Chapter

Applications of Medicinal Herbs and Essential Oils in Food Safety

Razzagh Mahmoudi, Ata Kaboudari and Babak Pakbin

Abstract

In the last few years, more and more studies on the biological properties of essential oils (EOs) especially antimicrobial and antioxidant properties in vitro and food model have been published in all parts of the world. But so far no comprehensive reports of these studies have been reported in food model from Iran. The focus of this overview lies in the using of EOs from some indigenous medicinal plants of Iran (including *Mentha longifolia*, *Cuminum cyminum*, *Teucrium polium*, *Pimpinella anisum* and *Allium ascalonicum*) in probiotic dairy products (especially cheese, yoghurt and Aryan) in recent years. Recently, consumers have developed an ever-increasing interest in natural products as alternatives for artificial additives or pharmacologically relevant agents. Among them, EOs have gained great popularity in the food, cosmetic as well as pharmaceutical industries. Despite the reportedly strong antimicrobial activity of EOs against food-borne pathogens and spoilage microorganisms, their practical application as preservatives is currently limited owing to the undesirable flavour changes they cause in food products. Nonetheless, more studies are necessary to the applicability of various EOs on other food models in Iran and other countries.

Keywords: EOs, functional dairy foods, natural preservative, sensory quality

1. Introduction

Today, due to the adverse effects of chemical preservatives, regarding the carcinogenic potential and toxicity to humans, as well as the high levels of antimicrobial agents present in plants, there is a growing interest in the use of natural preservatives derived from natural sources [1]. Food storage methods which maintain the quality and extend the shelf life of food because of improved production, supply and trading are important. Humans are familiar in keeping foods by different methods such as the use of heating, cooling, salting, etc. a long time ago, but for inhibition of pathogen growth and also prevention of food spoilage, a new method is more in need; therefore one of these methods is the use of essential oils and natural materials as antimicrobial additives in food [2].

Essential oils are composed of lipophilic and highly volatile secondary plant metabolites [3]. As defined by the International Organisation for Standardisation (ISO), the term "EOs" is reserved for a product obtained from vegetable raw material, either by distillation with water or steam, or from the epicarp of citrus fruits by a mechanical process, or by dry distillation, that is, by physical means only. EOs have been proposed as natural preservatives and are used as alternatives for the control of pathogenic microorganisms. Herbal EOs are aromatic oil liquids, extracted from

various parts of plants, and are used as flavouring agents in foods; thus the importance of the use of medicinal plants in food products can be multiple times [4].

2. How plants work

Preservatives are used to limit the growth and microbial activity in pharmaceutical products, food and cosmetics, and by interfering with cell membranes, enzymes and genetic structure of microorganisms have a preventive effect. To apply the essential oils as chemical preservatives in food, investigating their antibacterial activities alone and in combination with other factors affecting the growth of microorganisms in food and nutrition is essential in laboratory models [2]. The use of natural antimicrobial compounds such as essential oils, herbal extracts and spices for the protection of food against microbial spoilage has led to the identification of some of their unique features such as taste effects and antioxidant activity [5]. EOs have been used in human health as functional food, food additives, medicine, nutritional supplements and cosmetic manufacturing [4, 6, 7].

Essential oils and plant extracts with various biological compounds have very high potential for using as new drug combinations, healthcare and human and animal diseases as well due to the presence of anti-microbial compounds especially against Gram-Positive and Gram-Negative pathogens, Anticancer, Antioxidant and Free Radical Removal Factors as one of the most important natural sources for the using of them in medicines and foods [1]. Essential oils and extracts from medicinal herbs with antimicrobial, anticancer and antioxidant compounds (due to the presence of free radicals eliminating agents) have importance as new and natural drug combinations, both in the field of health and disease management and in the protection of raw and processed foods [8].

3. Importance of food-borne pathogens

Food-borne diseases recognised as one of the major public health problems worldwide, especially in developing countries, and, on the other hand, increasing incidence of food-borne disease along with its social and economic consequences have led to conducting extensive research in order to produce safer food and develop new antimicrobial agents; among them, the extensive use of probiotics and bacteriocins as biological additives is of considerable importance. With increase of urban population, tourism, immigration, a variety of food with different components, improve technology in the food industry, changes in food consumption culture and approach to food consumption, food preparation, and finally international trade in food, overburdened the more food illness in the present age, so that about 30 per cent of people in developed countries at least once a year to develop food-borne diseases [4]. Despite the reportedly strong antimicrobial activity of EOs against food-borne pathogens and spoilage microorganisms, their practical application as preservatives is currently limited owing to the undesirable flavour changes they cause in food products [6, 9–11].

4. Some of the most important plants that can be used in foods

4.1 *Mentha longifolia* L.

Mentha longifolia L. from *Lamiaceae* essentially grows in wet river banks of temperate areas of Central and South Europe, Australia, South-West Asia and Iran.

The EOs of this plant varying in quantity according to variety and characteristic of the growing site are composed of cationic compounds especially pulegone, 15–40% total alcohols, 7–12% limonene and Dilantin. This plant bears medicinal characteristics and has proven to be of benefit for digestive system disorders, vomiting and loss of appetite, ulcerative colitis and liver malfunctions. Other reported inhibitory effects have been reported towards microorganisms causing food-borne diseases, for example, *S. aureus*, *E. coli*, *Bacillus subsp*., *Salmonella subsp*. and *Aspergillus subsp*. [8, 12].

4.2 *Cuminum cyminum* L.

C. cyminum with the vernacular name of "Zireh e Sabs" (in Iran) is a plant belonging to the *Apiaceae* family applied in Iranian folk medicine since more than 200 years ago. Major constituents in *C. cyminum* essential oil (EO) are cumin aldehyde, cuminic alcohol, gamma-terpinene and ß-pinene [11, 13]. This plant has inhibitory effects on *E.coli*, *L. monocytopenia* and *S. aureus* [14].

4.3 *Teucrium polium* L.

This plant is belonging to the mint family, plateau, a height of 10 to 30 cm, with a white cottony appearance, usually in poor areas (nutrients and organic matter), rocky areas and sand dunes in Europe, the Mediterranean region, north of Africa and south west of Asia, including Iran, especially Khorasan province [2]. The studies have shown that this herb has antioxidant effects and antipyretic, antimicrobial and antispasmodic effects [15]. It has been reported that the ethanol extract of this herb has also an antibacterial activity against Gram-positive and Gram-negative microorganisms of the show itself [16]. *Bacillus cereus* in the food samples is one of the ingredients that is inhibited by the essential oil of this plant [2].

4.4 *Pimpinella anisum*

Pimpinella anisum L. is a plant with white leaves and small green yellowish seeds and is from the *Umbelliferae* family. This plant grows in countries such as Iraq, Turkey, Iran, India, Egypt and many tropical areas of the world [14, 17]. EOs of some species of this plant are used in treating diseases such as epilepsy [18].

4.5 *Echinophora orientalis*

Echinophora is a plant of the family *Apiaceae* that includes 10 species that have been distributed from the Mediterranean area to Iran. *E. orientalis* is a common species in Iran [19]. Two species of 10, including *E. sibthorpiana* and *E. orientalis*, are also growing in Anatolia, Turkmenistan, Armenia, Russia, Syria, the Balkans, Cyprus and Afghanistan [20, 21]. *Echinophora* EO contains alkaloid compounds and flavonoids [19]. γ-Decalactone, β-cis-ocimene and linalool L are the most important compounds in the EO of this plant [19]. This plant and its oil have antiseptic, antibacterial, antioxidant and antifungal effects and can inhibit human platelet aggregation and are also used in folk medicine to heal wounds and have carminative and digestive properties [22–25]. In the result of a study, different concentrations of *E. orientalis* EO significantly affected the growing of *S. aureus* bacterial in food model [19]. In another study, *E. tenuifolia* EO showed strong antimicrobial activity against *B. cereus* and *Staphylococcus spp* [26].

4.6 *Aloe vera* gel (*Aloe barbadensis Miller*)

Aloe vera (*Aloe barbadensis Miller*) is a plant, which belongs to the family of *Liliaceae*. *Aloe vera* grows in arid climates and is widely distributed in India, Africa and other arid areas [27]. The 0.7% of gel of leaves is made up of solids mainly carbohydrates [28]. Activity against a variety of infectious agents has been attributed to *Aloe vera* such as antiviral, antibacterial and antifungal effects [29–31]. Some specific plant's compounds have been proposed to have direct antimicrobial activity, for example, anthraquinones, dihydroxyanthraquinones and saponins [32–35]. The antibactericidal activity of *Aloe vera* gel may be attributed to active compounds such as alkaloids, tannins, flavonoids as well as saponins which have a direct antimicrobial activity [33, 36]. In the results of a study, the antimicrobial potency of *Aloe vera* gel aqueous extract against *E. coli* has been shown in yoghurt [37]. In the study of Agarry et al. [38], they reported that leaf extracts had antibacterial activity against bacterial species such as *S. aureus*, *Klebsiella pneumoniae* and *E. coli*. In another study, the ethanol extract of *Aloe vera* gel inhibited the growth of *E. coli* and *S. aureus* [39].

4.7 *Ferula sharifi*

The genus *Ferula* belongs to the family *Apiaceae* that comprises about 170 species in the world. These genera are produced from central Asia to northern Africa [40]. These plants are well documented as a good source of biologically active compounds such as sesquiterpenoids and sulphur-containing compounds [41]. Species of this genus have been used in traditional medicine for the treatment of various organ disorders, for example, *F. assa-foetida* used as anticonvulsant, carminative, antispasmodic, diuretic, aphrodisiac, antihelmintic, tonic, laxative and alterative or *F. persica* used as laxative, carminative, antihysteric and for treatment of lumbago, diabetes and rheumatism [22, 40, 42–45].

5. The sensitivity of some important food-borne pathogens to plant extracts and EOs

5.1 *Listeria monocytogenes*

Food-borne diseases are one of the major public health problems worldwide, and recent reports indicate that *Listeria monocytogenes* is a major concern. *Listeria monocytogenes* can cause food intoxication, meningitis and encephalitis [6]. Control of these bacteria and its diseases are very important. So, various studies have been carried out on the effects of different essential oils and extracts on growth and control of these bacteria.

In the study of Ehsani et al. [46], the results have shown that treatments of 0.1% *Allium ascalonicum* and *Pimpinella anisum* essential oils at the end of cheese ripening period showed the highest decrease in the mean bacterial colony counts. The results of Mahmoudi et al. study have shown that *Cuminum cyminum L.* essential oil on *Listeria monocytogenes* has effects at different concentrations [8]. These results, as well as the results from other studies, have shown that essential oils and plant extracts could help the control of the bacteria in the food industry.

5.2 *Salmonella typhimurium*

Salmonella typhimurium is a pathogenic food-borne bacterium. *Salmonella* is widespread worldwide and found sporadically in water, soil, animal food, meat,

faeces and vegetables and can infect many mammals and birds [47]. Considering that this bacterium can cause disease through food, including dairy products in humans, its control through essential oils and plant extracts is very much considered. *Salmonella* infection may occur in one of three clinical forms of self-sustaining gastroenteritis, then septicaemia with local lesions or an enteric fever or typhoid fever [48].

For example, *Teucrium polium* EO has the best *Salmonella* growth inhibition at 60 ppm and 80 ppm concentrations. In this research, no *Salmonella* was isolated during the 28 days of preservation of probiotic yoghurt [49].

5.3 *Staphylococcus aureus*

Staphylococcus aureus is one of the most important pathogenic food-borne bacteria. These bacteria can cause diarrhoea and vomiting intoxication [5]. Due to the importance of these bacteria and its toxicity, as well as due to the health hazards of chemical preservatives, researchers have used various essential oils and herbs to control these bacteria in their experiments [6].

In the result of one study, essential oil of *Mentha longifolia L.* with a concentration of 150 ppm has an inhibitory effect against *Staphylococcus aureus* [6]. In a study, 21 essential oils were used for antibacterial effects. As a result, the essential oils of *Corydothymus capitatus*, *Cinnamomum cassia*, *Origanum heracleoticum*, *Satureja montana* and *Cinnamomum verum* were effective against *Staphylococcus aureus* [50, 51].

Today, the importance of biofilm formation in the food industry is also high, so studies have also been carried out and are expanding. In these studies, vegetable oils are used to prevent and eliminate biofilms. For example, the compounds in essential oils such as SAB, C3 and C4 are highly effective against biofilms created by *Staphylococcus aureus* [52].

6. Herbal medicines appear relatively safe

Traditional medicine has brought the foundation of health care around the world from the earliest days of human beings. Medicinal plants have been known for many years as a rich source of well-known therapeutic agents for the treatment and prevention of various diseases, the most important of which is the social, cultural, spiritual and medicinal fields. Over the past centuries, severe changes in human lifestyle and dietary habits have led to the emergence of various chronic pathologies. Recently, "herbal renaissance" is a visible phenomenon worldwide, and two-thirds of the plant species in the world may have medicinal value. The World Health Organisation believes that 80% of the population in Africa and Asia uses traditional medicine as the first source for their health-care needs. Also, in the United States, more than 40% of the population has recently been identified with complementary and alternative supplements, including herbal supplements [53].

7. Conclusion

Herbal drugs appear to be relatively safe, but human research or prospective data on adverse effects and plant and drug interactions are limited. They generally have fewer drugs than their pure relatives because they contain a mixture of chemicals that are in low amounts. According to studies, the importance of edible oral pathogens is not covered for everyone. According to studies, the importance of food-borne pathogen bacteria is not covered for everyone. On the other hand, due to

the harmful effects of chemical preservatives and also the increase of drug resistance, the use of plants and their essential oils is very important. Essences and their effective compounds can be used to prevent poisoning and disease and to prevent the transmission of bacteria from food and food industry like dairy.

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