Healthful characteristics of pennyroyal essential oil

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ABSTRACT

Pennyroyal, an aromatic herb, is considered by food and medicine industries. It grows in different countries and provides various technological and functional properties. Essential oils (especially 'Pulegune') are the effective materials of pennyroyal that causes anti-microbial, anti-oxidant and aromatic properties. These essential oils have significant effects on preventing growth of several species of pathogenic and spoilage bacteria. Furthermore, these oils maintain food quality by preventing the oxidation of fatty acids and increasing product shelf life. Therefore, it seems that pennyroyal is an appropriate alternative for synthetic antioxidants. On the other hand, it can be used in treatment from medicinal point of view. Overall, pennyroyal essential oils are a good, natural and economical alternative for food and medicine industries. The present article focuses on the healthful and technological characteristics of pennyroyal essential oils.

Key words: Antimicrobial; Antioxidant; Aroma; Essential oils; Pennyroyal.

INTRODUCTION

'Labiatae' or 'Lamiaceae' family contains 220 genus and 3300 species that have different uses [1]. *Mentha Pulegium L.* or pennyroyal is one of the species of *Mentha* genus from *Labiatae* family [2-8]. This plant grows in southwest and central European countries like Ukraine, Ireland, North Africa, Ethiopia, Brazil, Tunisia, Portugal and Arabic countries [2, 4, 5, 9, 10]. Spain and Morocco are main pennyroyal oil producer countries which in order provide 3 and 7-16 tons per year [9]. This worth plant grows also spontaneously in humid parts of Iran [2, 9]. Its quality is affected by environmental conditions (e.g., water tension in summers) as well as the salinity of water and soil [10].

Studies have revealed that since pennyroyal essential oils have a great effect on preventing the growth and development of several species of pathogenic and spoilage bacteria, this herb can be used as an antispasmodic, antiseptic and anti-inflammatory agent [1, 2, 4, 10-13]. Evidences have shown that essential oils of this herb have been used in the traditional medicine in many countries [7]. There are also some reports about the role of these oils in maintaining food quality; because they prevent unsaturated fatty acids from oxidation and they also increase the products' shelf life. Therefore, it seems that pennyroyal is a good alternative for synthetic antioxidants. Moreover, it has been known that pennyroyal essential oils can be used as flavors (aromatic agents) in many foods like fermented milk drinks, ice cream, cake, herbal tea and candy [1, 11, 12, 14]. Besides food products, pennyroyal essential oils could be used in some detergents and soaps, dental products, insects and ticks repellent agents [2, 4, 8, 10, 11, 14, 17]. This article reviews healthful and technological characteristics of pennyroyal essential oils.

Pennyroyal essential oils

Essential oils are natural and volatile components which are naturally occurred in fruits and vegetables or can be produced synthetically. Naturally, these oils are obtained from distillation of a dry plant or parts of it.

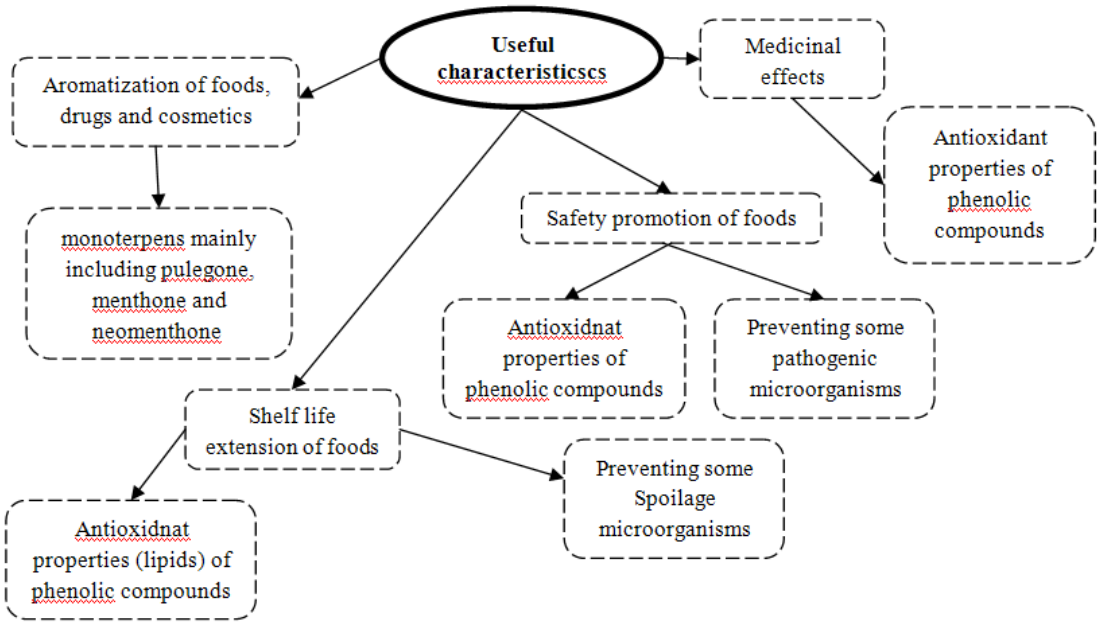

Figure 1. Useful properties of pennyroyal essential oils and some effective compounds.

Monotrepenes are considered as the main component of pennyroyal essential oils [3, 8, 11, 13, 16, 17, 19, 20] and these components mostly are formed by oxygenated monotrepenes like pulegone, menthone, and neo-menthone [1, 4, 6, 7, 18, 19, 23]. However, some other components like piperiton and 3-octanol have also been found in this herbs oil [1, 6, 21, 22]. Table 1 shows main components of pennyroyal essential oils in two different species. It is worth to say that the amount of essential oils in fresh herb depends on species of considered herb, environmental factors, ripening and removal time [19]. Afterwards, the extraction and storage conditions are considerably affect the quality and quantity of pennyroyal essential oils.

Characteristics of pennyroyal essential oils

Pennyroyal essential oils possess various useful functions. These functions can be classified in different classes. Figure 1 represents useful functions of pennyroyal essential oils. Below, the characteristics of mentioned essential oils are discussed:

Antimicrobial properties

In recent years, due to antimicrobial properties of plants, their oils have been given a lot of attention because it has been observed that the use of these agents can cause increase in many products shelf life such as fresh chicken, fish and meat while inhibiting some pathogens [21].

Antimicrobial properties of essential oils can be due to the existence of some groups like pulegone, menthone and neo-menthone [4]; because they can disrupt the structure of different layers in polysaccharides, fatty acids and phospholipids of bacterial membrane by changing permeability of cellular membrane and damaging of bacterial cell wall [4, 5]. However, reports have shown that this mechanism might decrease the efficiency of consumers' gastrointestinal tract by a negative effect on symbiotic bacteria there [5]. Researches demonstrate that pennyroyal essential oils have a strong antibacterial property against microorganisms such as *Salmonella typhimurim*, *Listeria monocytogenes*, *Yersinia enterocolitica*, *Escherichia coli*, *Bacillus cereus*, *Clostridium perfrigens*, Staphylococcus *aureus*, *Helicobacter pylori*, *Pseudomonas aeruginosa*, *klebsiella pneumonia* and *Brochothrix thermosphacta*. Among these microorganisms, the most and the least antimicrobial property has been observed for *S. typhimurim* and *B. thermosphacta*, respectively [4, 12, 23, 24]. Figure 2 shows antimicrobial effects of pennyroyal essential oils. It is understood that essential oils of this herb have a good capability for *Dermanysus gallinae's* inhibition which is oviparous chicken's pest. It should be pointed out that pennyroyal can cause visible stains on produces eggs and has a negative effect on sale.

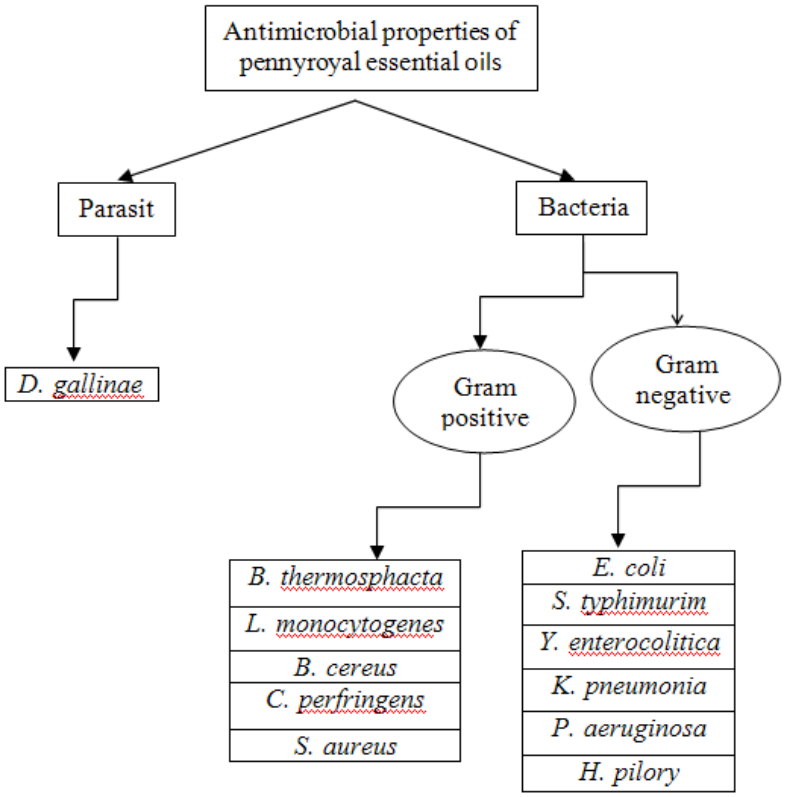

Figure 2. Antimicrobial properties of pennyroyal essential oils.

Therefore, the use of pennyroyal is not recommended in poultries' foods [18, 21, 25, 27].

Aromatic characteristic

It is determined that pennyroyal essential oils are cyclohexenes and aromatic, and pulegone is the original compounds of these oils that have a specific mint aroma from an intense to balsamic and pungent aroma. Quality and quantity of the aroma can be different based on herb variety, growth conditions, and processing and maintenance conditions. Weather conditions like temperature, the amount of sun and lack of water have great effects on the volatile compounds of pennyroyal. It has been proved that high temperature, lack of water and intense sun in summers; make the herb produce more monotrepens (like menthone and isomenthone) than pulegone. Pulegone besides its isomer 'isopulegone' and piperiton can have important portion in producing mint aroma. Some other compounds such as 3-octanol and noneone have been observed in pennyroyal, so that both of them especially 3-octanol have a huge role in aromatic characteristics of pennyroyal [6].

It has been understood that the method of volatiles extraction have considerable role in quality and quantity of plants' aroma. Pennyroyal essential oils extracted by 'supercritical fluid extraction (SFE) is better than the ones extracted with other methods [7].

Table 1. Type and proportion of the main pennyroyal essential oils in Portuguese and Iran

	Amount (percent)	
Compound	Sample of Portuguese in the summer	Sample of Iran in the spring
Pulegone	78.3	40.5
Menthone	8.8	35.4
Isomenthone	0.9	Low levels
Piperitone	0.09	5.2
3-Octanol	0.6	1.9
Menthol	1.1	Low levels
Neo-menthol	3.1	Low levels

It is more often to use both methods of Gas Chromatography-Mass Spectrometry (GC-MS) and Gas Chromatography-Olfactometry (GC-O) for departing volatile compounds of pennyroyal and its aromatic properties. GC-MS method is just used for determining volatile components of aromatic herbs; however, GC-O method provides the possibility of description and intensity of aromatic compounds. Therefore, regarding aroma characterization of pennyroyal, GC-O method can be used as a screening tool for ranking aromatic agents based on their aroma intensity [6]. In addition to these methods, SFE can also be one of the new and effective methods in separation and extraction of essential oils from various parts of herbs. Separated aromatic compounds through this method are classified in monotrepen, sesquiterpene, oxygenated monotrepene, oxygenated sesquiterpene and other hydrocarbon groups [27].

Antioxidant property

It is determined that pennyroyal essential oils have antioxidant property due to the existence of phenolic compounds such as flavonoids, phenolic acids, tannins and phenolic ditrepenes. The main components are pulegone and menthone. It has been known that watery extract of pennyroyal has the most antioxidant property and exhibits strong antioxidant property in foods especially during maintenance period [10]. Phenols are organic compounds and their hydroxyl groups are directly attached to aromatic ring, so that H-atom of the hydroxyl group can trap peroxyl radicals and prevents the oxidation of other compounds [4].

Observations have revealed that one of the main reasons of decrease in food quality is oxidation of unsaturated fatty acids which starts with the presence of free radicals. High amounts of Poly-unsaturated fatty acids (PUFA), e.g. linoleic land linolenic acids, in fats and oils or fats of foods makes them susceptible to oxidation. This problem becomes more severe when mentioned foods are subjected to the factors like oxygen, light, high temperature or some metals such as iron and copper [4,10]. Antioxidants are the main compounds which maintain fats and oils quality by delaying their oxidation. Although synthetic antioxidants like butylated hydroxy anisole (BHA), butylated hydroxy toluene (BHT) and tertiary butyl hydroquinone (TBHQ) are used widely in preventing the oxidation of fats and oils and increasing the shelf life of fatty foods, in recent years, due to their relative toxic carcinogen nature, the use of them has been criticized and limited [1,4]. This problem has led to increased interest for employing natural antioxidants including essential oil extracts. Phenolic compounds available in herbal sources play their antioxidant role by removing lipid radicals. In this regards, some kinds of vegetables have been known as rich sources of antioxidants such as savoy cabbage, spinach, savory, broccoli, onion, pennyroyal and rosemary [1].

Medicinal characteristics

Pennyroyal essential oils have used as an abortifacient and to induce menstruation. On the other hand, they have also been useful for treatments in some conditions and diseases such as various chronic diseases, digestion, liver and gallbladder disorders, goat, skin discoloration, skin disorders, aromatherapy, arthritis, infectious and parasitic diseases, cold, cholera, sinusitis, tuberculosis, food poisoning, bronchitis, and headache. Moreover, pennyroyal can be consumed as anti-flatulent, antitussive (expectorant), diuretic and anti-inflammatory, and it is used for treatment of infants' chronic diarrhea, children asthma and candidiasis. It has also been applied as anticonvulsive, antiemetic, anti-nausea, anti-stress, heart-stimulant and sedative in traditional medicine [3- 5, 8, 9, 14, 16, 20, 21-28, 30]. Apart from useful impacts of mentioned essential oils, there are some reports that consumption of pennyroyal in high-very high doses, in humans, can cause disorders such as gastritis, convulsion, disseminated intravascular coagulation (DIC), hepatotoxicity, pulmonary toxicity, renal failure, CNS toxicity, coma and even death [3, 8, 11, 14- 17].

CONCLUSION

Pennyroyal essential oils have unique characteristics and they can be applied in multiple functions such as Aromatization of foods in different industries as well as drug and cosmetics, possessing medicinal characteristics, strong antioxidant properties, and prevention of some pathogenic and spoilage microorganisms. It can be used for shelf life extension of foods and it is justifiable to be regarded as an appropriate alternative for synthetic antioxidants. Its aroma characteristic is compatible with many food and drug products and is very popular among consumers. Therefore, pennyroyal essential oils and its derivative essences have the potential to be vastly used in different industries. The

important issue that needs further investigations is to clarify the exact doses of mentioned essential oils for implying its various healthful functions. This is especially very important when the concentration of essential oils used is sufficient for exhibiting one or two healthful impact, but not the rest. This is also important for label claims on the labels of foods and drugs.

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