Vibriosis phytotherapy: A review on the most important world medicinal plants effective on *Vibrio* spp.

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**ABSTRACT**

Etiological investigations showed that *vibrio* is a Gram-negative, comma-shaped and facultative anaerobic bacterium, which is naturally found in marine environment. *Vibrio* causes many human diseases and often comes with foodborne gastroenteritis or diarrhea. Most of these foodborne infections are caused by *V. Cholerae* and *V. parahaemolyticus* and to a lesser extent create by *V. vulnificus*. Infection with these species is mostly due to the consumption of raw, improperly handled, under-processed and contaminated seafood like fish, shellfish and oyster. One of the biggest threats to public health is antibiotic resistance, such as resistance of vibrio species to a large number of antibiotics. This review focused on antibacterial activity of the world’s medicinal plants against vibrio species. Published articles were obtained from scientific databases including PubMed, Google scholar, Springer, Science Direct and scientific information database (SID) using following key words: vibrio, medicinal plant, essential oil and extract. Results of this literature have introduced some of the most important plants effective on *vibrio* spp., such as *Thymus vulgaris* (Thyme), *Syzygium aromaticum* (Clove), *Zataria multiflora* (Avishan shirazi), *Zingiber officinale* (Ginger), *Punica granatum* (Pomegranate), *Satureja bachtiarica* Bunge (Bakhtiari Savory), *Mentha spicata* (Spearmint), *Cuminum cyminum* (Cumin), *Eucalyptus globulus* (Blue gum), *Camellia sinensis* (Green tea), *Rosmarinus officinalis* (Rosemary) and *Allium sativum* (Garlic). Hence, phyto-therapy could be a suitable way to overcome the problem of development of the bacterial resistance to antibiotics.

**INTRODUCTION**

Antibiotics have the main role in the treatment of microbial infections, but their overuse is the major factor in the emergence of multi-drug resistant strains of microorganisms (Ventola, 2015). Drug resistance to human pathogenic bacteria was reported to have an increasing trend worldwide over the last few decades. Herbal remedies do not lead to many adverse effects of synthetic drugs, and they have a great therapeutic potential to heal several infectious diseases (Aminzare et al., 2015). They can possess strong antibacterial properties and have a significant role in the treatment of various illnesses all over the world (Silva and Fernandes Júnior, 2010; Aminzare et al., 2017a; Aminzare et al., 2017c).

Among bacterial pathogens, genus *Vibrio* has been recognized as the most important etiological factor responsible for many disease outbreaks (Sudheesh et al., 2012). *Vibrio* species are Gram-negative, curved rods highly motile with a single polar flagellum, they could be found in aquatic environment and in high numbers in marine organisms containing fishes, mollusks, corals, shrimps and zooplanktons (Manju et al., 2016; Akhondzadeh Basti et al., 2014). There are at least 14 pathogenic *Vibrio* species which can cause human infection. Vibrio infections are mainly classified into two different groups: *Vibrio cholerae* infections and non-*cholera Vibrio* infections (Chandru et al., 2013). Cholera is the major disease caused by *Vibrio* species, which occurs when *Vibrio cholerae* colonizes in small intestine releases a potent enterotoxin called choleragen. This toxin binds to cellular receptors in the intestine and releases an enzymatically active subunit that increases the production of intracellular cyclic adenosine monophosphate (cAMP). The resulting elevated cAMP level results in the secretion of large amounts of electrolytes and water into the intestinal lumen,
which is accompanied by vomiting, hypovolemic shock and acidosi (Erfanimanesh et al., 2014; Miyoshi, 2013). Furthermore, V. parahaemolyticus, V. alginolyticus and V. vulnificus are other important pathogenic species isolated from seawater and they are frequently related with gastrointestinal illnesses (Snoussi et al., 2008). Although V. parahaemolyticus is the most common cause of non-cholera Vibrio infection, V. vulnificus is responsible for 94% of non-cholera Vibrio fatal infections (Baker-Austin et al., 2010). Symptoms of V. parahaemolyticus infection can include; abdominal cramping, nausea, diarrhea, vomiting, and fever. V. vulnificus can cause similar symptoms, but it can also cause serious infections through pathogen’s entry into an open wound (Raszl et al., 2016). Vibrio infection is primarily transmitted through the consumption of raw or undercooked seafood or the exposure of wounds to warm seawater (Daniels and Shafaie, 2000). To the best of our knowledge, there is no review focusing on the plants with antibacterial activity on Vibrio species. There are only few studies on the effect of different essential oils and extracts on each Vibrio species separately (Hajlaoui et al., 2010; Al-Sahlany, 2016; Gra-cia-Valenzuela, 2014; Khanjari et al., 2013).

Therefore, the objective of the present study was to review former studies about the effect of any medicinal plant or their compounds against vibrio species in order to summarize the antibacterial activities of the most important plants, as natural antibacterial agents which could affect Vibrio species.

MATERIAL AND METHODS

All the required information was obtained by searching keywords including Vibrio, medicinal plant, extract and essential oil among published articles until May, 2017 in authentic scientific databases; Science Direct, Springer, Google scholar, Scopus, PubMed and Scientific Information Database (SID).

RESULT AND DISCUSSION

Effective medicinal plants against Vibrio species are listed in Table 1. The findings of the present study indicated that Allium sativum, Thymus vulgaris, Syzygium aromaticum, Zataria multiflora, Zingiber officinalis, Satureja bachttica Bunge, Punica granatum, Mentha spicata, Cuminum cyminum, Eucalyptus globulus, Camellia sinensis and Rosmarinus officinalis are the most important plants that have anti-vibrio activity.

Use of essential oils as antimicrobial factors in food industry may be considered as additional basic determinant to increase the shelf-life and safety of foods. Essential oils and extracts of different herbs, plants and spices constitute of strong natural biologically active agents and it has been recognized that the antimicrobial activity of essential oils is related to their chemical composition, especially the phenolic compounds in different parts of the plants such as roots, leaves, fruits, seeds and skin (Aminzare et al., 2016).

Phytochemicals studies show effective antimicrobial components in Thymus vulgaris (thyme) extract and essential oils such as carvacrol, thymol, linalool, geraniol and γ-terpineol (Borugá et al., 2014). Rosemary officinalis (rosemary) essential oil is also important for its medicinal uses and its potent antibacterial, antimitagenic, antiinflammatory and chemopreventive effects (Hussain et al., 2010). Punica granatum (pomegranate) is known to be a rich source of compounds such as ellagic acid and its derivatives, ellagittannins such as punicalin and punicalagin (Aminzare et al., 2016). The antimicrobial effect and inhibition activity of Zingiber officinale, known as ginger, can be related to the presence of sesquiterpenoids, which are the main components of ginger like zingiberene, p-Sesquiphellan, b-Bisabolene and ar-curcumene (Sasidharan and Menon, 2010; Sivasothy et al., 2011). Mentha spicata (spearmint), an aromatic member of the Lamiaceae family, is a glabrous and perennial herb with strong aromatic odor (Znini et al., 2011). The major constituents of the oil are carvone, cis-carveol, limonene, 1,8 cineole, cis-dihydro-carvone and carvyl acetate (Hussain et al., 2010). Allium sativum (garlic) has been utilized as food and drug for several thousand years (Karuppihand Rajaram, 2012). The antibacterial activity of garlic is widely related to allicin. It is also revealed that components containing sulphur in garlic and also bioflavonoids like quercetin and cyanidin in it have big role in prohibiting diseases and infections (Goncagul and Ayaz, 2010). Syzygium aromaticum (clove) oil is extensively used as a perfume and medicine for cure of various allergic disorders and dental problems (Rana et al., 2011). Eugenol is the major volatile ingredient of extracted oil from the flower buds. Besides eugenol, β-caryophyllene and eugenyl acetate are other compounds responsible for antimicrobial activity (Cortés-Rojas et al., 2014).

Analysis results indicated that antibacterial activity of Cuminum cyminum (cumin) essential oil is attributable to the high level of cumin aldehyde, as a major constituent, γ-terpinein and β-pinene (Raiesi et al., 2016a). The essential oil of leaves of Eucalyptus globulus (blue gum) has been consumed all over the world as an antiseptic and for reducing symptoms of cold, cough, sore throat and other diseases (Mulyaningsih et al., 2010). Eucalyp- tal (1,8-cineole) is the potent component of eucalyptus oil that is responsible for its several pharmacological effects (Bachir and Benali, 2012). Citronellal, citronellyl acetate and α-pinene are usually found in lower amounts in E. globulus essential oil (Mulyaningsih et al., 2010). Inhibition studies showed that Zataria multiflora (Avishan–Shirazi) essential oil and extract can prevent growth of bacteria including vibrio species. Carvacrol, thymol, p-Cymene and linalool are the main constituents of the essential oils from Z. multiflora (Tajik et al., 2015; Zomorodian et al., 2011). Green tea is one of the most traditional and popular therapeutic beverages used all over world. This product is made from the leaf of the Camellia sinensis plant (Sharangi, 2009). Good antibacte- rial activity of green tea depends on the presence of tannins, phenols, flavonoids and alkaloids (Kumar et al., 2012). The phytochemical screening of S. bachttica revealed that its essential oil contain thymol, carvacrol, γ-terpinein, p-Cymene and p-Caryophyllene (Salehi-Arjmand et al., 2014). Due to antimicrobial effect of these components, S. bachttica Bunge essential oil showed strong antimicrobial activity against different bacteria like vibrio species (Falsafi et al., 2015). S. mombin (bog plum) is a member of Anacardiaceae family which is widely used in various herbal remedies. Phytochemical studies demonstrated that S. mombin extract contain phenols, tannins, flavones, flavonoids, leucoanthocyanidins and saponins with significant antimicrobial activity (Da Silva et al., 2012). O. majorana (sweet marjoram) is frequently used for culinary and medicinal purposes. The analysis of the herb revealed the presence of terpenoids, flavonoids and tannins in marjoram extract (Vasudeva, 2015).
### Table 1: List of effective world medicinal plants against *Vibrio* species.

<table>
<thead>
<tr>
<th>S. no</th>
<th>Botanical name</th>
<th>Common name</th>
<th>Parts used</th>
<th>Phytoconstituent</th>
<th>Test microorganisms</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Albizia lebbeck</em></td>
<td>Flea tree</td>
<td>Burk</td>
<td>Methanolic extract</td>
<td>V. cholera</td>
<td>MIC and MBC were 24 mg/ml (Acharyya et al., 2009). Growth inhibition zone was 12 mm. MIC and MBC were 0.5 and 0.65, respectively (Maji et al., 2016).</td>
</tr>
<tr>
<td>2</td>
<td><em>Allium cepa</em></td>
<td>Onion</td>
<td>Bulb</td>
<td>Ethanolic extract</td>
<td>V. cholera</td>
<td>Growth inhibition zone was 25.83 mm. MIC was 19.20 mg/ml (Hannan et al., 2010).</td>
</tr>
<tr>
<td>3</td>
<td><em>Allium sativum</em></td>
<td>Garlic</td>
<td>Bulb</td>
<td>Methanolic extract</td>
<td>V. harveyi</td>
<td>20 and 30 μl of extract caused inhibition zone diameter of 22 and 24 mm, respectively (Vaseeharan et al., 2011).</td>
</tr>
<tr>
<td>4</td>
<td><em>Aristolochia bracteata Retz</em></td>
<td>Dutchman's pipe</td>
<td>Leaves</td>
<td>Chloroform extract</td>
<td>V. harveyi/V. vulnificus</td>
<td>Growth inhibition diameter was 7.4 ± 0.03 and 7.0 ± 0.05 mm against V. harveyi and V. vulnificus, respectively (Kavitha et al., 2016).</td>
</tr>
<tr>
<td>5</td>
<td><em>Azadirachta indica</em></td>
<td>Neem</td>
<td>Leaves</td>
<td>Ethanolic extract</td>
<td>V. cholera</td>
<td>Growth inhibition diameter was 16.5 mm. MIC and MBC were 2.5 and 10 mg/ml, respectively (Thakurta et al., 2007).</td>
</tr>
<tr>
<td>6</td>
<td><em>Bauhinia variegata</em></td>
<td>Mountain ebony</td>
<td>Burk</td>
<td>Ethanolic extract</td>
<td>V. cholera</td>
<td>Growth inhibition diameter was 16 mm and MBC was 1.56 mg/ml (Pokhrel et al., 2002).</td>
</tr>
<tr>
<td>7</td>
<td><em>Camellia sinensis</em></td>
<td>Green tea</td>
<td>Leaves</td>
<td>Aqueous extract</td>
<td>V. parahaemolyticus</td>
<td>Growth inhibition zone diameter was 16.33 mm (Kongchum et al., 2016). MIC was 0.25μg/μl (Mehrotra and Srivastava, 2010).</td>
</tr>
<tr>
<td>8</td>
<td><em>Chaetomorpha antennina</em></td>
<td>Bory</td>
<td>Leaves</td>
<td>Ethanolic extract</td>
<td>V. parahaemolyticus</td>
<td>Growth inhibition zones were 28mm and 36mm at the concentration of 150 μl and 200 μl, respectively (Thanigavelp et al., 2014).</td>
</tr>
<tr>
<td>9</td>
<td><em>Chelanthus collinus</em></td>
<td>Bentham</td>
<td>Leaves</td>
<td>Aqueous extract</td>
<td>V. cholera</td>
<td>Growth inhibition zone was 16 mm and MBC was 17μg/μl (Elangothamanavan et al., 2015).</td>
</tr>
<tr>
<td>10</td>
<td><em>Costus spiralis</em></td>
<td>Bloodberry</td>
<td>Aerial parts</td>
<td>Essential oil</td>
<td>V. cholera</td>
<td>Growth inhibition zone was 13 mm and MIC value was 0.060 mg/ml (Melissa et al., 2016).</td>
</tr>
<tr>
<td>11</td>
<td><em>Cuminum cyminum</em></td>
<td>Cumin</td>
<td>Seed</td>
<td>Essential oil</td>
<td>V. parahaemolyticus</td>
<td>Growth inhibition zone was 23 ± 1 mm diameter. MIC and MBC were 0.078 and 1.25 mg/ml, respectively (Hajhoui et al., 2019).</td>
</tr>
<tr>
<td>12</td>
<td><em>Cymbopogon nardus</em></td>
<td>Citronella</td>
<td>Aerial parts</td>
<td>Essential oil</td>
<td>V. cholera</td>
<td>The MIC value was 0.244 μg/ml (Wei and Wee, 2013).</td>
</tr>
<tr>
<td>13</td>
<td><em>Eucalyptus globulus</em></td>
<td>Blue gum</td>
<td>Flower</td>
<td>Essential oil</td>
<td>V. harveyi</td>
<td>MIC and MBC were 7.81μg/ml and 62.5μg/ml, respectively (Park et al., 2016).</td>
</tr>
<tr>
<td>14</td>
<td><em>Foeniculum vulgare</em></td>
<td>Fennel</td>
<td>Leaves</td>
<td>Methanolic extract</td>
<td>V. parahaemolyticus</td>
<td>Growth inhibition zone diameter was 14.7 mm. MIC and MBC were 250 and 1000 μg/ml, respectively (Mahbobi et al., 2007).</td>
</tr>
<tr>
<td>15</td>
<td><em>Helianthemum Glomeratum</em></td>
<td>Clustered Frostweed</td>
<td>Leaves</td>
<td>Methanolic extract</td>
<td>V. cholera/V. parahaemolyticus</td>
<td>MIC was 2.5 mg/ml against both species (Meckes et al., 1997).</td>
</tr>
<tr>
<td>16</td>
<td><em>Jatropha neospicataPax</em></td>
<td>Nettlespurge</td>
<td>Burk</td>
<td>Latex</td>
<td>V. cholera</td>
<td>Growth inhibition zone was 7.3 ± 0.5 mm. MIC and MBC were 4.0 and 6.0 mg/ml, respectively (Hernandez-Hernandez et al., 2017).</td>
</tr>
<tr>
<td>17</td>
<td><em>Mentha piperita</em></td>
<td>Peppermint</td>
<td>Leaves</td>
<td>Essential oil</td>
<td>V. parahaemolyticus</td>
<td>MIC was 18.20 ± 0.36 mm and MIC was 0.0030 (Al-Sahlany, 2016).</td>
</tr>
<tr>
<td>18</td>
<td><em>Mentha pulegium</em></td>
<td>Pennyroyal</td>
<td>Aerial part</td>
<td>Essential oil</td>
<td>V. cholera</td>
<td>Growth inhibition zone was 13 mm. MIC and MBC were 0.5 and 1 μg/ml, respectively (Mahbobi and Haghj, 2008).</td>
</tr>
<tr>
<td>19</td>
<td><em>Mentha spicata</em></td>
<td>Spearmint</td>
<td>Aerial parts</td>
<td>Essential oil</td>
<td>V. alginolyticus</td>
<td>Growth inhibition zone was 18.67 mm and MIC was 0.047 mg/ml, respectively (Snoussi et al., 2015).</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Growth inhibition zone was equal to 12 mm (Arumugam et al., 2010).</td>
</tr>
<tr>
<td>No.</td>
<td>Species</td>
<td>Type</td>
<td>Part</td>
<td>Extract/Extraction</td>
<td>MIC/Zone/Activity</td>
<td></td>
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<tr>
<td>-----</td>
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<td></td>
</tr>
<tr>
<td>21</td>
<td>Myrtus communis</td>
<td>Myrtle</td>
<td>Leaves</td>
<td>Aqueous extract</td>
<td>Growth inhibition zone was 12 ± 0.3 mm. MIC and MBC were 2 and 20 mg/ml, respectively (Taberi et al., 2013).</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Nigella sativa</td>
<td>Blackseed</td>
<td>Seed</td>
<td>Essential oil</td>
<td>Growth inhibition zone diameter was 23.9 mm (Manju et al., 2016).</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Ocimum basilicum</td>
<td>Basil</td>
<td>Whole plant</td>
<td>Ethanolic extract</td>
<td>Growth inhibition zone was 1.4 ± 0.2 cm and MBC was 3 ± 0.5 mg/ml (Sánchez et al., 2010).</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Ocimum gratissimum</td>
<td>Basil</td>
<td>Aerial parts</td>
<td>Essential oil</td>
<td>Growth inhibition zone was 15 ± 0.18 mm. MIC and MBC were 1.25 and 5 mg/mL, respectively (Igbinoson and Idemudia, 2016).</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Origanum majorana</td>
<td>Marjoram</td>
<td>Aerial parts</td>
<td>Essential oil</td>
<td>Growth inhibition zone was 12.33 mm. MIC and MBC were 0.39 and 3.125 mg/ml, respectively (Hajlaoui et al., 2016).</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Petroselinum crispum</td>
<td>Parsley</td>
<td>Aerial parts</td>
<td>Essential oil</td>
<td>Growth inhibition zone was 15 mm. MIC and MBC were 0.125 mg/ml and 0.125 mg/mL, respectively (Karimi et al., 2013).</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Punica granatum</td>
<td>Pomegranate</td>
<td>Fruit</td>
<td>Methanolic extract</td>
<td>Growth inhibition zone was 26 mm (Pradeep et al., 2008).</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Rosmarinus officinalis</td>
<td>Rosemary</td>
<td>Aerial parts</td>
<td>Essential oil</td>
<td>Growth inhibition zone was 10.66 mm. MIC and MBC were 0.625 mg/ml and 2.5 mg/ml (Snoussi et al., 2008).</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Satureja bachtiarica</td>
<td>Bunge</td>
<td>Aerial parts</td>
<td>Essential oil</td>
<td>Growth inhibition zone was 26.33 mm. MIC and MBC were 25 and 50 mg/ml, respectively (Miladi et al., 2013).</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Solanum nigrum</td>
<td>Black nightshade</td>
<td>Leaves</td>
<td>Ethanolic extract</td>
<td>MIC and MBC were 31 μg/ml (Pirbalouti et al., 2011).</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Spondias mombin</td>
<td>Hog plum</td>
<td>Leaves</td>
<td>Ethanolic extract</td>
<td>MIC and MBC were 12.5 and 25 mg/ml, respectively. (Rainsey et al., 2015).</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Stevia rebaudiana</td>
<td>Sweet Leaf</td>
<td>Leaves</td>
<td>Ethyl acetate extract</td>
<td>Growth inhibition zone was 12 mm. MIC and MBC were 0.031 and 0.125 mg/ml, respectively (Tyayaraj et al., 2014).</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Syzygium aromaticum</td>
<td>Clove</td>
<td>Leaves</td>
<td>Essential oil</td>
<td>Growth inhibition zone was 7 ± 0.8 mm. Both MIC and MBC were 1000 μg/ml (Ravikumar et al., 2011).</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Thymus vulgaris</td>
<td>Thyme</td>
<td>Aerial parts</td>
<td>Essential oil</td>
<td>MIC was 50 μg/ml (Tyayaraj et al., 2014).</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Tinospora cordifolia</td>
<td>Guduchi</td>
<td>Aerial parts</td>
<td>Ethanolic extract</td>
<td>Growth inhibition zone was 16.2 mm (Rainsey et al., 2015).</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Vitis vinifera</td>
<td>Grape vine</td>
<td>Fruit</td>
<td>Methanolic extract</td>
<td>MIC was 0.125% (Yano et al., 2006).</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Withania somnifera</td>
<td>Winter cherry</td>
<td>Leaves</td>
<td>Essential extract</td>
<td>Growth inhibition zone was 10 ± 0.33 mm. MIC and MBC were 2 and 4 mg/ml, respectively (Narousi et al., 2016).</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Zataria multiflora</td>
<td>Avishan-e Shirazi</td>
<td>Aerial parts</td>
<td>Essential oil</td>
<td>Growth inhibition zone was 22.33 ± 0.57 mg. MIC and MBC were 0.156 and 0.312 mg/ml, respectively (Snoussi et al., 2008).</td>
<td></td>
</tr>
</tbody>
</table>

Growth inhibition zone was 12 ± 1.50 mm and MIC was 50 ppm (Palavesam et al., 2006). Growth inhibition zone was 15 ± 0.58 mm (Pradeep et al., 2008). Growth inhibition zone diameter was 6 ± 0.58 mm (Pradeep et al., 2008). MIC and MBC were 12.5 and 25 ppm, respectively (Rainama et al., 2017). Plant showed maximum inhibitory activity and caused 24.3 mm growth inhibition zone (Sivaram et al., 2009). Growth inhibition zone was 10 mm and had a 12.5 mg/mL effect (Taherpour et al., 2015). MIC and MBC were 31 and 125 μg/mL, respectively (Pirbalouti et al., 2011).
The mode of action of the essential oils are associated to their chemical composition and their antimicrobial effect which is not imputable to special mechanism but is instead a cascade of to their chemical composition and their antimicrobial effect which is not imputable to special mechanism but is instead a cascade of reactions implying the whole bacterial cell (Nazzaro et al., 2013). In general, these components make phospholipid bilayer membrane susceptible, and then cause an increase in membrane permeability, where compounds may interrupt membrane, lose cellular integrity and could eventually lead to the cell death (Aminzare et al., 2016; Moreira et al., 2005). This study showed that various plants essential oils and extracts are strong resources of antimicrobial agents in Vibrio phytophagy.

**CONCLUSION**

The result of this review revealed that among all the vibrio species, most of the studies have focused on the antimicrobial properties of medicinal herb against V. cholera and V. parahaemolyticus. A few studies have discussed the effect of plant essential oils and extracts on V. vulnificus and V. harveyi. The findings of the present study indicated that Allium sativum, Thymus vulgaris, Syzygium aromaticum, Zataria multiflora, Zingiber officinale, Satureja bachtiarica Bunge, Punica granatum, Mentha spicata, Cuminum cyminum, Eucalyptus globulus, Camellia sinensis and Rosmarinus officinalis are the most important plants with anti-vibrio activity. Essential oils cause damage to biological membrane due to their lipophilic properties; however, specific functional groups are additionally effective. Among bioactive compounds, flavonoids, alcohols, aldehydes, aromatic compounds, phenolics, steroids and terpenoids have significant inhibitory effect. Hence, active ingredients of the plant extracts and essential oils with antimicrobial properties can be considered as effective anti-vibrio and anti-pathogenic bacterial compounds.

Regarding the importance of the medicinal plants, it seems that more studies should investigate the frequency of plant species all over the world. Because of the widespread use of medicinal plants, much more extensive researches in various fields of pharmacy are needed. Researches should determine suitable using methods of medicinal plants for personal and industrial policies through this botanical information.

**CONFLICT OF INTEREST**

There are no conflicts of interest.

**REFERENCES**


Aminzare et al. / Journal of Applied Pharmaceutical Science 8 (01); 2018: 170-177


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