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

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**ABSTRACT**

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* Dehn, *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 diarrhoea, 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 diarrhoea 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; Asadbeigy, 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 (Sadeghii, 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* Dehn, *Zataria multiflora*, *Mentha pulegium*, *Artemisia persica*, *Cuminum cyminum*, *Cordia myxa L.*, *Scrophularia striata*, *Mentha longifolia*, *Rosmarinus officinalis*, and...
Kordali Alipour Amin, including Hossinzadeh Ghaffaren, alpha anti (methyl Terpinoids, flavonoids, glycosides, and glucoseindoates 2014). Traditionally, persica 1989 of traditionally used to treat spasm and bloat, and as disinfectant (2008) of the effective compounds of eucalyptus that have antimicrobial properties (2008; cough, and some other ailments (2016; DISCUSSION

According to traditional medicine references, eucalyptus is used for treatment of boils, wounds, flu, fever, cough, and some other ailments (2004). 1, 8-Cineol, ethanone, eucalyptol, carvacrol, and a-pinene are some of the effective compounds of eucalyptus that have antimicrobial properties (2015; Akin, 2012; Ashour, 2008). According to traditional medicine, Z. multiflora is used to treat infections (2000). Thymol, carvacrol, and p-cymene are the main chemical compounds of Z. multiflora (2016). M. pulegium is traditionally used to treat spasm and bloat, and as disinfectant (1996; Lawless, 1995). The main compounds of M. pulegium essential oil are piperitone, pipertitenone, alpha-terpineol, and pulegone (2008; Duke, 1989). A. persica is traditionally used as disinfectant and to treat microbial and fungal diseases (Kordali, 2005). A. persica contains monoterpenes and sesquiterpenes such as β-thujone, 1, 8-cineol, β-thujone and 4-terpineol (2014). Traditionally, C. myxa is used as digestive and to treat cough due to pulmonary diseases (1991). Terpinoids, flavonoids, glycodies, and glucoseindioates have been extracted of C. myxa. Gamma-terpinein, 2-methyl-3-phenyl-propanal, myrtenal, and glucopyranosides are the main compounds of C. myxa essential oil (Morshedi, 2014; Jalali-Heravi, 2007). Many years ago, C. myxa was introduced as an antibacterial, antiviral, and anti-cough agent (2005). Flavonoid compounds have been isolated from C. myxa, including robinin, July - September 2016 1249 JCPS Volume 9 Issue 3

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

<table>
<thead>
<tr>
<th>Scientific names</th>
<th>Family name</th>
<th>Persian name</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eucalyptus camaldulensis Dehnn</td>
<td>Myrtaceae</td>
<td>Okaliptus</td>
<td>An experimental study demonstrated that the MIC of methanolic eucalyptus extract was 1.25-5 mg/mL for Bacillus subtilis (Jouki, 2010).</td>
</tr>
<tr>
<td>Zataria multiflora</td>
<td>Lamiaceae</td>
<td>Avishan Shirazi</td>
<td>An experimental study demonstrated that different concentrations (0.005%, 0.3%, and 0.015%) of Z. multiflora essential oil were effective in inhibiting B. cereus in barley soup model (Alipour-Eskandani, 2009).</td>
</tr>
<tr>
<td>Mentha pulegium</td>
<td>Lamiaceae</td>
<td>Pouneh</td>
<td>An experimental study indicated that 0.1 g of Mentha pulegium essential oil had an MIC of 5000 and monolaurin+M. pulegium essential oil an MIC of 26 (Neyriz Nagadehi, 2010).</td>
</tr>
<tr>
<td>Artemisia persica</td>
<td>Asteraceae</td>
<td>Dermayne irani</td>
<td>A study showed that methanolic A. persica extract was effective on B. cereus growth with 400 μg/mL MBC and 100 μg/mL MIC (Niaian, 2011).</td>
</tr>
<tr>
<td>Cumimum cyminum</td>
<td>Apiaceae</td>
<td>Zire sabz</td>
<td>An experimental study of C. cyminum essential oil effect on B. cereus growth in a food model demonstrated that B. cereus logarithm decreased significantly at 300 and 450 PPM under 10°C and at 450 PPM under 25°C (Moradi, 2012).</td>
</tr>
<tr>
<td>Cordia myxa L.</td>
<td>Boraginaceae</td>
<td>sepestan</td>
<td>An experimental study demonstrated that 60 mg/mL of C. myxa caused an 18.4±5.2 inhibition zone for B. cereus (Pirnia, 2015).</td>
</tr>
<tr>
<td>Scrophularia striata</td>
<td>Scrophulariacae</td>
<td>Gole meymouni-sazouei</td>
<td>An experimental study indicated that the most effective extract on B. cereus caused a 21-mm inhibition zone and had a 60 mg/mL MIC and 70 mg/mL MBC (Safavi, 2013).</td>
</tr>
<tr>
<td>Mentha longifolia</td>
<td>Asteraceae</td>
<td>Naena</td>
<td>An experimental study demonstrated that 50 μg of M. longifolia extract caused decrease in the number logarithm of B. cereus bacteria by 0.18 (Babayi, 2004).</td>
</tr>
<tr>
<td>Rosmarinus officinalis</td>
<td>Lamiaceae</td>
<td>Rozmari</td>
<td>An experimental study indicated that 100 μg of R. officinalis extract caused a decrease in the number logarithm of B. cereus bacteria (Babayi, 2004).</td>
</tr>
<tr>
<td>Lavandula sp.</td>
<td>Lamiaceae</td>
<td>Ostokhodous</td>
<td>An experimental study demonstrated that 100 μg of Lavandula sp. caused a decrease in the number logarithm of B. cereus (Babayi, 2004).</td>
</tr>
</tbody>
</table>
datiscoside, rutin, hesperadin, dihydorobinetin, caffeic acid and chlorogenic acid that have antimicrobial property (Saki, 2014; Aberoumand, 2011). *S. striata* as a plant of Snapdragonhas 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, anaesthetic, 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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plants in Iran
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persica Boiss
Nikbakht MR, Sharifi S, Emami SA, Khodaie L
combination with Mentha pulegium L
Neyriz Nagadehi M, Razavifar V, Zeynali A, Delshad R, The effect of monolaurin in
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