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Review Article

Application of Vegetable Peels as Antioxidants in Food Industry

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ABSTRACT

Fruit and vegetable by-products in food processing industry ranks second largest generator of waste on earth after household waste. Food products contain antioxidants that scavenge and neutralise oxidation process in our body. Oxidation reaction release free radicals that initiate the chain reaction thus damaging the cells. Antioxidants remove free radicals and intermediates by oxidising themselves. Main objective of antioxidants is to protect food from oxygen. Synthetic as well as natural antioxidants are utilised in food industry but the major drawback of synthetic antioxidant is carcinogenic effect. Research is being directed on vegetable peel. Vegetable peel is rich source of bioactive compound. By-products of fruit and vegetable can be utilised as source of phytochemical and antioxidants. Antioxidants activities of watermelon peel, cucumber peel, potato peel, their sources, mode of action and application are reviewed in this paper.

Keywords: Free radicals; Polyphenols; Oxidation; Waste utilization; Bioactive compound

INTRODUCTION

Antioxidants are indispensable for maintenance of health in living beings. They safeguard cell from the harm caused by free radicals. Oxidation process is defined as chemical reaction transferring electron to oxidising agent. Antioxidants inhibit chain reaction by eliminating free radicals and restrict oxidation reaction by oxidising themselves. Thereby antioxidants act as reducing agent such as ascorbic acid, thiol, and polyphenol. Antioxidants are adjoined to frying medium to safeguard against oxygen and hence enhance the shelf life of fried food product.

Antioxidants are classified as primary (natural antioxidants) and secondary (synthetic antioxidants). Natural antioxidant reacts with lipid radicals, transforming them into highly stable product. They are chain breaking. Primary antioxidants are phenolic in structure. It consists of polyphenol, vitamins and minerals [1].

Metabolism of macromolecules such as carbohydrates are affected by antioxidant enzymes which have antioxidant mineral as cofactor. Examples are copper, zinc, selenium, iron and manganese. Vitamin C and vitamin E are most important for metabolic functions in body. Flavonoids and carotenoids are phenolic compound present in plant pigments. Catechins are present in green as well as black tea. They possess strong antioxidant properties. By products obtained from post-harvest management and horticultural based food industries have proved them to be safe antioxidations for increased shelf life due to their antioxidant and antimicrobial properties.

Synthetic antioxidants produce include Butylated Hydroxy Toluene (BHT), Butylated Hydroxy Anisole (BHA), propyl gallate, Tertiary Butyl Hydroquinone (TBHQ), metal chelating agent (EDTA) and Nor Dihydro Guaretic Acid (NDGA). Effectiveness of antioxidants on shelf life of banana chips was studied by Noor and Augustin. They observed that banana chips when fried in RBD (refined bleached and deodorised) olein with BHA or BHT were having longer shelf life than fried in RBD olein without antioxidants. Study showed that BHT was more effective than BHA in enhancing shelf life of banana chips.

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LITERATURE REVIEW

Antioxidants

Free radical chain reaction can be delayed or reduced by donation hydrogen from antioxidants reaction is done by donating electron to free radicals , thus by breaking the chain or by eliminating ROS and RNS initiator by putting off chain initiator catalyst [2].

Food preservation by antioxidants

Addition of antioxidant in food is most popular method of enhancing shelf life of food product especially fat containing food. The main function of antioxidant is to trap free radical and slower the rancidity caused due to oxidation. Antioxidants prevent undesirable change in nutritional quality and flavour and protect the cell against diseases [3]. Secondary antioxidants such as BHA, PG, BHT are used as food additives but their application has been re-evaluated due to possibility of toxic/carcinogenic substance formed during degradation [4]. There is need for natural and safe antioxidant in food industry. Thereby replacing synthetic antioxidants with natural plant extract is being focused on.

Natural antioxidants

Vegetables are rich in antioxidants benzoquinone, acetophenone, hydroxy benzoic acid, phenyl acetic acid, flavonoids, naphthoquinones lignans, lignins, anthraquinones etc. are regarded main dietary phenolic compound [5].

Studies show that free radicals in human organ result in oxidative damage to lipid, nucleic acid, protein and thereby are responsible for initiation phase of regressive disease. Antioxidants such as phenolic and phytochemicals antioxidants present in fruits and vegetables are efficient of neutralisation and help in prevention of certain diseases [6]. Polyphenols act as scavengers. Natural antioxidants have showed effectiveness in reducing peroxide formation in oil such as cotton seed and soyabean oil absorbed in fried bread cubes when stored at 60°C. Tocopherol in vegetable oil is an antioxidant that extends the shelf life of fried oil. Vegetables and spices have antioxidant properties used for preservation of lipid in biological system [7].

By products of fruits and vegetables are used in different industries. For instance, production of activated carbon from water melon peel [8]. Co culture including *Aspergillus niger* and *Saccharomyces cerevisiae* at different concentration 3.0 to 12% were observed by Singh, et al. in synchronous saccharification and fermentation process for bioethanol production at various temperature 20°C to 50°C and varied pH (4.0 to 7.0). Natural biocontrol agent and bio pharmaceutical in potato peel utilize chromatographic separation and purification [9]. Nutraceutical utilize food industry waste [10].

Natural antioxidants from peels

Few fruit and vegetable yield 20% to 30% of by product [11]. Peels are rich in bioactive compound for instance phenolic compound, flavonoid, carotenoid, anthocyanin and vitamin. In most cases fruit and vegetable by product contain same or even greater amount of antioxidant and antimicrobial compound [12]. By product of fruit and vegetable processing can be employed as source of phytochemical and antioxidants. Peels contain greater amount of phenolic compound and ascorbic acid than in pulp Goulas, et al. and in green type as compared to ripe Fatemeh, et al. The major fruit peels show 2 to 27 times higher antioxidant activity as compared to fruit pulp [13]. Edible banana pulp (*Musa* × *paradisiaca*) contains 232 mg/100 g of dry weight constituting 25% of peel.

Some inexpensive antioxidants are residues from star fruit Shui, et al. grape pomace Lafka, et al. by product from pomegranate Singh, et al. and banana peel [14]. Agro industrial waste including dry crude extract such as granatum, olive europaea leaves were examined for their antifungal and antimicrobial properties activities by Lutfullah, et al. Extracts were tested against pathogenic bacteria like *Staphylococcus aureus*, *Bacillus cereus* and *Escherichia coli*. Results show that all the extracts inhibited growth of pathogenic bacteria.

Banana peel

Cavendish banana protects itself from oxidative stress caused by extreme sunshine and extreme temperature by producing antioxidants in large quantity [15]. Banana peel is good source of antioxidants for food and functional food against cancer and heart disease but is under utilised. Peel contains polyphenol 0.90 g-3.0 g/100 g dry weight. Fruit peel contains various antioxidants compound such as gallactocatechin and dopamine.

Studies indicate that green banana peel extract exhibit more activities than yellow peel. Stage of ripeness green and ripe and part on antioxidant activity of banana was studied by Fatemeh, et al. TFC (Total Flavonoid Content) and Total Phenolic Content (TPC) of raw banana is more than ripe fruit. Radical scavenging activity range between 26.55% to 52.66% of extract. Antioxidant activity and antioxidant component of three varieties of banana were determined Nagarajaiah, et al. Nendrabale peel exhibits scavenging activity 90% in ethanolic extract. Nendrable peel exhibits maximum antioxidant activity as compared to other three varieties. Incorporation of 0.02% nendran banana peel to oil at 165°C and stored under MAP in laminate pouches ensure shelf life of 3 months. Ehiowemwengeian, et al. observed the *in vitro* antibacterial activity of peels on gram positive and negative bacteria. He found that Minimum Inhibitory Concentration (MIC) of ethanolic extract ranges 16 mg/ml to 512.5 mg/ml to 1025 mg/ml.

Potato peel

Potato peel is new source of polyphenol, natural antioxidant and dietary fibre. Studies on potato peel extract show antioxidant activity. Potato peel is 12% of fresh waste. Potato peel is an excellent source of phenolic compound. 50% of phenolic is present in peel and decrease towards tuber. Ferulic acid is active radical scavenging compound in bound form. The potato peel is therefore an active source of antioxidant. Potato peel petroleum ether extract was observed during 60 days storage of refined

soyabean oil at 45°C. It showed less value of free fatty acid 0.012%, 0.109% and peroxide value 10.0, 9.0 meq/kg.

Watermelon peel

Watermelon (*Citrullus lanatus var. lanatus*) has therapeutic effects. Citrullin and lycopene aid in treatment and management of ailment such as cancer, heart disease. Phenolic content of water melon was very low (9.8 g/kg) as compared to tomato peel phenolic content 68.79 g/kg. Erukainure, et al. observed nutritional enhancement reported exponential growth in protein, ash, crude fibre, lipid, phenolic, and flavonoid content. The study showed that *Saccharomyces cerevisiae* improves the quality of rinds and minimizes the antinutritional factor.

High antioxidant and free radical scavenging activities were observed in methanol extract of *C. lanatus* seeds. Studies showed that watermelon peel is rich source of antioxidant and its potential is due to phenolic content

Most prominent phenolic compound in watermelon peel is hydroxybenzoic acid (958.3 µg/g dry weight). Inclusion of rind, peel powder in cake batter increases shelf life of cake by inhibiting lipid peroxidation, free fatty acid formation during storage.

DISCUSSION

Cucumber peel as antioxidant

Cucumis sativus L. peel is inexpensive source of flavonoid and can be used as potential source of antioxidant for industrial use.

Zeyeda, et al. carried research on phenolic content of few vegetable waste and result were observed in following order as olive leaves, tomato peel, cucumber peel, watermelon peel, potato peel. Chlorophyll, pheophytin, phellandrene and caryophyllene 1.21-3.46 mg/g were found in peel. Cucumber and watermelon peel contain chlorophyll and pheophytin in highest amount. At higher concentration *i.e.*, 800 ppm cucumber peel has lower antioxidant activity as compared to 200 ppm additives of TBHQ (Tertiary Butyl Hydroquinone).

Phenolics, in fruits, herbs and vegetables, cereals and other plant material are of great interest in food industry since they prevent oxidative degradation of lipid and thus improving the nutritional content and quality of food. Phenolic compound exhibit strong antioxidant properties. Consumption of food rich in natural antioxidants and fortified food with antioxidant ensure required antioxidants and help prevent development of disease caused due to oxidative stress.

Mango peel

Mangifera indica L. popularly known as mango is one of the highly consumed fruits in fresh or processed form all over the world. Mango peels are rich in phytochemicals that can be used for developing high value application in horticulture industry. Peels are rich in pectin, lipids, proteins, carotenoids, hemicellulose, cellulose, vitamins and polyphenols which are essential for good health.

Amount of peels generated from mango is major waste in food industry. Although biodegradable takes longer time for decomposition thus resulting in environmental hazard. Studies show that mango peel contains polyphenols, carotenoid, enzymes and dietary fibres altogether contributing to its antioxidant activity and functional properties.

Mango peel, based on antioxidant activity is utilised as peel flour. It can be used as functional ingredient in development of healthy food product. For instance, bakery products such as bread, biscuits and cakes as well as noodles and healthy baby food.

CONCLUSION

Vegetable peels are inexpensive rich source of bioactive compound especially antioxidant. In comparison to synthetic antioxidant, they are good for health, safe carcinogenically and eco-friendly. The researches discussed in this review demonstrate the polyphenolic content of few selected vegetables peel and will also help in identification of active constituent that will sustain antioxidant activity and protect from free radical. This information may be useful for identifying processing waste material. They are rich in polyphenol content for development of food with enhanced shelf life and additives with antioxidant properties.

REFERENCES

1. Agarwal M, Kumar A, Gupta R, Upadhyaya S. Extraction of polyphenol, flavonoid from *Emblica officinalis, Citrus limon, Cucumis sativus* and evaluation of their antioxidant activity. Oriental J Chem. 2012;28(2):993-998.
2. Al-Sayed HMA, Ahmed RA. Utilisation of watermelon rinds and sharlyn melon peels as a natural source of dietary fibre and antioxidants in cake. An Agric Sci. 2013;58(1):93-95.
3. Ayala-Zavala JF, Wang SY, Wang CY, Gonzale-Aguilar GA. Effect of temperature on antioxidant capacity and aroma compounds in strawberry fruit. Lebensm Wissu Technol. 2004;37(7):687-695.
4. Erukainure OL, Oke OV, Daramola AO, Adenekan SO, Umanhonlen EE. Imrovement of biochemical properties of watermelon rinds subjected to *Sacchromyces cerevisiae* solid media fermentation. Pakistan J Nutri. 2010;9(8):806-809.
5. Nagarajaiah BS, Prakash J. Chemical composition and antioxidant potential of Peels from three varieties of banana. Asian J Food Agric Ind. 2011;4(1):31-46.
6. Nguyen TBT, Ketsa S, van Doorn WG. Relationship between browning and the activities of polyphenol oxidase and phenylalnine ammonialyase in banana peel during low temperature storage. Postharvest Biol Technol. 2003;30(2):187-193.
7. Noor N, Augustin MA. Effectiveness of antioxidants on the stability of banana chips. J Sci Food Agric. 2006;35(7):805-812.
8. Gonzalez-Montelongo RM, Gloria Lobo G, Gonzalez M. Antioxidant activity in banana peel extracts: Testing extraction conditions and related bioactive compounds. Food Chem. 2010;119(3):1030-1039.
9. Goulas V, Manganaris GA. Exploring the phytochemical content and the antioxidant potential of *Citrus* fruits grown in Cyprus. Food Chem. 2012;131(1):39-47.
10. Guo C, Yang J, Wei J, Li Y, Xu J, Jaing Y. Antioxidant activities of peel, pulp and seed fractions of common fruit as determined by FRAP assay. Nutr Res. 2003;23(12):1719-1726.

11. Hurrell R. Influence of vegetable protein sources on trace element and mineral bioavailability. J Nutr. 2003;133(9):2973S-2977S.
12. Kazuhiro N, Takayuki M, Tamaki H, Hidenori K. Antioxidative activity bound form phenolics in potato peel. Biosci Biotechnol Biochem. 2006;70(6):1489-1491.
13. Rimando AM, Perkins-Veazie PM. Determination of citrulline in watermelon rind. J Chromatography. 2005;1078(1-2):196-200.
14. Lafka TI, Sinanoglou V, Lazos ES. On the extraction and antioxidant activity of phenolics compound from winery wastes. Food Chem. 2007;104:1206-1214.
15. Kanazwa K, Sakakibara H. High content of dopamine, a strong antioxidant, in Cavendish banana. J Agric Food Chem. 2000;48(3):844-848.