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Natural Fruit based antioxidants: A novel strategy for use in meat and meat products

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Abstract
Nowadays, conventional antioxidant sources, notably grains, oilseeds, spices, fruit and vegetables are favoured for usage in various meat products due to the possible toxicity of synthetic antioxidants. The majority of a fruit's antioxidant potential is mostly due to the abundance of phenolic chemicals. Numerous phytochemicals included in fruits may aid in preventing cells from oxidative damage brought on by free radicals, hence lowering the incidence of degenerative illnesses like cardiovascular disease, different malignancies, and neurological disorders. The food industry may extract and use natural antioxidants from a variety of plants, including blueberries, broccoli, chokeberries, cinnamon, ginger, oregano, olives, plums, pomegranate, grape skin, seed, and peel extracts etc. One of the most significant issues that decreases the freshness of meat and meat based products is lipid oxidation. The frequency of free radicals and TBARS readings have been successfully decreased by use of antioxidants obtained from all of these conventional sources. Thus, by using various types of fruits, vegetables etc. and their by-products in meat and processed meat products, lipid oxidation is prohibited and average storage life is significantly improved. The meat industry has a lot of potential for using fruits, vegetables, grains etc. as conventional sources of antioxidants. This article aims to give a general overview of the naturally occurring plant-based antioxidants found in meat and processed meat based products.

Keywords: Plant based antioxidants, processed meat products; phytochemicals; phenolic chemicals

Introduction
All-important amino acids and the B-complex vitamins and minerals can be found in meat and meat products, which are also a good source of other nutrients (Mishra *et al.*, 2015a) [27]. Resh meat is a highly perishable commodity because of its inherent qualities, which include relatively high water activity, a pH that is somewhat acidic, the availability of carbohydrates (glycogen) and proteins (Mishra *et al.*, 2015b) [28]. The food industry is now required by the rising popularity of natural foods to incorporate natural antioxidants into a variety of goods in order to prevent the oxidative breakdown of lipids, enhance food value and dietary value, and eliminate possibly harmful artificial antioxidants (Camo *et al.*, 2008) [11]. Natural antioxidants may be crucial in the fight against diseases brought on by oxidative damage, according to research, and they may even lessen the development and mutagenicity of heterocyclic amines in cooked meat (Tsen *et al.*, 2006) [39]. Plant-based natural antioxidants are becoming more and more prevalent as functional food and feed components. Other significant natural antioxidant qualities in food include anti-radiation, anti-mutagenic, anti-inflammatory, antibacterial, and other beneficial actions. Natural antioxidants are also being used in food production because research has shown that they are advantageous for both preventing medicine and extending the shelf life of food products (Anon, 2000) [2].

Fruits, vegetables, and whole grains include a variety of bioactive substances (Sedani *et al.*, 2018) [34]. They include a very diverse class of substances with various chemical structures, distributions in nature, potential sites of action, efficacy against oxidative species, specificity, and biological action. Pharmacologically it is generally recognised that a diet rich in fruits and vegetables lowers the hazard of illnesses related to stress, such as cancer and cardiovascular disease (Aune, 2017) [3]. Lipids are significant meat-building blocks that are in charge of giving meats their ideal flavour, fragrance, tenderness, and juiciness. Because meat and meat products' lipids have desirable properties, they are also very susceptible to lipid oxidation (Bariya *et al.*, 2020) [5]. One of the main reasons for the quality degradation and shortened shelf life of meat products is lipid and auto-oxidation. Meat and meat based products are very

much prone to development of rancidity (Mishra *et al.,* 2014) [26]. Meat that has been oxidised produces unpleasant flavours, odours, and colour changes, as well as the potential for toxicity, all of which render it unfit for human eating (Chatli and Joseph, 2014) [15]. Prior to refrigeration, meat is processed by grinding, cooking, and other methods that damage muscle cell membranes, allowing unsaturated lipids to interact with pro-oxidants like non-haem iron and speed up lipid oxidation, which results in rancidity and rapid quality degradation (Tichivangana and Morrissey, 1985) [38]. The mark of lipid unsaturation, type of muscle, animal food, additions like salt, cooking technique, mode of storage, and muscle pH are all factors that affect a muscle's susceptibility to lipid oxidation (Rhee and Ziprin, 2001) [33]. The process of cooking meat results in the formation of hydro-peroxides, which are easily converted into a variety of volatile organic combinations, including aldehydes, ketones, alkanes, alcohols, esters and acids. These volatile organic composites are what cause oxidative flavours, the loss of pigments and vitamins, and a decrease in the sensory quality of meat and processed meat products. As a result of the heating process' disruption of the muscle cell's structural integrity, inactivation of anti-oxidative enzymes, and production of catalytic iron from myoglobin, both lipids and proteins may be impacted. Because grinding or grating can destroy muscle cell membranes, unsaturated lipids react with pro-oxidants like non-heme iron to enhance lipid oxidation (Gallego *et al.,* 2015) [17]. These items have a comparatively short shelf life due to decrease in particle-size, successive introduction to different microbiological pollutants, the pro-oxidant action of salt, and these factors combined (Giriprasad *et al.,* 2015) [19]. Through a variety of techniques, including curing, vacuum packaging, packaging in a changed atmosphere, and best prominently adding artificial or natural antioxidants, the frequency and amount of oxidative descent be able to be decreased. Despite being widely utilised, synthetic antioxidants like BHT and BHA have in recent times been linked to harmful effects. Natural antioxidants are found in various fruits and plant producs and can be used as a good replacement for currently utilised artificial antioxidants due to their high phenolic component concentration (Nunez de Gonzales *et al.,* 2008) [29]. In addition to serving as reducing agents, free radical terminators, metal chelators, and singlet oxygen scavengers, plant phenolic compounds have a variety of other uses. Numerous studies have looked into the antioxidant potential of various fruits. This study reviews the antioxidant activity of various fruits in various meats and processed meat products.

Sources of natural antioxidants

Fruits and vegetables

Fruits and other plant products are a rich source of natural plant based antioxidants and a very good replacement for presently employed conservative antioxidants because of their high phenolic component concentration (Nunez de Gonzales *et al.,* 2008) [29]. In numerous research (Giriprasad *et al.,* 2015; Brannan, 2008; Lee *et al.,* 2006) [19, 9, 24] the antioxidant activity of many fruits such as extract of grape seed, plum, Mousambi fruit, cranberry, pomegranate and bearberry) in various fresh meat and processed meat products has been examined. Other significant natural antioxidant related characteristics of food include anti-mutagenic, anti-bacterial, anti-inflammatory, and other advantageous effects (Sun *et al.,* 2002; Belleville, 2002) [36, 6].

Plum

Prunes, which are dried plums, are also sweet and juicy and have a number of antioxidants. It is well known that plums and prunes have a laxative effect. This effect has been allied to various fruit-based substances, including dietary fibre, sorbitol, and isatin. According to Nunez de Gonzalez *et al.* (2008) [29] food components made from plums serve as flavourings, antimicrobials, antioxidants, and fat substitutes. Nunez de Gonzalez *et al.* (2008) [29] stated that the use of plum in sliced gammon enhanced the value of shear force, cooking loss, and redness. In foods such irradiated turkey, precooked pork sausages and roasted beef, plums have proven to have antioxidant effects (Nunez de Gonzalez *et al.,* 2008) [29].

Different quantities of plum puree (5%, 10%, or 15%) were employed by Yildiz-Turp and Serdaroglu (2010) [41] in low-fat beef patties during storage and they reported that the control samples' TBARS values were higher than those of the samples that had plum puree added. The hue of the samples was dramatically changed by the addition of plum puree to the recipe.

Cranberry

According to Seifried *et al.* (2007) [35] raw cranberries are a good source of antioxidants, polyphenol, which are phytochemicals being studied for their potential to assist the immune system, the cardiovascular system, and even as anti-cancer agents. Since the beginning of the twenty-first century, raw cranberries have been promoted as a "super fruit" in the global functional food business because of their high nutritional and antioxidant content. According to Vinson *et al.* (2001) [40], cranberries contain a lot of phenolic compounds, which can prevent lipid oxidation. The ability of the various polyphenolic classes found in cranberries to prevent lipid oxidation in mechanically separated turkey and cooked ground pork was investigated by Lee *et al.* (2006) [24]. In this study, mechanically separated turkey treated with cranberry juice powder at 0.32% demonstrated equal inhibition of lipid oxidation to rosemary extract used at 0.04% in samples held for 14 days at 2 °C. In comparison to the control, both treatments nearly 10-fold reduced the production of TBARS. According to various research (Raghavan and Richards, 2006; Larrain *et al.,* 2008) [31, 22] cranberry press cake and cranberry juice powder may be employed as antioxidants in meat and various poultry based products.

Grapes

In contrast to white grapes, which have a higher concentration of flavan-3-ols (also known as catechins), purple grapes often have a higher concentration of anthocyanins as their primary polyphenolics. According to Cantos *et al.* (2002) [12], the anthocyanin concentration in purple grape skin is greater than the absence of anthocyanins in white grape skin, which accounts for the higher total content of phenol, a laboratory indicator of antioxidant strength, in purple types. According to Carpenter *et al.* (2007) [14], grape seed extract has a twenty- and fifty-fold greater antioxidant capacity than both vitamin E and vitamin C.

Various researches reported that the grape seed extract can be used as an active natural antioxidant in both raw as well as cooked pork (Lau and King, 2003; Carpenter *et al.,* 2007; Brannan, 2008) [23, 14, 9] According to Ahn *et al.* (2002) [1] sensory qualities like colour, odour, and warmed over flavour

(WOF) were unaffected by grape seed extract at lower concentrations (0.2% and below).

Bearberry

The edible fruit, a favourite diet of bears, gave rise to the name "bearberry" for the plant. The plant contains several essential oils, arbutin, tannic acid, gallic acid, phenolic glycosides, and flavonoids (Hansel *et al.*, 1992) [20]. Carpenter *et al.* (2006) [13] looked at the anti-inflammatory properties of various plant Bearberry extracts underwent stress associated with oxidation in cells and were proven to be potent antioxidants.

Carpenter *et al.* (2007) [14] investigated the effects of bearberry on raw as well as cooked pork patties. Pork patties that had already been cooked were heated to an internal temperature of around 72 °C and then kept for an additional 8 °C. In polystyrene/ethylvinyl alcohol/polyethylene trays with low oxygen permeability film, both cooked and uncooked patties were stored before being flushed with a 75% O_2: 25% CO_2 mixture. Carpenter *et al.* (2007) [14] discovered that when uncooked pork patties were stored for 12 days at 4 °C, oxidation of lipid was dramatically decreased compared to the control.

Pomegranate

Pomegranate fruit portions have a significant amount of antioxidants in them. Tannins, anthocyanins, and flavonoids are abundant in the peel and rind. According to Cam *et al.* (2009), the pomegranate exhibits greater antioxidant activity in both juice and extract than several other common fruits. Gil *et al.* (2000) [18] discovered that commercial pomegranate juice had three times the antioxidant activity of green tea and red wine.

Golden apple (Bael)

India is the home of the *Aegle marmelos* plant, also known as bael. The Indian subcontinent has long used the matured fruits of the bael tree as a food item. According to Suvimol *et al.* (2008) [37], the pulp of the bael fruit is having significant bioactive substances such as various phenolics, pectins, alkaloids, coumarins, tannins and flavonoids that have been linked to a decrease in the threat of increasing chronic diseases. It also includes numerous vitamins as well as minerals, including vitamin A, vitamin C, Vit B1, Vit B2, calcium, niacin and phosphorus, according to Purohit and Vyas (2005) [30] and Rathore (2009) [32]. As a result, the beal fruit may suggest that it is utilised in traditional ethnic medication.

Citrus fruits

In the Indian subcontinent, citrus fruits are widely available. Numerous citrus fruits, including lemon, mousambi, lime, orange and pomelo are grown in profusion throughout India. The production of wine and citrus juice generates significant quantities of phenolic compound-rich left overs and garbage. Citrus coverings are abundant in pectin, which is best known to have cholesterol- and blood-sugar-reducing qualities, according to Baker (1994) [4]. According to Bocco *et al.* (1998) [8], citrus industry peel and seeds can make up as much as 50% of the weight of the entire fruit.

Giriprasad *et al.* (2015) [19] studied the effect of mousambi peel powder and amla powder on the storage stability of functional restructured buffalo meat steaks stored at refrigeration temperature (4 ± 1 ℃) for a period of 20 days and reported that TBRAS value was significantly lower in treated restructured meat products as compared to control products during the entire storage period. The antioxidant and antibacterial effects of rosemary, orange, and lemon extracts in cooked Swedish-style meatballs were also studied by Fernández-López *et al.* (2005) [16]. All of the extracts were found to be efficacious in a lard system, and additional analysis of the development of rancidity as TBARS compounds steadily revealed that the citrus preparations can prevent around 50% of the rancidity.

Other fruits

Jia *et al.* (2012) [21] examined the antioxidant performance of black currant (*Ribes nigrum* L.) extract in chilled-stored raw pork patties. Black currant extract was extracted with 40% ethanol for two hours, yielding the highest anthocyanin concentration, best radical scavenging properties, and second-strongest reducing power. Pork patties were given black currant extract at a rate of 5, 10, or 20 g/kg. Pork patties exposed to black currant extract treatments showed dose-dependent reductions in thiobarbituric acid-reactive substance values, carbonyl formation, and sulfhydryl loss when compared to controls ($p<0.05$), demonstrating that the black currant extract significantly inhibited lipid and protein oxidation.

Melissa officinalis lyophilized aqueous ethanolic extract was used by Berasategi *et al.* (2011) [7] to make a new bologna-style sausage preparation that was increased in omega-3 polyunsaturated fatty acids. It was compared to the synthetic antioxidant butyl hydroxyanisole for its ability to lessen PUFA oxidation. The formulation reduced the -6/-3 ratio dramatically from 17.3 to 1.9 by increasing the quantity of -3 PUFAs, particularly-linolenic acid. In a study, Liu *et al.* (2009) [25] investigated the effects of varying dietary additions of a natural extract of chestnut wood on rabbit productivity, carcass features, meat quality, lipid oxidation, and composition of fatty acids and authors reported that the extract had no significant effect on shear force, or colour, live weight, productive qualities, dressing %, skin weight, hot carcass weight, pH, cooking losses,

Conclusion

Due to lipid oxidation during storage, meat products are especially vulnerable to value loss in terms of colour and flavour. Due to the pro-oxidant qualities of salt, small sized particles during processing, and successive introduction to numerous microbiological diseases, meat products have a comparatively small short shelf life. In order to replace synthetic antioxidants, the meat and poultry industries are looking for sources of natural antioxidants. Due to their high phenolic component concentration, fruits extracts can be used as an excellent source of natural plant based antioxidants and a good replacement for presently used synthetic or commercial antioxidants. Numerous studies have examined the effectiveness of fruit based extracts in preventing lipid oxidation. The development of antioxidant extracts from plant material is an expanding field of study.

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