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Utilization of Fruit and Vegetable Peels as Value-Added Ingredients in Dairy Products

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SUMMARY

Fruits and vegetables are widely consumed by health-conscious consumers and comprise a significant portion of the functional and nutritional food market. However, food processing is resulting in a major loss of nutritional components, and waste produces severe economic and environmental issues. Fruits and vegetables include husk, peels, pods, pomace, seeds, and stems, which are typically discarded despite the fact that they contain potentially healthful substances such as carotenoids, dietary fibers, enzymes, and polyphenols. The growing interest of the food industry in the nutritional and biofunctional properties of polyphenols has pushed the use of fruit and vegetable waste in the development of enriched and functional foods with applications in dairy products. Furthermore, it provides evidence regarding the applicability of fruit and vegetable waste in different dairy formulations especially ice cream, Bhapa dahi, and bakery-based products.

INTRODUCTION

Approximately 40% of food that is produced in India is wasted, as stated in the Food and Agriculture Organization (FAO) report. In addition, the Food Corporation of India reported a reduction of approximately 10-15% in total food production. The Ministry of Food Processing Industries (MFPI) estimated that India lost about 12 and 21 million tonnes, respectively, of fruit and vegetables overall. This is worth approx. 4.4 billion USD, with a total value of food loss and waste of 10.6 billion USD (Kumar *et al.*, 2020). According to the definition of "fruit and vegetable waste" (FVW), it refers to an inedible portion of produce that is discarded at a specific time, such as during handling, collection, processing, and shipping (Chang *et al.*, 2006). This concept allows fruit and vegetable waste to be regarded as a loss as opposed to waste. FVW can be produced at many points along the food supply chain, from the farm to the consumer, including both the pre and post-consumer stages (Panda *et al.*, 2016).

Utilization of fruit and vegetable peels in different ways is gaining attention due to their nutritional and pharmacological properties. Peels are novel source of dietary fiber, polyphenols, flavonoids and carotenoids that can be utilized therapeutically (Yadav *et al*., 2022). Peels of fruits and vegetables exhibit 2 to 27-fold higher antioxidant activity than fruit pulp (Gupta *et al.*, 2017). Peels are also a good source of minerals such as calcium, zinc, manganese and iron. Ascorbic acid content is higher in peels than in fruit pulp (Gorinstein *et al*., 2001). Therefore, manufacturers add such functional ingredients to food products to attract the attention of health-conscious consumer). Moreover, use of synthetic antioxidants may be implicated in many health risks, including cancer and carcinogenesis (Kaur and Kapoor, 2001). Thus, interest in peels of fruits and vegetables, which are a good source of natural antioxidants has greatly increased in recent years. Certain anti-nutrients such as oxalates, hydrogen cyanides, phytates and alkaloids are also present in fruit and vegetable peels. However, the level of these anti-nutrients in peels were within the threshold value reported as safety limit (Gupta *et al.*, 2017).

Utilization of fruit and vegetable peels in dairy products

Research related to utilization of value added products viz. essential oils, polyphenolic compounds, pigments, dietary fibre, enzymes, fermented edible products obtained from fruit and vegetable peels.

Essential oils: Citrus peels are a potential source of essential oil (EO) and yields 0.5 to 3.0 kg oil/tonne of fruit (Sattar and Mahmud, 1986). Citrus EO is widely used in alcoholic beverages, confectioneries, soft drinks, perfumes, soaps, cosmetics and household products (Njoroge et al., 2005). It improves the shelf-life and the safety of fresh fruits, skim milk and low-fat milk and exhibits broad-spectrum antibacterial activity (Shabnam et al., 2011). Lemon EO contains D-limonene, which improves the immunity, energizes and stimulates the mind and body.

Polyphenolic compounds: Phenolic compounds in the peels of citrus fruits, apples, peaches, pears, yellow and white flesh nectarines, banana, pomegranate, mulberry, blackberry, tomatoes and sugar beet etc. is more than twice the amount present in edible tissue. Mango peels are rich in gallic and ellagic acids (Omre and Singh, 2018).

Polyphenols reduce incidence of cardiovascular diseases and are thought to inhibit oxidation of LDL (Rice-Evans, 2001). Polyphenols can reduce the systolic pressure and the level of plasma cholesterol in humans and animals, inhibit platelet aggregation and prevent thrombosis. Analysis of different parts of know fruit indicated that the naringin content was the highest (0.422 mg/g) in peel, followed by juice (0.230 mg/g) and seed (0.134 mg/g) (Premi et al., 1994).

Pigments: Tomato peel is a rich source of carotenoids such as lycopene (Knoblich et al., 2005). Beetroot peel is a potential source of valuable water-soluble nitrogenous pigments, called betalains, which comprise two main groups, red betacyanins and yellow betaxanthins. Betalains have been extensively used as natural colorants in the modern food industry (Azeredo, 2009).

Dietary fibre: Fruit and vegetable peels are used as sources of dietary fibre supplements (gelling and thickening agents) in refined food. The fruit and vegetable materials were found to maintain antioxidant activity after extrusion, retarding product oxidation.

Enzymes: Plant food residues including trimmings and peels might contain a range of enzymes capable of having a wide range of applications. Banana waste can be used for the biotechnological production of α-amylase, hemicellulase and cellulase (Krishna, 1999). Sapota peels and citrus peels can be used as substrates for the production of pectinase. Jadhav et al. (2013) utilized banana peel for producing lipase an important enzyme that is extensively used in the food and dairy industry for the hydrolysis of milk fat, cheese ripening, flavor enhancement, and lipolysis of butter fat and cream. Knoblich (2005) suggested that banana peel could be employed as a promising substrate for the production of amylase by Bacillus subtilis. Mango peels can be used for the production of cellulase (Wadhwa and Bakshi, 2013).

Fermented edible products: Vinegar can be prepared from fruit wastes. The procedure for vinegar production by fermenting waste from pineapple juice and orange peel juice has been outlined by Gautam and Guleria (2007).

Miscellaneous products: Neo hesperidin and naringin from bitter orange peel can serve as starting materials for the production of sweeteners. The orange peels can be used as low-cost and eco-friendly adsorbents for removing dyes from wastewater (Wadhwa and Bakshi, 2013).

Processing of peels: Mann (2013) standardized a procedure for preparation of candied kinnow peels from kinnow peel shreds. For the addition of candied peel to ice cream, the syrup was drained from the peels and these peels were used in ice cream. Batawyet al. (2014) described a method for the preparation of pomegranate peel powder and mango peel powder. Pomegranate and mango fruits were air dried in a ventilated oven at 50°C for 18 h and the dried peels were powdered using a hammer mill and sieved through a 150 mm sieve ground to a fine powder.

Applications

Kinnow peel: Mann (2013) incorporated different forms of kinnow peel at different levels i.e. frozen (unblanched and blanched 1, 3 and 5%, each), dried (unblanched and blanched 0.5, 1 and 1.5%, each) and candied (3, 6 and 9%) in ice cream. Ice cream with candied kinnow peel was found to be the best on the basis of overall acceptability score, after 42 days of storage. Flavonoids (naringin) content was found to be higher in all the ice creams containing kinnow peels.

Orange peel: Bhapa dahi was prepared by addition of candied orange peel (6% by weight of base mix) and orange peel powder (2% by weight of base mix) along with mango pulp (18.0% by weight of base mix) & orange crush (20% by weight of base mix) as a flavoring. The resultant product had higher amount beta-carotene, vitamin C and fiber with good textural properties compared to control which was prepared without addition of orange peel.

Ghee residue candy was prepared by incorporating dried orange peel powder and aqueous extract at various levels of 5, 10, 15 % (T1, T2, T3). The vitamin C analysis in ghee residue candy (T2) had a decreasing trend which was observed on storage at refrigerated temperature. On the basis of sensory evaluation, using 9-point hedonic scale, T2 was found to be the best among the various levels tried. The texture, sweetness and overall acceptability for T2 were found to decrease during the entire period of storage of 60 days.

Orange peel powder was used in various proportion viz. 0, 5, 10, 15 and 20% levels for incorporation in biscuits. On the basis of overall sensory attributes, biscuits prepared with 10% of orange peel powder were recorded higher acceptability as compared to other samples. It was also found that the spread ratio of the biscuits was decreased as the % of orange peel powder was increased. The increase in powder concentration, the protein, and fat content was decreased while the dietary fibre was increased (Zaker *et al*.,2016).

Use of orange peel powder was found to be very effective as an adsorbent for reducing Chemical Oxygen Demand (COD) and total dissolved solids (TDS)from dairy industry effluent.

Passion fruit peel: In a study, it was found that fermented milk with the addition of passion fruit peel flour (PFPF) @ 1.0 %was the most preferred among panelists amongst all the levels studied viz. 1.0, 2.0, and 3.0 %. Fermented milk prepared using 2.0 % PFPF showed the highest water-holding capacity and syneresis decreased by raising the levels of PFPF.

Apple peel: Lazari *et al*. (2018) incorporated pulverized apple peel in the production of low-calorie ice cream with good sensory acceptance and cost reduction.

Tomato skin/peel: Addition of tomato skin improved the oxidative stability of ghee during accelerated storage. Various oxidative parameters such as Free Fatty Acids (FFA), ThiobutyricAcid (TBA), Peroxide Value (PV) were lower for tomato-added ghee samples as compare to control sample. The skin content of Ruby variety tomato had more lycopene and it gave better oxidative stability in ghee during storage as compared to Shaktiman variety of tomato (Hazra *et al*., 2014).

Pomegranate peel: Mango or pomegranate peels powder (MPP or PPP) can be incorporated with whey powder when used as ingredient in functional yogurt. The addition of 1.0% whey powder in supplemented milk yoghurt with 1.0% PPP or MPP lead to a significant increase in flavor score and enhanced the sensory quality of yogurt product compared with yogurt samples supplemented with 2.0% PPP or MPP.

Carrot peel: Biscuit samples were made from wheat flour substituted with different levels of carrot peels 5%, 10%, 15%, and 20%. Biscuit samples containing 15% carrot peels showed the highest levels of Fe, Ca, and Cr compared to all the other samples. Evaluation of organoleptic properties indicated that the best two samples were biscuit samples substituted with 10% and 15% carrot peels, respectively. Haematological measurements of and biological results showed that biscuit samples of 10% carrot peels produced high levels of blood haemoglobin (13.40g/dl), haematocrit (43.82%), RBCs (4.980 million/ml^3) and serum iron (184.00µg/dl) in rats. Generally, biscuit samples containing up to 10 % carrot peels in the presence of vitamin A showed good results (Wadhwa and Bakshi, 2013).

Mango peels: Acceptable biscuits with mango flavor were obtained by incorporating up to 10% mango peel powder (MPP) and mango seed kernel powder (MKP) up to 40%. The content of phenolics increased from 3.84 to 24.37 mg/g of biscuit incorporated with MPP and MKP. By incorporating mango peels and kernel powders, it is possible to enhance the nutritional quality and improve the antioxidant properties of biscuits.

Potato peel: A protein/fiber-enriched cake with good sensory quality could be produced by the substitution of wheat flour with 5% of potato peel powder. The incorporation of potato peel powder at 5% increased the dough strength and elasticity-to-extensibility ratio.

Banana peel: Banana peels have a good potential for incorporation in dairy products like *Gulab Jamun, peda,* ice cream etc. Partial substitution of banana peel into noodles may be useful for controlling starch hydrolysis in yellow noodles.

Citron peel: Candy was prepared with 4 different combinations of to (control), sliced citron peel + 30% sugar, T2 (sliced citron peel + 40% sugar), and T3 (sliced citron peel + 50% sugar). T2 was found to be the most preferred candy. The products were assessed for organoleptic quality during storage at room temperature (25-30°C) for 6 months. It was observed that T2 could be preserved safely for 6-month polythene bags (Shamrez *et al*., 2013).

Health benefits:

Peels (apple, mango, carrot, potato, banana, pomegranate, tomato etc.) are rich in antioxidant and vitamin C which can protect LDL cholesterol from oxidation to help reduce the incidence of heart disease Hesperidin, which is present in all citrus peels have been found to have antioxidant properties (Yadav *et al*., 2022). Banana peel is an ideal source for carrying oxygen to the cells and production of energy, synthesis of collagen and for proper functioning of the immune system, cell growth and heart. Banana peel is a source of tryptophan and lutein known to reduce oxidative stress and neutralize free radical damage (Gupta *et al.*, 2017). Citrus peels, apple peel, mango peel, banana peel and pomegranate peel are a good source of minerals such as iron, magnesium, calcium and zinc which play a key role in various physiological functions of the body, especially in the building and regulation processes (Wadhwa and Bakshi, 2013). Passion fruit peel contains 10-20 g of pectin per 100 g peel, which is known for its prebiotic action. Health benefits such as antihypertensive, antioxidant, hypo-cholesterolemic, reduction of blood glucose level, have been attributed to peel (Kumar *et al.*, 2020).

CONCLUSION

Fruit and vegetable peels etc. are a rich source of nutrients (dietary fibers, flavonoids, vitamins, minerals, etc). Peels of fruit and vegetables can be used as functional ingredients in the formulation of healthy and nutritious dairy products. These can also be used for the production of many value-added products viz. essential oils, polyphenols, pigments, etc. Effective and efficient utilization of fruit and vegetable peels can produce a range of value-added products and also help in waste management and the reduction of environmental pollution.

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