have been discovered, as well (Dufrenne, 1994; Rusul, 1995). *B. cereus* can cause two symptoms, vomiting as with *Staphylococcus aureus* and diarrhea as with *Clostridium perfringens* (Kramer, 1989). To fight these bacteria, many antibiotics have been developed. These antibiotics may lead to antibiotic resistance and certain side effects. In this regard, further scientific investigations are required to develop nature- and plant-based antibiotics because antibiotic resistance is increasing.

Recently, phytotherapy has been increasingly used to prevention and treatment of diseases, especially infectious. As well, scientists are interested in using medicinal plants to treat infections because these plants cause much fewer side effects than chemical drugs. Many of the medicinal plants are highly capable of fighting bacterial and fungal pathogens because of having effective and antioxidant compounds. Besides that, plant resources are used as a flavoring agent, in addition to antimicrobials, in food industries because people are reluctant to use the foods that contain chemical preservatives (Asadi-Samani, 2014; Bahmani, 2014; Amirmohammadi, 2014; Karamati, 2014; Eftekhari, 2012).

Through further research, medicinal plants, as with synthetic drugs, can be scientifically and meticulously assessed and hence an appropriate culture can be established to prescribe and use them (Bahmani, 2014; 2015; Kooti, 2014; Rabiei, 2013; Moradi, 2013; 2014; Samarghandian, 2016; Saki, 2014; Asadbeygi, 2014). Since many centuries ago, physicians have been paying attention to plants, and the therapeutic and harmless effects of the plants have been experienced and documented over many years (Bahmani, 2014; 2015; 2016; Asadi-Samani, 2013; 2015; 2016; Delfan, 2014; 2015; 2016; Parsaei, 2016; Ghasemi Pirbalouti, 2013; Jivad, 2016). Medicinal plants cause fewer side effects because they are nature-based and agreeable to the organisms of the body (Sadeghihe, 2007; Ebrahimie, 2015; Parsaei, 2016; Mahmoudian Sani, 2016; Bahmani, 2013; 2014; Beyrami-Miavagi, 2014; Mohsenzadeh, 2016; Gholami-Ahangaran, 2012; Cheraghi, 2016). The aim of this review article is to report the native medicinal plants of Iran that are effective on *B. cereus*.

2. MATERIALS AND METHODS

The data were drawn by searching for these words: medicinal plants, extract, essence, nature-based compounds, and *B. cereus*, in the articles indexed in some databases including Scientific Information Database, Magiran, Google Scholar, and some other databases indexing the publications in Persian language.

3. RESULTS

The findings indicate that *Eucalyptus camaldulensis* Dehnh, *Zataria multiflora*, *Mentha pulegium*, *Artemisia persica*, *Cuminum cyminum*, *Cordia myxa* L., *Scrophularia striata*, *Mentha longifolia*, *Rosmarinus officinalis*, and

Lavandula sp. are effective on *B. cereus*. In table 1, details of 10 major medical plants effective on *B. cereus* have been shown.

Table.1.The most important medicinal plants native to Iran effective on *Bacillus cereus*

Scientific names	Family name	Persian name	Main results
<i>Eucalyptus camaldulensis</i> Dehnh	Myrtaceae	Okaliptus	An experimental study demonstrated that the MIC of methanolic eucalyptus extract was 1.25-5 mg/mL for <i>Bacillus subtilis</i> (Jouki, 2010).
<i>Zataria multiflora</i>	Lamiceae	Avishan Shirazi	An experimental study demonstrated that different concentrations (0.005%, 0.3%, and 0.015%) of <i>Z. multiflora</i> essential oil were effective in inhibiting <i>B. cereus</i> in barley soup model (Alipour-Eskandani, 2009).
<i>Mentha pulegium</i>	Lamiaceae	Pouneh	An experimental study indicated that 0.1 g of <i>Mentha pulegium</i> essential oil had an MIC of 5000 and monolaurin+ <i>M. pulegium</i> essential oil an MIC of 26 (Neyriz Nagadehi, 2010).
<i>Artemisia persica</i>	Asteraceae	Dermaneye irani	A study showed that methanolic <i>A. persica</i> extract was effective on <i>B. cereus</i> growth with 400 µg/mL MBC and 100 µg/mL MIC (Niakan, 2011).
<i>Cuminum cyminum</i>	Apiaceae	Zire sabz	An experimental study of <i>C. cyminum</i> essential oil effect on <i>B. cereus</i> growth in a food model demonstrated that <i>B. cereus</i> logarithm decreased significantly at 300 and 450 PPM under 10°C and at 450 PPM under 25°C (Moradi, 2012).
<i>Cordia myxa</i> L.	Boraginaceae	sepestan	An experimental study demonstrated that 60 mg/mL of <i>C. myxa</i> caused an 18.4±5.2 inhibition zone for <i>B. cereus</i> (Pirnia, 2015).
<i>Scrophularia striata</i>	Scrophulariaceae	Gole meymouni-sazouei	An experimental study indicated that the most effective extract on <i>B. cereus</i> caused a 21-mm inhibition zone and had a 60 mg/mL MIC and 70 mg/mL MBC (Safavi, 2013).
<i>Mentha longifolia</i>	Asteraceae	Naena	An experimental study demonstrated that 50 µg of <i>M. longifolia</i> extract caused decrease in the number logarithm of <i>B. cereus</i> bacteria by 0.18 (Babayi, 2004).
<i>Rosmarinus officinalis</i>	Lamiaceae	Rozmari	An experimental study indicated that 100 µg of <i>R. officinalis</i> extract caused a decrease in the number logarithm of <i>B. cereus</i> bacteria (Babayi, 2004).
<i>Lavandula sp.</i>	Lamiaceae	Ostokhodous	An experimental study demonstrated that 100 µg of <i>Lavandula sp.</i> caused a decrease in the number logarithm of <i>B. cereus</i> (Babayi, 2004).

DISCUSSION

According to traditional medicine references, eucalyptus is used for treatment of boils, wounds, flu, fever, cough, and some other ailments (Babayi, 2004). 1, 8-Cineol, ethanone, eucalyptol, carvacrol, and α -pinene are some of the effective compounds of eucalyptus that have antimicrobial properties (Ghaffar, 2015; Akin, 2012; Ashour, 2008). According to traditional medicine, *Z. multiflora* is used to treat infections (Hossinzadeh, 2000). Thymol, carvacrol, and p-cymene are the main chemical compounds of *Z. multiflora* (Saedi Dezaki, 2016). *M. pulegium* is traditionally used to treat spasm and bloat, and as disinfectant (Newall, 1996; Lawless, 1995). The main compounds of *M. pulegium* essential oil are piperitone, piperitenone, alpha-terpineol, and pulegone (Mahboubi, 2008; Duke, 1989). *A. persica* is traditionally used as disinfectant and to treat microbial and fungal diseases (Kordali, 2005). *A. persica* contains monoterpenes and sesquiterpens such as β -thujone, 1, 8-cineol, α -thujone and 4-terpineol (Nikbakht, 2014). Traditionally, *C. cyminum* is used as digestive and to treat cough due to pulmonary diseases (Thappa, 1991). Terpinoids, flavonoids, glycosides, and glucoseindoates have been extracted of *C. cyminum*. Gamma-terpinene, 2-methyl-3-phenyl-propanal, myrtenal, and glucopyranosides are the main compounds of *C. cyminum* essential oil (Morshedi, 2014; Jalali-Heravi, 2007). Many years ago, *C. myxa* was introduced as an antibacterial, antiviral, and anti-cough agent (Amin, 2005). Flavonoid compounds have been isolated from *C. myxa*, including robinin,

datisoside, rutin, hesperidin, dihydrorobinetin, caffeic acid and chlorogenic acid that have antimicrobial property (Saki, 2014; Aberoumand, 2011). *S. striata* as a plant of Snapdragon has traditional medical usage. Some of its main compounds are aucubin and catalpol. Also the anti-bacterial effects of *S. striata* can be due to the presence of phenolic, flavonoid, and flavonol compounds (Tanideh, 2015; Rostami, 2015). *M. longifolia* as an Iranian traditional medicine is used for treating stomach and intestinal disorders (Jalilzadeh-Amin, 2015). Menthone, isomenthone, menthol, 1, 8-cineole, borneol, and piperitenone are some of the compounds of *M. longifolia* (Mikaili, 2013; Zeinali, 2005). *R. officinalis* essential oil is used as a spice in food industries. Besides that, this plant is known as a medicinal plant because of having extensive antimicrobial and antioxidant properties (Wang, 2008). Antibacterial, antifungal, carminative, muscle-relaxant, analgesic, hypnotic, and sedative properties of *L. officinalis* have long been known (Toyoshi, 2006). Linalool, linalyl acetate, luteolin, ursolic acid, umbelliferone are some of the most important compounds of *L. officinalis* (Hajhashemi, 2003). Because these plants have antimicrobial effects according to traditional medicine, their anti-*B. cereus* effects have been confirmed in scientific investigations, and their compounds have already been identified in phytochemical investigations, their effective compounds can be used to produce nature-based, anti-*B. cereus* antibiotics.

4. CONCLUSION

Because these plants have antimicrobial effects according to traditional medicine, their anti-*B. cereus* effects have been confirmed in scientific investigations, and their compounds have already been identified in phytochemical investigations, their effective compounds can be used to produce nature-based, anti-*B. cereus* antibiotics.

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