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Essential Oils: Its Components and Its Application in Food Preservatives

M Beyau Konyak

Department of SBSR, Sharda University, Uttar Pradesh, India

Abstract: ***With increasing globalization means high demand on import and export of goods including food materials. This makes it all the more necessary to take extreme care of food and its products. Used of chemicals and toxic compound to preserve food product has leads to an increase in antibiotics resistanceof some pathogen which has cause a major concern. Therefore, recent development is mainly focusing on the use of nontoxic antimicrobial compound such as Essentail oils as natural preservation for food products. Because of the presence of secondary metabolites and some antimicrobial agent, they are widely used in the flavor, food, fragrance, and cosmetic industries in many applications. The application of this natural preservatives is a promising technology. An Essential oil along with some new approaches plays a vital role in longer shelf life.***

Keywords: Antimicrobial, terpenes, terpenoids, phenylpropenes, application of essentials oils, perpectives of essential oils and its limitations

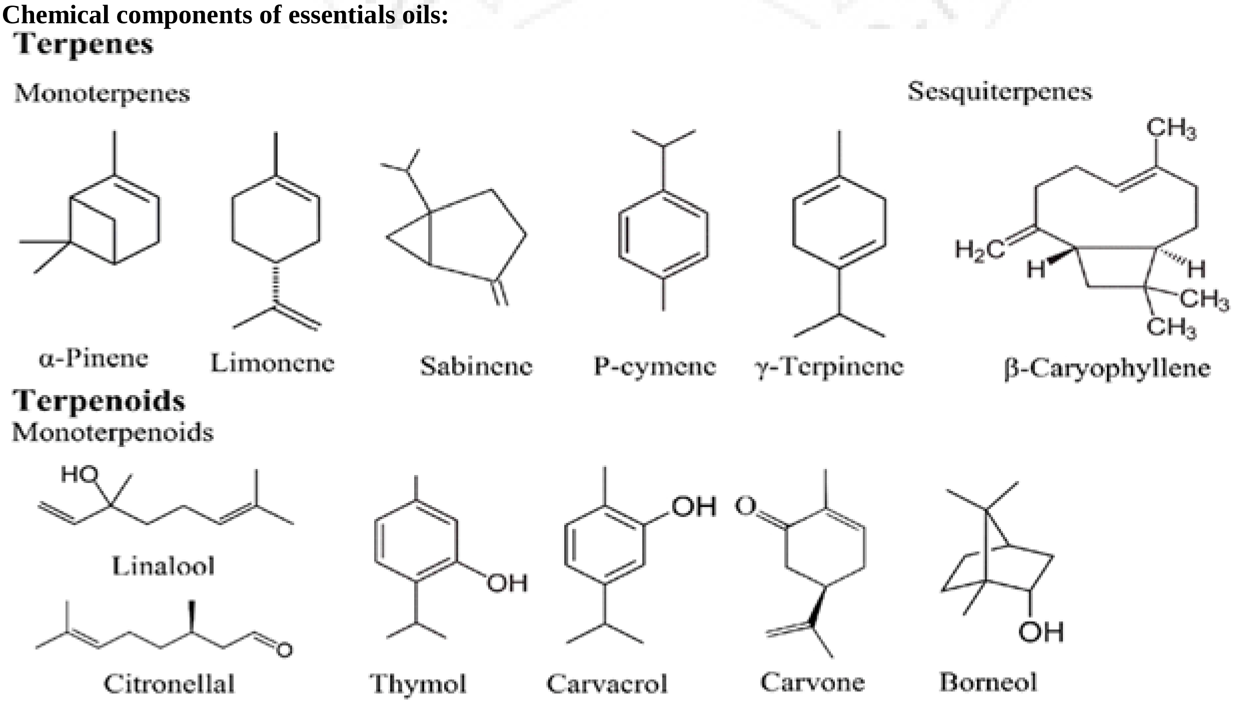
1. Introduction

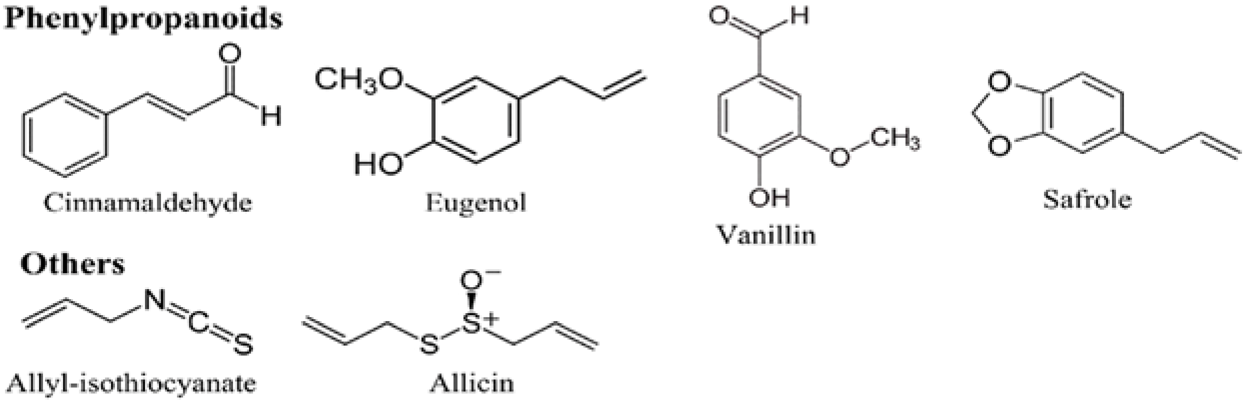
Essential oils (sometimes referred to as EOs) are volatile aromatic compounds extracted from the bark, flowers, leaves, roots, seeds, stems, and other parts of plants. Essential oils, like all organic compounds, are made up of hydrocarbon molecules and can further be classified as terpenes, alcohols, esters, aldehydes, ketones and phenols etc. They give its distinct aroma and play a crucial role in the survival of the plant as a whole, as well as its participation in the chain of life[1].They are used as alternatives medicine[2] , perfumes, cosmetics, soaps and other products, for flavoring food and drink, and for adding scents to incense and household cleaning products. Some EOs possess special medicinal properties to cure organ dysfunction or systemic disorder [3].

Essential oils have been used in folk medicine throughout history. Their initial application was in medicine, but in the nineteenth century their use as aroma and flavor ingredients increased and became their major employment. Almost 3000 different essential oils are known, and 300 are used commercially in the flavor and fragrances market [4].

Essential oils play an important role in plant defense as they often possess secondary metabolites and has antimicrobial properties [5,6] .The antibacterial properties of secondary metabolites were first evaluated using essential oil vapors by De la Croix in 1881[4]. Since then, essential oils or their components have been shown to not only possess broad-range antibacterial, but also antiparasitic, insecticidal , antiviral, antifungal, and antioxidant properties. Furthermore, they also function as growth enhancers for animals[7].

Chemical components of essentials oils:





Terpenes

It inhibits the accumulation of toxins and help discharge existing toxins from the liver and kidneys. Terpenes are a large and diverse class of organic compounds, produced by a variety of plants, particularly conifers, and by some insects. They have a strong odor which may protect the plants that produce them by deterring herbivores and by attracting predators and parasites of herbivores.[8]Although sometimes used interchangeably with "terpenes", terpenoids (or isoprenoids) are modified terpenes as they contain additional functional groups, usually oxygen-containing.[9]

Terpenes are hydrocarbons produced from combination of several isoprene units (C5H8) and are synthesized in the cytoplasm of plant cells, and the synthesis proceeds via the mevalonic acid pathway starting from acetyl-CoA. The main terpenes are monoterpenes (C10H16) and sesquiterpene (C15H24). Examples of terpenes include p-cymene, limonene, terpinene, sabinene, and pinene .

They do not represent a group of constituents with high inherent antimicrobial activity. For example, p-cymene do not has antimicrobial activity against several Gram-negative pathogens even at 85700 µg/mL concentration [10].

Terpenoids

Terpenoids sometimes called isoprenoids, are naturally occurring organic chemicals derived from terpenes. About 60% of known natural products are terpenoids. Although sometimes used interchangeably with "terpenes", terpenoids contain additional functional groups, usually O-containing.[11] Terpenoids are terpenes that undergo biochemical modifications via enzymes that add oxygen molecules and move or remove methyl groups [12].

The terpenoids are a large group of antimicrobial compounds that are active against a broad spectrum of microorganisms, with the most active monoterpenoids identified so far being carvacrol and thymol .The antimicrobial activity of most terpenoids is linked to their functional groups, and it has been shown that the hydroxyl group of phenolic terpenoids and the presence of delocalized electrons are important for antimicrobial activity. For example, the antimicrobial activity of the carvacrol derivatives carvacrol methyl ether and p-cymene were much lower than carvacrol [13]. The antimicrobial activity of essential oils can often be correlated to its content of phenolic constituents .

In 2000 Dorman and Deans investigated the effect of terpenoids against 25 different bacterial strains. It showed that all terpenoid compounds, except borneol and carvacrol methyl ester, exhibited a broad antimicrobial activity. The antimicrobial activity of carvacrol, thymol, linalool, and menthol were evaluated against Listeria monocytogenes, Enterobacter aerogenes, E. coli, and Pseudomonas aeruginosa respectively. The most active compound was carvacrol followed by thymol with their highest MIC being 300 and 800 µg/mL, respectively [14]. These results confirm that terpenoids are closely related to terpenes.

Phenylpropenes

phenylpropene is derived from the general shikimate/ phenylpropanoid synthesis pathway, and belong to the immensely diverse and important class of phenylpropanoids [15]. Phenylpropene is the scaffold for a class of derivatives called phenylpropenoids, that may also be called Phenylpropenes, propenylphenols, alkenylbenzenes or allylbenzenes

Phenylpropanoids have their name from the six-carbon aromatic phenol group and the three-carbon propene tail of cinnamic acid, produced in the first step of phenylpropanoid biosynthesis. The phenylpropenes constitute a relatively small part of essential oils, and those that have been most thoroughly studied are eugenol, isoeugenol, vanillin, safrole, and cinnamaldehyde.

Comparison of molecules that are chemically similar to eugenol and isoeugenol indicated that the free hydroxyl groups are important for their activity against bacteria, but not yeast [16]. Furthermore, the antimicrobial activity of phenylpropenes depends on the kind and number of substituents on the aromatic ring, selected microbial strains, and the experimental test parameters such as choice of growth medium, temperature, etc.

The antibacterial activity of eugenol was evaluated against 25 different bacterial strains of which only one strain was not inhibited. Isoeugenol and eugenol showed pronounced inhibition activity against yeasts and 6 out of 10 Gram-positive and Gram-negative bacteria at 1000 µg/mL [16]. The antimicrobial properties of isoeugenol appear more potent than eugenol, as lower MIC values are found against a variety of bacteria, yeast, and molds. Interestingly, isoeugenol and eugenol have higher antimicrobial activity against Gram-negative bacteria, yeasts, and molds than Gram-positive bacteria .

Other compounds

Essential oils contain a number of different degradation products originating from unsaturated fatty acids, lactones, terpenes, glycosides, and sulfur- and nitrogen-containing compounds [17]. Two examples of sulfur- and nitrogen-containing compounds with known antimicrobial activity are allicin and allyl isothiocyanate (AITC).

Allicin (diallyl thiosulfinate) is found in garlic and plays an important role in plant defense.

Isothiocyanates, also known as mustard oils, are common essential oil constituents from plants belonging to the mustard family. Allyl isothiocyanate in vapor and liquid forms has demonstrated high bactericidal activity against various food spoilage microorganisms and food pathogens, including E. coli O157:H7 [18], S. typhimurium, L. monocytogenes, and other aerobic Gram-negative spoilage bacteria , and a broad spectrum of fungi .

Essential oils as Natural food preservation

The demand for minimally processed, easily prepared and ready-to-eat 'fresh' food products, globalization of food trade, and distribution from centralized processing pose major challenges for food safety and quality.

A recent consumer trend toward preference for products with lower salt and sugar content presents an increased need for efficient food preservatives, as lowering the salt and sugar content would otherwise compromise the product's shelf-life[19]. Food-borne microbial outbreaks are driving a search for innovative ways to inhibit microbial growth in foods while maintaining quality, freshness, and safety. The increasing antibiotic resistance of some pathogens associated with foodborne illness is another concern . Therefore, there has been increasing interest in developing novel types of effective and nontoxic antimicrobial compounds to protect the food against contamination and the consumer against infection.

Numerous studies have been published on the antimicrobial activities of plant essential oils (EOs) and their constituents against foodborne pathogens. Recent research has been focused on incorporation of these naturally occurring, food-compatible and safe compounds into foods to protect them against pathogenic bacteria. Development of antimicrobial edible films to protect fresh and processed foods from human pathogens and extend the shelf life of foods is becoming the new trend in food safety research.

Natural antimicrobials can be applied in food e.g. fresh fruits and vegetables, for antifungal effects, improvement of the quality and nutritional value of food [20]. A variety of bioactive molecules derived from EOs also can be used directly in food products or in products for cleaning food. The potential use of EOs as natural antimicrobials and antioxidants which has been reported in meat, fish, vegetables and dairy products are summarized in Table 1

Natural antimicrobials could be used alone or in combination with other preservation technologies. For instanceTassou et al. observed a synergism between NaCl and mint oil against Salmonella enteritidis and Listeria monocytogenes. Several authors reported a synergistic action of nisin and EO or pure components of essential oils [21].The used of clove essential oils along with agar to make agar films incorporated with fish protein hydrolysate on flounder (Paralichthys orbignyanus) fillets shelf-life. [22]

Antimicrobial efficacy of plant antimicrobials depends on several factors including genetic, culture, post harvest condition, the method of extracting EOs, kind of solvent, the volume of inoculum, growth phase, and intrinsic or extrinsic properties of the food such as pH, fat, protein, water content, antioxidants, preservatives, incubation time/temperature, packaging procedure, and physical structure of food as well as oxygen concentration and availability [23]

Table 1: The EOs applications in some Food products

Food group	food	essential oils	microorganisms	Inhibitory effects	references
Meat	Minced mutton	Clove	L. monocytogenes	Yes	[24]
	Cooked chiken breast	eugenol	L. monocytogenes	Yes	[25]
Fish	Coated semi fried tuna slices	Eugenol and linalool	Increased shelf life	Yes	[26]
	Cod fillets	Oregano	P. phosphoreum	Yes	[23]
Vegetables	Carrots	thyme	E. coli	Yes	[27]
Dairy	milk	carvacrol	L. monocytogenes	yes	[28]

Perspectives and limitations of Essential oils

A range of essential oil components have been accepted by the European Commission for their intended use as flavorings in food products. The United States Food and Drug Administration (FDA) also classifies these substances as generally recognized as safe (GRAS). The crude essential oils classified as GRAS by FDA include amongst others clove, oregano, thyme, nutmeg, basil, mustard, and cinnamon. There are regulatory limitations on the accepted daily intake of essential oils or essential oil components, so before they can be used in food products, a daily intake survey should be available for evaluation by FDA.

Despite the demonstrated potential of essential oils and their constituents in vitro, their use as preservatives in food has been limited because high concentrations are needed to achieve sufficient antimicrobial activity. Furthermore, the antimicrobial potency of essential oil constituents also depends on pH, temperature [30], and the level of microbial contamination. Extrapolation of results from in vitro tests to food products is thus difficult at best, and a lower performance of the antimicrobial compound must be expected.

2. Conclusion

Many varieties of herbs and spices has an antimicrobial activity which can be used for preservation and flavoring agent at foods products. Several Essentials oils has an antimicrobial activity against food borne pathogens in vitro and, to a lesser extent, in foods. It has been reported that the antimicrobial activity of Essentail oils is due to the presence of their chemical composition .The chemical composition mostly depend upon its geographical origin and harvesting period including climatic, geographical, soil characteristics, the separated part of plant as well as genetic, post-harvest processing conditions, the method of extraction, kind of solvent, the volume of inoculum, growth phase.

It also depend upon the intrinsic or extrinsic properties of the food such as protein,ph level, water content, antioxidants, preservatives, incubation time/ temperature, packaging procedure, and physical structure of food as well as oxygen concentration and availability are influencing.

It has observed in most of the cases that Gram-positive bacteria are slightly more sensitive to EO than Gram-negative bacteria due to lack of outer membrane protection of cell wall, which restricts diffusion of hydrophobic compounds through its lipopolysaccharide covering. Among gram-negative bacteria, Pseudomonads, especially P. aeruginosa, is the least sensitive to the action of EOs.

There can be possible negative effects of essential oils on sensory parameters, which may limit their applications, especially in high concentrations. In such case, they can be used in combination with other preservation techniques such as using appropriate packaging materials.

Recent development is mainly focus on the use of essentails oils in combination with other preservative technology .Such several successful combined methods of application of these EOs along with new approaches such as hurdle technology and modified-atmosphere packaging created pleasant odor with longer shelf life.

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