

THE ROLE OF NANOTECHNOLOGY APPLICATION IN ANTIOXIDANT FROM HERBS AND SPICES FOR IMPROVING HEALTH AND NUTRITION: A REVIEW

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Abstract

Spices and herbs have been the basis of traditional medicines and flavouring food throughout the world for thousands of years and continue to provide new remedies to humankind. They are known for their antioxidant properties, antibacterial, antifungal and have the ability to produce multidimensional flavours in food. The antioxidant components with a wide variety of free radical scavenging compounds such as phenolic compounds, vitamins, alkaloids and terpenoids known as a main dietary constituents contributing to medicinal effect. However it is being reported that these compounds have low absorption activities in the body system and in food due to their larger particle size, complex chemical structure and poor water solubility of the constituent compounds. Several researchers have been proved that particle size reduction can improve solubility and increase the dispersion rate of poorly water – soluble active ingredients. The application of nanotechnological method is believed can improve the characteristic of micro structured bioactive compound of spices and herbs by enhancing their water solubility, bioavailability, increasing absorbency to organism as well as antioxidant properties which facilitate the active ingredients to disperse and dissolve stably and homogeneously.

Keywords: Nanotechnology, antioxidant, spices, herbs.

1 INTRODUCTION

Human have long a history of using medicinal herbs and spices in their daily life as medicine and food preservatives. It is believed that some of spices and herb can promote youthfulness and improve health status due to its antioxidant properties. The majority of active compounds are phenolics, vitamin C, vitamin E, tannins and carotenes which have been reported as excellent of sources antioxidant properties (Nurain et al., 2012; Thitilertdecha et al., 2008). Malaysian has a long history of using herbs and spices in their lives as table salad food (ulam), food preservatives and alternative medicine (Ibrahim, 2004). Herbs and spices are great sources of phytochemical compound that have therapeutic value such as antioxidants, singlet oxygen quenching, antiseptic and antimicrobial compound. Thus, herbs and spices not only provide antimicrobial compounds to retard microbial growth but also prevent off-flavour development. These are attributes in snack food and meat products. It also continues to play an important role in the prevention of various health problems, especially in developing countries, where most of the people have limited resources and do not have an access to modern treatment. The medicinal properties of medicinal herbs and spices sometimes

overlap with their nutritional properties. Medicinal herb can be defined as plants which have health promoting and curative properties while spices are plants that are fragrant and aromatic or pungent to the taste of seed leaves, roots, barks and flowers which are used as food additives, flavouring or to preserve food (Peter, 2001).

The study of antioxidants from natural sources has received much attention and efforts have been put into identifying compounds that can act as suitable antioxidants to replace a synthetic antioxidant. However it is being reported that antioxidant itself have several disadvantages such as low absorption in food and body system due to their bigger particle size, complex chemical structure and poor water solubility of the constituent compounds. Therefore, several researches are being done to improve the antioxidant properties available such as using nanotechnology. Thus this paper provides some information and related researches to the implication of nanotechnology on plants bioactivity.

2 PLANTS AS SOURCE OF NATURAL ANTIOXIDANT

An antioxidant is defined as “any substance that delays, prevents or removes oxidative damage to a

target molecule” (Halliwell & Gutteridge, 2007). In our biological system, an antioxidant also can be explained as “any substance that when present at low concentrations compared to that of an oxidizable substrate would significantly delay or prevent oxidation of that substrate” (Halliwell et al., 1995). In terms of oxidizable substrate, it is maybe any molecule that can be found in foods or biological materials including carbohydrates, DNA, lipids and proteins (Wanasundara & Shahidi, 2005). The oxidation process is very important because it can control the production of free radicals and the unbalanced mechanism. Therefore, antioxidants may serve to control the levels of free radicals and other “reactive species” to minimize oxidative damage (Tang & Halliwell, 2010). Antioxidants are also known for their potential in promoting health and lowering the risk for cancer, hypertension and heart disease (Valko et al., 2007).

Besides playing an important role in physiological systems, antioxidants especially synthetic antioxidants such as Butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA) and butylhydroquinone are usually used as a food additive to prolong the shelf life of foods and maintain the quality of that food rather than improving the quality of the food. BHA and BHT has a good characteristic in food additive because their high stability, low cost and high efficacy in a variety of food system (Wong et al. 2006; Wanasundara & Shahidi, 2005; Chen, 1992). However, the use of these synthetic antioxidants has been decreasing since they're suspected as a promoter of carcinogenesis as well as several consumer rejections of synthetic food additives (Chen, 1992; Velasco, 2011). Due to this problem, a natural antioxidants have an advantage to use in food application beside it has a high consumer acceptance and their safe use. Studies of antioxidants have done much over the past two decades and it is becoming increasingly important since lately because many health problems that have arisen due to free radicals. Thus, around the world there is an increased interest to revive in studying the natural antioxidants in foods and the potential health benefits of natural antioxidants in relation to prevention and therapy for health and diseases. It's already known that plants including spices and herb plants possessed antioxidative properties and have been used worldwide especially in traditional preparations to treat many diseases. In general most antioxidants can be derived from the diet such as vitamin A, C, E, carotenoids and phenolic compounds. The compounds dietary constituents contributing to protective effects are the antioxidant components especially flavonoids that have been reported able to interfere with the activities of enzymes involved in scavenger a wide range of reactive oxygen, chlorine, and nitrogen generation, quenching free radicals, chelating transition metals and rendering in redox inactive in the Fenton reaction (Ikram et al., 2009; Wong et al., 2006; Tian & Hua, 2005; Tang & Halliwell, 2010; Heim et al., 2002). Therefore, plant derived antioxidants are now receiving a special attention because it has been reported to possess good

antioxidant properties (Wenli 2004, Gan et al., 2010). Zheng & Wang (2001) also mention that spices and herbs are a superb source of phenolic compounds (flavonoids, phenolic acid and alcohols, stilbenes, tocopherols, tocotrienols), ascorbic acid and carotenoids which have been reported to show high antioxidant activity.

3 NANOTECHNOLOGY APPLICATION IN SPICES AND HERBS

Nanotechnology is expected to be the basis of main technological innovations in the 21st century. In general, it is a new and a fast emerging field involved in the manufacture, processing and application of structures, devices and systems through the development of materials in the nanoscale dimension which is less than 100nm (Bouwmeester et al., 2009) even higher than 200nm respectively (Mainardes & Evangelista, 2005). The technology has opened up new avenues of research and development in a number of fields, including medicine, cosmetics, agriculture and food, and it is being used as a means to understand how physicochemical characteristics of nano-sized substances can change the structure, texture and quality of foodstuffs. Due to the uniqueness of nano-sized characteristics, nanotechnologies have emerged as a potential aid to advances in the production of improved quality food with functionalised properties (Chusen et al., 2012; Chaudhry et al., 2008). The application of nanotechnology possesses many advantages, such as increasing compound solubility, reducing medicinal doses, and improving the absorbency of herbal medicines compared with the respectively crude drugs preparations (Bhadoriya et al., 2011). Due to these amazing functional properties, recently numerous researches have been done to make use of nanomaterials from plants based on antioxidant. It is being reported that the plant (herbs and spices) with major constituents such as flavonoids and lignans are hard to be effectively absorbed primarily due to poor solubility in either water or oil, larger particle size and complex chemical structure (Hidayah et al., 2012; Ma et al., 2009; Sonada et al., 2008; Takatsuka et al., 2009). Therefore, numerous studies have been conducted to improve the value in use and overcome this problem. It has been practically proved that particle size reduction strategies particularly nanotechnology can improve solubility and increase the dissolution rate of poorly water soluble active pharmaceutical ingredients (Hidayah et al., 2012; Itoh et al., 2003; Kim et al., 2008; Sonada et al., 2008; Su et al., 2006).

Nanoparticles produced through nanotechnology development possesses many advantages, such as improving component solubility, enhancing of bioavailability, reducing medicinal doses and improving the absorbency of medicinal doses compared with the respective crude drugs preparations and achieving steady-state therapeutic levels of drugs over an extended period compared with the traditional drug

preparation (Bhadoriya et al., 2011; Brigger et al., 2002). Generally, greater intracellular uptake and bioactivity shown by nanoparticles compared to microparticles due to their small size particle and relative mobility. In a year 2006, Su et al. shown that the yield extraction of *Rhizoma Chuanxiong* is increased with nanonization technique as well as enhanced the bioactivity effectiveness where the cellular tissues are broken into pieces, dispersed stably and homogeneously as compared to its raw material. Reported from Yen et al. (2010) revealed that nanoparticle-encapsulated from curcumin, call as “nanocurcumin” can be readily dispersed in aqueous media when it has coated ordinary hydrophobic curcumin particle with hydrophilic polymer (N-isopropylacrylamide with N-vinyl-2-pyrrolidone and poly(ethylene glycol) monoacrylate) nanoparticles. This nanocurcumin is soluble in water and can be readily absorbed into bloodstream. Nanotechnology approaches also show can enhance the bioavailability of genistein. The research conducted by Leonarduzzi et al. (2011) stated that Antioxidant properties in several plants were also affected by this technology. Liu et al. (2008) shown that Danshen samples prepared using nanotechnology exhibited more scavenging power compared to its traditionally ground material based on DPPH radical scavenging and ferrous ions chelating assays. Moreover the reducing power of nanosized Danshen was also significantly better than the common preparations. On the other hand the antioxidant activity of the quercetin nanoparticles evaluated in vitro using free radical scavenging activity test and reducing power test also indicates that inclusion of quercetin into chitosan nanoparticles enhanced the bioavailability of quercetin (Zhang et al., 2008). Thus they suggested that modern technique which is nanotechnology give a greater release of active components in tested samples which are an active components release is affected by particle size. This result was also supported by Manharaj and Chen (2006) that mentioned the smaller particles have a larger surface area, therefore, most of the active components associated would be at or near the particle surface, leading to faster release. Whereas, larger particles have large cores which allow more drug to be encapsulated and slowly diffuse out. On the other hand, the evaporative precipitation of nanosuspension (EPN) to antimalarial drug, artemisinin (ART) demonstrate that the nanoparticle fabrication of ART via full factorial experimental design has increased in their concentration and ration of solvent to antisolvent. The particle diameters of EPN prepared ART nanoparticles were found to be 100-300nm and markedly increased as compared to the original ART powder (Kakran et al., 2010). Nanotechnology in insoluble drugs is also well documented. Sonoda et al., (2008) explored that the effect of nanotechnology in insoluble drug can improve the poorly water-soluble drug flurbiprofen (FP) such as dissolution property by formation of crystalline nanoparticle drugs. Similar results also showed in ursodeoxycholic acid (UDCA), diphenyl hydration (phenytoin) and biphenyl dimethyl

dicarboxylate (DDB) thereby increases its concentration in the blood to the desired level (Itoh et al., 2003; Kim et al., 2008; Ma et al., 2009). All these studies proved that the particle reduction technology especially nanotechnology can effectively improve the functional properties of plants such as spices and herbs as well as in insoluble compounds.

4 CONCLUSIONS

The development of nanotechnology has a great potential for improving bioactivity in herbs and spices. The technology has demonstrated a large number of advantages including enhancement of solubility and bioavailability, protection from toxicity, enhancement of pharmacological activity, enhancement of stability, improving tissue macrophages distribution, and sustained delivery, protection from physical and chemical degradation. The use of antioxidant through application nanotechnology has a great potential in the future for enhancing the biological activity of spices and herbs thus overcoming nutritional and health problems.

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