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ANTIOXIDANT AND ANTIMICROBIAL PROPERTIES OF PLANT EXTRACTS AND THEIR RECENT APPLICATIONS IN MEAT PRODUCT PROCESSING

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Abstract

This review study aimed to give information about the use of plant extracts in meat product processing as antimicrobial and antioxidant agent. Microbial spoilage and lipid oxidation are the major causes of the deterioration and reduction of shelf-life in meat products. Lipid oxidation in meat products results in formation of off-flavors and undesirable chemical compounds such as aldehydes, ketones, alcohols and hydrocarbons. Growth of microorganisms in meat products causes not only microbial spoilage but also development of food borne diseases. To inhibit lipid oxidation and growth of microorganisms, especially pathogenic microorganisms in meat products, several preservation techniques, such as pasteurization, reduction of water activity (salting, drying, freezing etc.), acidification, fermentation, synthetic and natural antimicrobial and antioxidant additives have been used in meat industry. Many synthetic and natural food additives such as butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA), propyl gallate, α-tocopherol, nisin and organic acids are commonly used in the meat industry to inhibit or delay the oxidation process and reduce the microbial growth. In recent years, consumer demands for natural food additives have increased because of negative and toxic effects of synthetic food additives on human health. Herbs, spices, fruits and vegetables, and their powders, oils and extracts have been reported to be a good source of various phenolic compounds, such as flavonoids, terpenoids, carotenoids, could therefore be incorporated in meat products as a source of natural antioxidants and antimicrobials to extend shelf-life and safety of meat products.

Key words*: Meat, antioxidant, antimicrobial, plant, extract.*

INTRODUCTION

Meat and meat products are sensitive to quality deterioration due to their rich nutritional compound such as proteins, lipids, vitamins and minerals. Microbial growth and chemical changes are the two main causes of deterioration in meat products (Shah et al., 2014). As a result of lipid oxidation, undesirable reactions that deteriorate flavor, odor, color, sensory and textural properties of meat products can be occurred (Shah et al., 2014). Pathogenic microorganisms can also potentially cause food borne diseases (Lucera et al., 2012). Lipid oxidation and microbial growth can be reduced by applying synthetic or natural antioxidant and antimicrobial agents to the meat product processing to improve the product quality, shelf-life and safety (Kim et al., 2013).Synthetic food additives have been widely used for inhibiting lipid oxidation and microbial growth in meat products due to their strong antioxidant and antimicrobial activities, and their low production cost and easy accessibility (Falowo et al., 2014). Due to the potential toxicological effects of synthetic antioxidants, the use of alternative natural additives has become widespread due to consumer demands. Herbs, spices, fruits and vegetables, and their powders, oils and extracts were found to be a good source of natural antioxidants and antimicrobials to extend food quality and stability.

Antioxidative Effective Plant Extracts

Antioxidants can inhibit the oxidation of lipids, proteins, carbohydrates and pigments in meat products, therefore the product quality and shelf-life can be improved by antioxidants (Karre et al., 2013). Antioxidants can delay or inhibit the oxidation process through breaking the oxidative free radical chain reaction, decomposing peroxides, deactivating singlet

oxygen, chelating metal ions, absorbing ultraviolet radiation and scavenge oxygen (Shah et al., 2014). Antioxidants, which are widely used in meat products, are divided into two groups as synthetic and natural. Natural antioxidants from plants have been obtained from different sources such as fruits, vegetables, herbs and spices (Falowo et al., 2014).

There are a number of studies on the use of natural antioxidants in meat products, and it appears that these antioxidants have been extracted from different plant parts such as leaves, roots, stems, fruits and seeds (Rather et al., 2016).The extracts of rosemary, grape seed, ginger, cinnamon, garlic, pomegranate, broccoli, onion, myrtle, mint, nettle and green tea have been widely studied for their antioxidant potential (Banerjee et al., 2012; Karre et al., 2013). The antioxidant effect of echinicea, mysore thorn, mango seed, cranberry and strawberry, citrus peel, coffee, olive leaf, oregano, adzuki bean and carob fruits extracts were also investigatedin broiler meat, beef patties, bologna type-mortodella, rabbit meat, raw chicken drumettes, pork patties, cooked beef and pork, pork sausages (Carpenter et al., 2007; Rojas and Brewer, 2008; Mirshekar et al., 2009; Jayawardana et al., 2011; Karre et al., 2013; Falowo et al., 2014; Rather et al., 2016). Furthermore, the antioxidant effects of aloe vera, fenugreek, ginseng, mustard, rosemary, sage extracts and tea catechinswere studied on pork patties (McCarthy et al., 2001).The results of some previous studies are presentedbelow.

Zhang et al. (2016) stated that cloves and rosemary extracts were highly effective against lipid oxidation and had potential to be used as a natural antioxidant in raw chicken meats. El-Zainy et al. (2016) demonstrated that grape seeds polyphenols extract was effective in terms of lowering TBARS in raw beef sausage. Qi and Zhou (2013) reported that the lotus seed epicarp extract significantly delayed the level of lipid oxidation in pork homogenates. Banerjee et al. (2012) reported that TBARS values of broccoli powder extract containing nuggets were lower than those with BHT, furthermore, 2% was the most effective concentration. Rababah et al. (2011) reported that green tea extract, commercial grape seed extract and TBHQ significantly decreased lipid oxidation of the goat meats. Wojciak et al. (2011) indicated that green tea, rosemary and red pepper extracts effectively reduced the lipid oxidation in cooked pork. Additionally, researcher reported that pepper extract showed the lowest TBARS. Kanatt et al. (2010) noted that pomegranate peel extract observed significant antioxidant activity whereas the pomegranate seed extract did not have any significant activity. Akarpat et al.(2008)reported that the lipid oxidation in beef patties was slowed down by myrtle, rosemary, nettle and lemon balm leaf extracts. Myrtle and rosemary extracts showed the higher antioxidant effects than nettle and lemon balm extracts. Ahn et al. (2007) found that grape seed extract, pine bark extract, oleoresin rosemary and synthetic antioxidants (BHA/BHT) delayed the formation of TBARS by 92%, 94%, 92% and 75%, respectively, and significantly lowered the hexanal content. Lee and Ahn (2005) reported that plum extract reduced TBARS effectively in irradiated turkey breast rolls. Rojas and Brewer (2008) found that oregano extract (0.02%) was effective at reducing lipid oxidation in vacuum-packaged cooked beef. Carpenter et al. (2007) found that grape seed and bearberry extract significantly decreased lipid oxidation in raw and cooked pork patties. Lee et al. (2006) also showed that cranberry extract exhibited 51% of TBARS formation in cooked pork. El-Alim et al. (1999) found that basil, sage, thyme and ginger extracts were effective antioxidants in meat system.

Antimicrobial Effect of Plant Extracts

The use of natural antimicrobials such as organic acids, essential oils, plant extracts could be a good strategy to inhibit microbial spoilage of meat products (Negi, 2012). The plant extracts and essential oils demonstrated potential antimicrobial effects according to the following mechanisms: (1) The phenolic compounds in these extracts and essential oils affect enzyme activity or cause protein denaturation, respectively. (2) It causes changes in the permeability of microbial cells.(3) It causes changes in the functions of the normal activity of cell membranes such as

electron transfer, nutrient exchange, protein synthesis, nucleic acids and enzymatic activity (Aminzare et al., 2016).There are many studies on the use of extracts and especially essential oils from different plant sources such as ginger, cinnamon, garlic, rosemary, oregano, basil, cloves, marjoram, turmeric and sage in order to determine the antimicrobial activity on meat products (Lucera et al., 2012).

Abdulla et al. (2016) indicated that the Ziziphus leaves extracts inhibited the growth of *Bacillus subtilis, Escherichia coli, Neisseria gonorrhoeae, Pseudomonas aeruginosa, Staphylococcus aureus* and *Streptococcus faecalis*, and decreased the total viable counts in sausages. Zhang et al. (2016) reported that the spice extracts (rosemary, cloves and their combination) were highly effective against microbial growth in raw chicken meats. Kramer et al. (2014) pointed out that the inhibitory activity of the hop extracts against *L. monocytogenes* was strongly reduced in a fat-containing model meat marinade system. Nejad et al. (2014) reported that the 1 mL garlic aqueous extract was effective in decreasing the growth of *S. aureus* in hamburgers. Baker et al. (2013) found that the rosemary and ginger extract or their combination with sodium lactate have an inhibitory effect against the coliform, lipolytic, proteolytic and psychrophlic bacteria. Uçak et al. (2011) reported that rosemary extract in combination with vacuum packaging was effective controlling microbial growth in fish burgers. Jałosińska and Wilczak (2009) reported that rosemary, cranberry and lovage extracts inhibited growth of the microorganisms in meatballs and rosemary extract was characterised with the strongest antimicrobial activity. Ahn et al. (2007) indicated that 1.0% grape seed and pine bark extracts were effectively reduced the numbers of *E. coli* O157:H7, *Salmonella Typhimurium, L. monocytogenes* and *Aeromonas hydrophila* in cooked beef. Kim and Fung (2004) indicated that the arrowroot tea extract slightly inhibited *S. enterica* serotype *enteritidis* and *L. monocytogenes* in ground beef. Careaga et al. (2003) reported that 1.5 mL/100 g Capsicum extract was adequate to inhibit *S. typhimurium* in raw minced beef, however, the required extract dose for a bactericidal effect against *P. aeruginosa* was 3 mL/100 g.

CONCLUSIONS

The use of extracts for antioxidant and antimicrobial effects has been widely investigated in different types of meat and meat products. These studies demonstrate that plant extracts have antioxidant and antimicrobial effects. The results pointed out that extracts are as effective as or better than synthetic antioxidants. Antimicrobial effects of extracts have been shown to be highly effective in *in vitro* studies, however, antimicrobial effect may decrease when extracts are added into meat systems. Thus, there is need for more research to improve the antimicrobial efficiency of plant base extracts in meat systems. It can be concluded that using plant extracts in meat product processing is beneficial strategy to extend shelf-life and safety of meat products.

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