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Editorial Open Access

Volatile Phytochemicals: Potential Role in Food Safety and Preservation

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Editorial

The antimicrobial activity of various volatile phytochemicals has been studied against different food-borne microbes. In some of our studies essential oils were also tested as food additives or antimicrobial agents using, the actual food model systems. No doubt, the essential oils have high efficiency against the food-borne pathogen and spoilage microorganisms in food matrix however, a higher concentration of essential oil is still needed. Unfortunately, this higher dose may imply an organoleptic impact, caused by altering the natural taste of the food by exceeding the acceptable flavor thresholds. Therefore, some alternative approaches are required to minimize essential oil concentrations. Antimicrobial potential of the essential oil in vapour phase was evaluated as an alternative technique beyond the year 2000, which entailed the development of advanced antimicrobial systems. The concept of integrating upcoming technologies with conventional food preservation methods is also being increasingly explored. These studies are concerning about antimicrobial efficacy of essential oils in vapour phase along with its application potential in combination with another hurdle technology including thermal treatment, high pressure, packaging material and air ions for food preservation [1-3].

One of the most widely used methods for screening the antimicrobial potential of essential oils in vapour phase is the disc volatilization test. Alternatively, some studies have used “kill time assays” [4,5] wherein the microbes are exposed to certain concentrations of essential oil vapours in time as well as dose dependent manner and plates are incubated to determine the microbial growth inhibition. Recently, an innovative methodology has been adopted where several plates can be exposed to essential oil vapours at a time in multiple petriplate exposure chambers. This multiple petriplate exposure chambers are also used for the integration of other air disinfection techniques along with natural volatiles. Initially, Prof Nerin group established the vapour phase antimicrobial activity of clove, cinnamon, thyme and oregano oils against a number of bacterial, fungal and yeast strains. These authors also concluded that vapours from other essential oils such as ginger and rosemary are not so effective. To examine the changes in composition of essential oil vapour atmosphere over time, they performed SDME, GC-MS followed by principal component analysis, and established that carvacrol, thymol and cinnamic aldehyde are most effective in antimicrobial agents. Further, These vapor-phase approaches appear to be very promising and applied in active packaging. Essential oil vapours can create a protective atmosphere with minimum organoleptic alteration of the packaged foods [6]. This kind of packaging is very beneficial for the inhibition of noxious microbes present on the surfaces and interference with the foods. It is also considered an attractive option by packaging manufacturers in the view of the compliance with existing regulations. Regulation 2004/1935/EC of the European council (Regulation (E.C.) No. 1935/2004) stipulates that every substance that is incorporated into food from packaging must meet criteria stated in Council Directive 89/107/EEC concerning food additives/flavorings. Natural extracts, essential oils and other phytochemicals, are categorized as flavorings agents by the European Decision 2002/113/EC (Regulation No. 113/2002/EC) and generally recognized as safe (GRAS) by the U.S. food and drug administration. However, to establish any standardization of these essential oils is not possible because of their variable chemical composition.

For enhancing the efficacy in vapour phase, different combinations of the essential oils were used to determine the additive, synergistic or antagonistic effect. A relative fractional inhibitory concentration index was also established to evaluate the relative contribution of different components in a mixture of various essential oil vapours [7]. We have determined the better performance of essential oil vapours than the liquid oils and justified them by Scanning electron microscopy (SEM), Transmission electron microscopy (TEM) and Atomic force microscopy (AFM) [5,8,9]. We have observed that essential oil vapour treated cells exhibit more cell membrane disruption, leakage of cytoplasm, increase in cell surface roughness and reduction in cell height. As per the chemical composition of these essential oils and their vapours, it was concluded that enrichment of certain monoterpenes in the vapour phase enhanced the antimicrobial efficacy of vapours. As we found that antimicrobial volatile molecules directly interact with target cells, resulting in a greater affinity toward the cells membrane, ability to partition within the cell membrane and penetrate into the cells. However, the efficacy of essential oil vapours is depending on the chemical constituents as well as their vapour pressure. We have observed that the relative antimicrobial efficacy of selected essential oils in liquid and vapour phase followed the same trend i.e. lemon grass essential oil < mentha essential oil < eucalyptus essential oil [8,10]. Other than chemical constituents, physical state of the volatile compounds also influences the antimicrobial activity. Many environmental factors including temperature and water activity can also modulate the vapour pressure of the volatile compounds and alter the antimicrobial activity [11-14].

For the preservation of real foodstuffs, the matrix for antimicrobial coatings also play a very important role because diffusion of volatiles through antimicrobial coating is strongly influenced by the thickness and nature of polymeric matrix. It was also observed that cinnamon or oregano essential oil incorporating polypropylene films had better antifungal potential than polyethylene/ethylene vinyl alcohol copolymer (PE/PVOH) films. One more important factor is the migration rate of the volatile compounds from packaging material into the foodstuffs. Because packaging would have no harmful effects on human beings, acceptance in terms of minimal/tolerable organoleptic effect, the migration of volatiles constituents to food stimulants should be below the limits stipulated in Commission Directive 2002/72/EC.

Since food matrices are more complex than culture media, customized or ad hoc solutions need to be applied to specific foodstuffs, depending on their natural microbiota, composition, and capacity to absorb candidate antimicrobial agents. The use of essential oils or their volatile compounds in combination with modified atmospheric packaging has been demonstrated for organoleptic, sensory, nutritive and functional properties of food materials. Essential oil can also used as an air disinfectant in a close chamber or in room because of their volatile nature. These natural volatiles can treat large areas/products without requiring direct contacts with surfaces. This quality can make the essential oils suitable for the exposure of perishable harvested/ processed food commodities. It some studies, it is also reported that fruits exposure to eucalyptus/cinnamon oil vapour enrichment improves antimicrobial protection during fresh produce storage and aroma fruit quality-related attributes.

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