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

Majid Aminzare[1], Mohammad Hashemi[2], Zahra Abbasi[1], Mehran Mohseni[1], Elham Amiri[1,*]

[1]Department of Food Safety and Hygiene, School of Public Health, Zanjan University of Medical Sciences, Zanjan, Iran.
[2]Department of Nutrition, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.

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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 foodborn 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).

*Corresponding Author
Elham Amiri, Department of Food Safety and Hygiene, School of Public Health, Zanjan University of Medical Sciences, Zanjan, Iran.
E-mail: e_amiri93 @ yahoo.com

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 cholera* infections and non-cholera *Vibrio* infections (Chandru *et al.*, 2013). Cholera is the major disease caused by *Vibrio* species, which occurs when *Vibrio cholera* 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 acidosis (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 (Snoussiet 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; Gracia-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 officinale*, *Satureja bachtiarica 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 (Borugă *et al.*, 2014). *Rosemary officinalis* (rosemary) essential oil is also important for its medicinal uses and its potent antibacterial, antimutagenic, antiphlogistic, antioxidant 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, ellagitannins 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-dihydrocarvone and carvyl acetate (Hussain *et al.*, 2010). *Allium sativum* (garlic) has been utilized as food and drug for several thousand years (Karuppiahand 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-terpinene and β-pinene (Raeisi *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). Eucalyptal (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-e 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 antibacterial activity of green tea depends on presence of tannins, phenols, flavonoids and alkaloids (Kumar *et al.*, 2012). The phytochemical screening of *S. bachtiarica* revealed that its essential oil contain thymol, carvacrol, γ-terpinene, p-Cymene and p-Caryophyllene (Salehi-Arjmand *et al.*, 2014). Due to antimicrobial effect of these components, *S. bachtiarica* Bunge essential oil showed strong antimicrobial activity against different bacteria like vibrio species (Falsafi *et al.*, 2015). *S. mombin* (hog 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).

Table1: List of effective world medicinal plants against *Vibrio* species.

S. no	Botanical name	Common name	Parts used	Phytoconstituent	Test microorganisms	Finding
1	*Albizia lebbeck*	Flea tree	Bark Leaves	Methanolic extract Acetone extract	*V. cholera* *V. cholerae*	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.*, 2010).
2	*Allium cepa*	Onion	Bulb	Ethanolic extract	*V. cholera*	Growth inhibition zone was 25.83 mm. MIC was 19.20 mg/ml (Hannan *et al.*, 2010).
3	*Allium sativum*	Garlic	Bulb Bulb	Methanolic extract Aqueous extract	*V. harveyi* *V. cholerae*	20 and 30µl of extract caused inhibition zone diameter of 22 and 24 mm, respectively (Vaseeharan *et al.*, 2011). MIC was10 mg/ml (Sharma and Patel, 2009).
4	*Aristolochia bracteata Retz*	Dutchman's pipe	Leaves	Chloroform extract	*V. harveyi/V. vulnificus*	Growth inhibition diameter were 7.4 ± 0.03 and 7.0 ± 0.05 mm against V. harveyi and V. vulnificus, respectively (Kavitha *et al.*, 2016).
5	*Azadirachta indica*	Neem	Leaves Leaves	Methanolic extract Ethanolic extract	*V. cholera* *V. parahaemolyticus*	Growth inhibition diameter was 16.5 mm. MIC and MBC were 2.5 and 10 mg/ml, respectively (Thakurta *et al.*, 2007). Growth inhibition zone was 12.8 mm. MIC and MBC were 6.5 and 7 mg/ml (Mahfuzul Hoque *et al.*, 2007).
6	*Bauhinia variegata*	Mountain ebony	Bark Bark	Ethanolic extract Essential oil	*V. cholera* *V. cholerae*	Growth inhibition diameter was 12 mm and MBC was 1.56 mg/ml (Pokhrel *et al.*, 2002). Growth inhibition zone was 24 mm (Mahfuzul Hoque *et al.*, 2007).
7	*Camellia sinensis*	Green tea	Leaves Leaves	Aqueous extract Aqueous extract	*V. parahaemolyticus* *V. cholerae*	Growth inhibition zone diameter was 16.33 mm (Kongchum *et al.*, 2016). MIC was 0.25µg/µl (Mehrotra and Srivastava, 2010).
8	*Chaetomorpha antennina*	Bory	Leaves	Ethanolic extract	*V. parahaemolyticus*	Growth inhibition zones were 28mm and 36mm at the concentration of 150 µl and 200 µl, respectively (Thanigaivel *et al.*, 2014).
9	*Cleistanthus collinus*	Bentham	Leaves Leaves	Aqueous extract Acetone extract	*V. cholera* *V. cholerae*	Growth inhibition zone was 16mm and MIC was 177µg/µl (Elangomathavan *et al.*, 2015). Growth inhibition zone was 13 mm. MIC and MBC were 0.40 and 0.60 mg/ml, respectively (Maji *et al.*, 2010).
10	*Cordia globosa*	Bloodberry	Aerial parts	Essential oil	*V. cholerae*	Growth inhibition zone was 13 mm and MIC value was 0.060 mg/ml (Melissa *et al.*, 2016).
11	*Costus spiralis*	Spiral ginger	Leaves	Ethanolic extract	*V. cholera*	MIC value ranged from 1–5 mg/ml (Pérez *et al.*, 2008).
12	*Cuminum cyminum*	Cumin	Seed Seed	Essential oil Essential oil	*V. cholera* *V. parahaemolyticus*	Growth inhibition zone was 23 ± 1 mm diameter. MIC and MBC were 0.078 and 1.25 mg/ml, respectively (Hajlaoui *et al.*, 2010). Growth inhibition zone was 11.67 mm. MIC and MBC were 12 and 25mg/ml, respectively (Raissy *et al.*, 2015).
13	*Cymbopogon nardus*	Citronella	Aerial parts	Essential oil	*V. cholera*	The MIC value was 0.244 µg/ml (Wei and Wee, 2013).
14	*Eucalyptus globulus*	Blue gum	Leaves Flower	Essential oil Essential oil	*V. harveyi* *V. cholera*	MIC and MBC were 7.81µg/ml and 62.5µg/ml, respectively (Park *et al.*, 2016). Growth inhibition zone diameter was 14.7 mm. MIC and MBC were 250 and 1000 µg/ml, respectively (Mahbobi *et al.*, 2007).
15	*Foeniculum vulgare*	Fennel	Leaves	Methanolic extract	*V. parahaemolyticus*	MIC and MBC were 4 mg/ml and 8 mg/ml, respectively (Amare *et al.*, 2014).
16	*Helianthemum Glomeratum*	Clustered Frostweed	Leaves	Methanolic extract	*V. cholerae/V. parahaemolyticus*	MIC was 2.5 mg/ml against both species (Meckes *et al.*, 1997).
17	*Jatropha neopaucifloaPax*	Nettlespurge	Bark	Latex	*V. cholerae*	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).
18	*Mentha piperita*	Peppermint	Leaves Leaves	Essential oil Ethanolic extract	*V. parahaemolyticus* *V. cholerae*	Growth inhibition zone diameter was 18.20 ± 0.36 mm and MIC was 0.0030 (Al-Sahlany, 2016). MIC and MBC were 6.25 and 12.5 ppm, respectively (Rahnama *et al.*, 2017).
19	*Mentha pulegium*	Pennyroyal	Aerial part Leaves	Essential oil Essential oil	*V. cholerae* *V. cholerae*	Growth inhibition zone was 13 mm. MIC and MBC were 0.5 and 1 µg/ml, respectively (Mahboubi and Haghi, 2008). Growth inhibition zone diameter was 20 mm (Marzouk *et al.*, 2008).
20	*Mentha spicata*	Spearmint	Aerial parts Leaves	Essential oil Ethanolic extract	*V. alginolyticus* *V. cholerae*	Growth inhibition zone was 18.67 mm and MIC was 0.047 mg/ml, respectively (Snoussi *et al.*, 2015). Growth inhibition zone was equal to 12 mm (Arumugam *et al.*, 2010).

21	*Myrtus communis*	Myrtle	Leaves Leaves	Hydroalcoholic Essential oil	*V. cholerae* *V. parahaemolyticus*	Growth inhibition zone was 12.4 ± 0.3 mm. MIC and MBC were 2 and 20 mg/ml, respectively (Taheri *et al.*, 2013). Growth inhibition diameter zone was 11.34 mm. Both MIC and MBC were 200 mg/ml (Raissy *et al.*, 2015).
22	*Nigella sativa*	Blackseed	Seed Seed	Essential oil Ethanolic extract	*V. parahaemolyticus* *V. cholerae*	Growth inhibition zone diameter was 23.9 mm (Manju *et al.*, 2016). Growth inhibition zone was 11.15 mm (Howlader *et al.*, 2017).
23	*Ocimum basilicum*	Basil	Whole plant Stem	Ethanolic extract Eessential oil	*V. cholerae* *V. parahaemolyticus*	Growth inhibition zone was 1.4 ± .2 cm and MBC was 3 ± 0.5 mg/ml (Sánchez *et al.*, 2010). Growth inhibition zone was 15.3 mm and MIC was recorded 250µg/ml (Hossain *et al.*, 2010).
24	*Ocimum gratissimum*	African Basil	Leaves Aerial parts	Aqueous extract Ethanolic extract	*V. parahaemolyticus* *V. cholerae*	Growth inhibition zone was 15 ± 0.18 mm. MIC and MBC were 1.25 and 5 mg/mL, respectively (Igbinosa and Idemudia, 2016). Growth inhibition zone was 12.5 mm at concentrations of 1000 µg/ml (Mann, 2012).
25	*Origanum majorana*	Marjoram	Aerial parts	Essential oil	*V. alginolyticus*	Growth inhibition zone was 12.33 mm. MIC and MBC were 0.39 and 3.125 mg/ml, respectively (Hajlaoui *et al.*, 2016).
26	*Petroselinum crispum*	Parsley	Aerial parts Leaves	Essential oil Essential oil	*V. cholerae* *V. cholera*	Growth inhibition zone was 12 mm. MIC and MBC were 0.011 and 11.25 mg/ml (Snoussi *et al.*, 2016). Growth inhibition zone was 15 mm. MIC and MBC were 0.125 mg/ml and 0.125 mg/ml, respectively (Karimi *et al.*, 2013).
27	*Punica granatum*	Pomegranate	Fruit Leaves	Methanolic extract Aqueous extract	*V. cholerae* *V. parahaemolyticus*	Growth inhibition zone was 26 mm (Pradeep*et al.*, 2008). Growth inhibition zone was 11 mm and MIC was 10 mg/ml (Sharma and Patel, 2009).
28	*Rosmarinus officinalis*	Rosemary	Aerial parts Leaves	Essential oil Essential oil	*V. alginolyticus* *V. alginolyticus*	Growth inhibition zone was 10.66 mm. MIC and MBC were 0.625 mg/ml and 2.5 mg/ml (Snoussi *et al.*, 2008). Growth inhibition zone was 26.33 mm. MIC and MBC were 25 and 50 mg/ml, respectively (Miladi *et al.*, 2013).
29	*Satureja bachtiarica Bunge*	Marzeh e Koohi	Aerial parts Leaves	Essential oil Essential oil	*V. parahaemolyticus* *V. Parahaemolyticus*	MIC and MBC were 31µg/ml (Pirbalouti *et al.*, 2011). MIC and MBC were 12.5 and 25 mg/ml, respectively. Growth inhibition zone was 16.2 mm (Raissy *et al.*, 2015).
30	*Solanum nigrum*	Black nightshade	Leaves Fruit	Ethanolic extract Methanolic extract	*V. cholera* *V. cholerae*	MIC and MBC were 50 and 100 ppm, respectively (Rahnama *et al.*, 2017). MIC and MBC were 8 and 12 mg/ml, respectively (Acharyya *et al.*, 2009).
31	*Spondias mombin*	Hog plum	Leaves	Ethanolic extract	*V. cholerae*	Growth inhibition zone was 22 mm. MIC and MBC were 83.13 and 166.25 mg/ml (Shittu *et al.*, 2014).
32	*Stevia rebaudiana*	Sweet Leaf	Leaves Leaves	Ethyl acetate extract Ethanolic extract	*V. cholerae* *V. parahaemolyticus*	Growth inhibition zone was recorded 18 mm (Jayaraman *et al.*, 2008). Growth inhibition zone was 12.18 mm and MIC was recorded 100 µg/disc (Siddique *et al.*, 2014).
33	*Syringodium isoetifolium*	Seagrass	Leaves Leaves	Ethanolic extract Methanolic extract	*V. parahaemolyticus* *V. parahaemolyticus*	Growth inhibition zone was 7 ± 0.8 mm. Both MIC and MBC were 1000 µg/ml (Ravikumar *et al.*, 2011). MIC was 50 µg/ml (Iyapparaj *et al.*, 2014).
34	*Syzygium aromaticum*	Clove	Leaves Leaves	Essential oil Essential oil	*V. parahaemolyticus* *V. parahaemolyticus*	MIC was 0.125% (Yano *et al.*, 2006). Growth inhibition zone was 10/33 ± 0/33 mm. MIC and MBC were 2 and 4 mg/ml, respectively (Narouie *et al.*, 2016).
35	*Thymus vulgaris*	Thyme	Aerial parts Leaves	Essential oil Essential oil	*V. parahaemolyticus* *V. alginolyticus*	Growth inhibition zone was 22.33 ± 0.57 mm. MIC and MBC were 0.156 and 0.312 mg/ml, respectively (Snoussi *et al.*, 2008). Growth inhibition zone was 32 ± 1 mm. Both MIC and MBC were 3.12 mg/ml using agar disc diffusion method (Miladi *et al.*, 2013).
36	*Tinospora cordifolia*	Guduchi	Aerial parts	Ethanolic extract	*V. parahaemolyticus*	Growth inhibition zone was 15 ± 1.50 mm and MIC was 50 ppm (Palavesam *et al.*, 2006).
37	*Vitis vinifera*	Grape vine	Fruit	Methanolic extract	*V. cholerae*	Growth inhibition zone diameter was 6 ± 0.58 mm (Pradeep *et al.*, 2008).
38	*Withania somnifera*	Winter cherry	Leaves Root	Ethanolic extract Methanolic extract	*V. cholerae* *V. harveyi*	MIC and MBC were 12.5 and 25 ppm, respectively (Rahnama *et al.*, 2017). Plant showed maximum inhibitory activity and caused 24.3 mm growth inhibition zone (Sivaram *et al.*, 2004).
39	*Zataria multiflora*	Avishan-e Shirazi	Leaves Aerial parts	Methanolic extract Essential oil	*V. cholera* *V. parahaemolyticus*	Growth inhibition zone was 10 mm and had a 12.5 mg/mL MIC (Taherpour *et al.*, 2015). MIC and MBC were 31 and 125 µg/ml, respectively (Pirbalouti *et al.*, 2011).

40	*Zingiber officinale*	Ginger	Rhizomes Whole plant	Essential oil Aqueous extract	*V. cholera* *V. cholerae*	MIC value was determined 500 µg/ml (Hamad *et al.*, 2016). Growth inhibition zone was equal to 9 mm (Islam *et al.*, 2014).

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 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 *Vibriosis* phytotherapy.

CONCLUSION

The result of this review revealed that among all the *vibrio* species, most of the studies have focused on the antibacterial 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.

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