Salmonelllosis Phytotherapy: A review on Iranian most important medicinal plants affecting on Salmonella

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ABSTRACT

Salmonella are isolated from diarrheal diseases, typhoid fever, bacteremia and enterocolitis. Salmonella-related diseases are major health problem in most of countries. Scientific research approach has been to achieve plants bioactive substances due to drug resistance and side effects of chemical antimicrobial drugs. Plants can be considered as a source of potentially useful chemicals but only a fraction of them have been used in medicine. We aimed in this review article to present anti Salmonella effects of Iranian native medicinal plants. The information was obtained using key words including Salmonellosis, Salmonella, medicinal plant, essential oil, searching scientific databases scientific information database (SID), Magiran, Google scholar, Blackwell, Wiley, Springer and ScienceDirect. Ten plant families of native medicinal plants of Iran were found to be effective on Salmonella including Thymus multiflora, Thymus vulgaris, Hibiscus sabdariffa, Ferulago angulata, Avicennia marina, Crocus sativus L, Cordia myxa L, Ziziphus clinopodioides, Allium sativum, Teucrium polium L, Satureja hortensis L, Anethum graveolens and Vaccinium arctostaphylos plants. Phenolic compounds, flavonoids and tannins, such as thymol, carvacrol and coumarin have been isolated from the most anti salmonellosis plants. Carvacrol is common antioxidant and bioactive compound in all of these plants. Most used medicinal plants as anti-Salmonella compound has belonged to Lamiaceae family (31% of Iranian native plant families). Active ingredients of Lamiaceae medicinal plants can be produced and entered in pharmaceutical market as anti-Salmonella drugs.

KEY WORDS: Salmonella, Medicinal plants, Essential oil, Iran

1. INTRODUCTION

Salmonella group comprising over 2,300 serotypes adapted to growth in human and animal’s body and can cause wide range of diseases. Salmonella Typhi and S. Paratyphi limited to human and cause enteric fever. Enteric fever is a global health problem and affects approximately 13-17 million people worldwide with six million deaths, annually (Lesser and Miller, 2005). Salmonella enteric fever is endemic in Indian Subcontinent, Central and South America and Asia with rapid population growth, increasing urbanization, improper disposal of human excreta and restricted water resources. Salmonella are isolated from diarrheal diseases, typhoid fever, bacteremia and enterocolitis. Salmonella-related diseases are major health problem in the world, especially in developing countries, including Iran (Nordmann, 2008). Infectious disease is the major cause of mortality, especially in third world countries. Due to high cost and probably resistant to available antibiotics and their side effects during long therapeutic period, some of them may be more dangerous than the disease (Fatholahzadeh, 2009; Asadollahi, 2012; Taherikalani, 2011; Emaneini, 2009; Jabalameli, 2011; Soroush, 2010; Taherikalani, 2008; Pakzad, 2011; Shahsavani, 2012; Haghhi-Ashtiani, 2007; Khoramrooz, 2012; Asadollahi, 2011; Akbari, 2010; Jabalameli, 2012; Sahebekhtiar, 2011; Kalantari, 2007; Nakhjavani, 2013). Salmonella diseases occur in humans in the form of food infection, gastroenteritis, typhoid fever and sometimes septicemia. Animal foods suitable place for Salmonella serotypes and are important as a source for human non typhoid salmonellosis such as poultry meat and meat products. S. typhimurium and S. typhi are human compatible serotypes with no diseases in non-human hosts. Pathogenic bacteria become resistant to antibiotics and antimicrobials drugs by different mechanisms such as: changing of permeability to drugs, efflux pump, using secondary metabolic pathways, changing of drugs receptors and producing of destructive enzymes (Oussalah, 2005).

Antibiotics are the most prescribed drugs in the infectious diseases which confront with pathogens by removing or stopping their proliferation. Major problems of antibiotics are their irreparable side effects and microbial resistance. Therefore, it seems using of new drugs or medicinal plants with fewer side effects is necessary (Kokoska, 2002). Undoubtedly, one of the most ancient human approaches is use of herbs to treat diseases. A close relationship between people and plants has always been during the development of the human civilization. Due to drug resistance and side effects of chemical anti-bacterial drugs, scientific researches tendency increased on natural resources in recent decades, including several studies on antibacterial activity of various plants (Lin, 1999; Bahmani, 2012, 2013, 2014, 2015; Delfan, 2014; Amirmohammadi, 2014; Eftekhari, 2012; Gholami-Ahangaran, 2013; Forouzan, 2012;

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2. MATERIALS AND METHODS

The information was obtained using key words including Salmonellosis, Salmonella, medicinal plant, essential oil, searching scientific databases scientific information database (SID), Magiran, Google scholar, Blackwell, Wiley, Springer and Sciencedirect.

3. RESULTS

Ten plant families of native medicinal plants of Iran were found to be effective on, including Thymus multiflora, Thymus vulgaris, Hibiscus sabdariffa, Ferulago angulata, Avicennia marina, Crocus sativus L., Cordia myxa L., Ziziphora clinopodioides, Allium sativum, Teucrium polium L., Satureia hortensis L., Anethum graveolens and Vaccinium arctostaphylos plants. Effective Medicinal plants against Salmonella are listed in Table 1. Most used medicinal plants as anti-Salmonella compound has belonged to Lamiaceae family (31% of plant families).

Table 1. Effective medicinal plants native to Iran used against Salmonella

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Plant Family</th>
<th>Farsi name</th>
<th>Discussion</th>
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<tbody>
<tr>
<td>Thymus multiflora</td>
<td>Lamiaceae</td>
<td>Avishan shirazi</td>
<td>Antibacterial property of thyme essential oil (EOs) on the growth of Salmonella typhimurium in the soup was significant and correlation coefficient between logarithmic number of Salmonella and EOs concentration was 0.2 – 0.4 (Mosavai, 2010).</td>
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<tr>
<td>Thymus vulgaris</td>
<td>Lamiaceae</td>
<td>Avishan baghi</td>
<td>Obtained results showed that the number of Salmonella enteritis in sauce samples containing different concentration of Thymus extract in comparing with control sample had significant difference, statistically. Samples containing 0.1 and 0.2% extract had the same effect on Salmonella enteritidis (Zabetian-Hosseini, 2010).</td>
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<tr>
<td>Hibiscus sabdariffa</td>
<td>Malvaceae</td>
<td>Chai torsh</td>
<td>Salmonella Enteritidis showed low sensitivity to the hibiscus extracts. Most significant antimicrobial effect on the bacteria showed in Concentrations of 30 and 40 mg/ml (Tabatabaei-Yazdi, 2015).</td>
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<tr>
<td>Ferulago angulata</td>
<td>Apiaceae</td>
<td>Chavill</td>
<td>Results of a study by disk diffusion method showed that ethanol extract of Chavill had MIC and MBC on S.typhimurium (PTTC 1609), 64 and 32 mg/ml, respectively (Tabatabaei-Yazdi, 2014).</td>
</tr>
<tr>
<td>Avicennia marina</td>
<td>Acanthaceae</td>
<td>Harra</td>
<td>The Methanol extract of mangrove plant has shown quite anti-Salmonella effect in a 2 mg/ml dose in vitro. The ethanol extract of the leaves of mangrove in concentrations of 20, 25, 30, 35 and 40 mg were quite effective against salmonella (Alizadeh Behbahani, 2014).</td>
</tr>
<tr>
<td>Crocus sativus L.</td>
<td>Iridaceae</td>
<td>Zafaran</td>
<td>MIC of saffron’s methanol extract for salmonella typhimurium was 40 mg/ml. It was found inhibition diameter of aqueous extract of saffron on Salmonella typhimurium was up to 20 mm, for ethanol extract of saffron up to 21 mm and 20 mm for methanol extract (Gandomi NasrAbadi, 2012).</td>
</tr>
<tr>
<td>Cordia myxa L.</td>
<td>Boragaceae</td>
<td>Sepstan</td>
<td>MIC and MBC of Methanol extract of Cordia myxa L. on Salmonella typhi were 32 and 256 mg/ml, respectively (Pirnia, 2015).</td>
</tr>
<tr>
<td>Allium sativum</td>
<td>Liliaceae</td>
<td>Sir</td>
<td>Garlic accelerates the process of improving clinical symptoms of intestinal infection with Salmonella</td>
</tr>
<tr>
<td>Plant Species</td>
<td>Family</td>
<td>Main Components</td>
<td>Effect</td>
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<tr>
<td>Zizipho clinopodioides</td>
<td>Lamiaceae</td>
<td>Kakuti</td>
<td>The minimum inhibitory and bactericidal concentrations of Zizipho was determined 250 μg / l on Salmonella enteritidis (Anonymm, 2007).</td>
</tr>
<tr>
<td>Teucrium polium L.</td>
<td>Lamiaceae</td>
<td>Kalpooreh</td>
<td>Results showed a bactericidal effect of T. polium on Salmonella typhi and its inhibition diameter was 22 mm and 17 mm when tetracycline was used (Moghtader, 2013).</td>
</tr>
<tr>
<td>Satureia hortensis L</td>
<td>Labiatae</td>
<td>Marzeh</td>
<td>Mice treated with ethanol extract of Satureia hortensis L. and Anethum graveolens alone and in combination with neutral supernatant of probiotics compared with control group was showed significant decrease in shedding and colonization of Salmonella typhimurium, respectively (Anonyme, 2013).</td>
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<td>Anethum graveolens</td>
<td>Umbelliferae</td>
<td>Shvid</td>
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<tr>
<td>Vaccinium arctostaphylos</td>
<td>Ericaceae</td>
<td>Siahdar</td>
<td>Salmonella typhi strain were sensitive to aqueous and methanol extract of Vaccinium arctostaphylos. Extracts inhibition diameter on bacteria was 6.6 -26.6 mm. MIC and MBC values were between 50 - 200 mg/ml and 100 - 400 mg /ml, respectively (Mocini, 2015).</td>
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</table>

**DISCUSSION**

Medicinal plants and their compounds have fewer side effects due to natural origin and compatibility with the body systems and are considered as an alternative to chemical antibiotics because of microbial resistance to this class of drugs (Kasra Kermanshahi, 2008; Mitscher, 1972). According to reliable reports in the scientific literature, different compositions of herbs, spices, vegetables, leaves, bark and animal tissue have antimicrobial properties (Bart, 2004; Cowan, 1999; Gould, 1996; Lemay, 2002; Roler, 1999; Smith–Palmer, 2001).

Many studies have been implemented in relation to antibacterial effects of Lamiaceae essential oils and their known compounds including carvacrol and thymol (Kim, 1995; Nickavar, 2005; Sacchetti, 2005; Yang, 2001). Phytochemicals studies show effective antimicrobial compounds in *Thymus vulgaris* extract are Flavonoids such as Apigenin, Naringenin, Luteolin, and essential oils with Carvacrol and Thymol (Behnia, 2008). The main component of *Thymus multiflora* essential oil is Thymol, with antimicrobial properties. Antimicrobial mechanism of essential oils is due to their reaction with microorganism’s cell membrane and changing its permeability to compounds such as potassium ion and hydrogen (Smith-Palmer, 1998).

Effective components of *Ferulago angulate* are phenolic compounds such as Thymol, Carvacrol, Eugenol and Coumarin. It's known that Carvacrol prevent the proliferation of cells and kill the pathogenic bacteria through destruction of cell membranes, effects on intracellular PH homeostasis and disturbance in the inorganic ions balance (Madureira, 2005).

A. marina has aliphatic acids and alcohols, alkaloids, carotenoids, tannins, terpenes, glycosides and etc compounds (Chen, 2008). Phytochemical analysis of *Cordia myxa* L. show that this plant contains flavonoids such as rutin, phenolic derivatives, terpenes, coumarin, Pyrrolizidine alkaloids such as macrophiline, sterols and saponins (Jamkhande, 2013). Allicin is active ingredient and pharmaceutical composition of *Allium sativa* (Gomaa and Hashish, 2003). Pulegone is active ingredient of a number of Lamiaceae family plants such *Zizipho clinopodioides* (Sajadi, 2003; Babakhanloo, 1998; kugel, 1991). Teucrium polium L. plant analysis show that Carvacrol, β-caryophyllene, γ-cadinene, α-humulene, Germacrene D and is Caryophyllene oxide are active ingredients (Aburjai, 2006; Cakir, 1998). *Satureia hortensis* L. containing carvacrol and main active compounds of Anethum graveolens are Flavonoids such as quercetin 3-O-beta-d-glucuronide and isorhamnetin 3-O-beta-d-glucuronide (Sefidkon, 2005; Abbasi, 2005; Singh, 2005; Misaghi, 2007; Ogubanwgo, 2003; Mahboubi and Haghi, 2008; Delaquis, 2002). *Vaccinium arctostaphylos* contains phenolic compounds, anthocyanins, myricetin, thymol and carvacrol (Guha, 2013; Pervin, 2013; Puupponen-Pimiä, 2005; Puupponen-Pimiä, 2001). Phenolic compounds, flavonoids and tannins, such as thymol, carvacrol and coumarin have been isolated from the most anti salmonellosis plants including *Thymus multiflora* (common thyme), *Thymus vulgaris* (Garden thyme), *Hibiscus sabdariffa* (hibiscus), *Ferulago angulate* (Chavill), *Avicennia marina* (mangrove), *Crocus sativus* L. (saffron), *Cordia myxa* L. (Wild Iris), *Zizipho clinopodioides* (Zizipho radish), *Allium sativa* (garlic), *Teucrium polium* L. (poly germander), *Satureia hortensis* L. (savory), *Anethum graveolens* (dill) and *Vaccinium arctostaphylos* (Vaccinium). Carvacrol is common antioxidant and bioactive compound in all of these plants.
CONCLUSION

The active ingredients of plant extracts and essential oils with antimicrobial properties can be considered as effective anti-Salmonella and anti-pathogenic bacterial compounds after separation and complementary pharmaceutical studies. Most used medicinal plants as anti-Salmonella compound has belonged to Lamiaceae family (31% of Iranian native plant families). Active ingredients of Lamiaceae medicinal plants can be produced and entered in pharmaceutical market as anti-Salmonella drugs.

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Iran


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Ethanolic Extracts of Cordia myxa L


