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Bioactive Compound and Health Benefits of Fruits and Vegetables by products: A review

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Abstract
The waste produced from the processing industry extreme variation due to wide varieties of fruits and vegetables. The production and processing of fruits and vegetable increased, the disposal of waste represent a growing problem while the by-products like fruit and vegetable pomace contains a considerable amount of nutrients like antioxidants, water soluble vitamins, minerals, fiber etc. In this paper mainly focus on the frequently consumed fruits and vegetables which are discarded as waste after juice extraction. The purpose of this review paper to discuss the nutritional importance of fruit and vegetable pomace and the natural flavor presents in the fruit peels and by - products. Vegetable mainly carrot and beetroot by-product are discarded which can be use as functional nutrients for some food products. Carrot residues contain a considerable amount of beta carotene and minerals, beetroot residues are a great source of fiber, folate, manganese, potassium, iron, and vitamin C.

Keywords: bioactive, antioxidants, folate, manganese, potassium

Introduction
Food processing industry including fruits and vegetables processing is the second largest generator of wastes into the environment only after the household sewage. A huge amount of waste in the form of liquid and solid is produced in the fruit and vegetable processing industries is valuable but biodegradable natural resources with large economic potential. Different fruits and vegetable possess various quantities of waste. Waste product which is thrown into the environment has a very good antimicrobial and antioxidant potentiality. These are novel, natural and economic sources of anti-microbes and antioxidants, which can be used in the prevention of diseases caused by pathogenic microbes. These all benefits will open up as a scope for future utilization of the waste for therapeutic purpose (Joshi *et al.*, 2012) [18]. Fruits and vegetables have a crucial role in our diet and human life, and therefore the demand for such important food com-modities has increased very significantly as a result of the growing world population and the changing dietary habits (Schieber andothers, 2001; Vilari no and others, 2017) [29, 36]. Higher production and growth, and the lack of proper handling methods and infrastructure, have led to huge losses and waste of these important food commodities, as well as their components and by-products and residues. Losses and waste of fruits and vegetables occur during all phases of the supply and handling chain, including during harvesting, transport to packing houses or markets, classification and grading, storage, marketing, processing, and at home before or after preparation. Losses also occur during the supply chain from production throughout all postharvest stages before consumption (Parfitt *et al.*, 2010) [25]. Waste, on the other hand, is food that is fit for consumption, but is not consumed and instead discarded, and this generally relates to consumer or retailer behavior (FAO, 2014) [11]. Losses and waste are in two forms quantitatively and qualitatively (FAO 2014) [11]. Quantitatively they refer to masses or volumes, which reduce the amount of food available for consumption. Qualitatively, they represent decreases in edibility, nutrition, caloric value, consumer acceptability, economic value, which all are recognized before the food item is discarded. Qualitative losses and waste are more difficult to assess and quantify, despite their important impact on nutrition, health, and economic returns. Losses and waste of horticultural commodities are high in developing as well as in developed countries, but at different points of the handling chain. It is common that losses are higher in so-called developing countries due to lack of proper handling techniques, while waste is higher in developed countries and affluent societies in developing countries. In other words, food losses are commonly the result of technical limitations in infrastructure and handling, such as storage, packing, and packaging, marketing, while food waste is commonly the result of negligence or a conscious decision to through food away. Kader (2005) [19] estimated that approximately one-third of all fruits and vegetables produced worldwide are lost during postharvest. Postharvest losses are estimated to be 2% to 23% depending on the commodity, with an overall average of 12% (Kader, 2005) [19]. (FAO, 2014) [11]. Revealed that processing, packaging, distribution, and consumption of fruits and vegetables in the developed parts of China, India, Philippines, and the United States alone produce approximately 55 MMT of fruit and vegetable waste.

The waste obtained from fruits and processing industry is extremely diverse due to the use of wide variety of fruits and vegetables, the broad range of processes and the multiplicity of products. For example, tropical and subtropical fruits processing have considerably higher ratios of by-products than the temperate fruits (Schieber *et a.*

2001) [29]. Due to increasing production and processing of fruits and vegetables, disposal represents a growing problem since the plant material is usually prone to microbial spoilage, thus limiting further exploitation. On the other hand, costs of drying, storage and shipping of by-products are economically limiting factors. Therefore, agro-industrial waste is often utilized as feed or as fertilizer. There is a trend to find new sources of functional ingredients such as plant food by-products that have traditionally been undervalued (Rodríguez *et al.,* 2006) [27]. The term "by-product" suggests that plant food wastes might be usable and have their own market. The processing of plant foods results in the production of by-products that are rich sources of bioactive compounds, including phenolic compounds (Schieber *et al*., 2001) [29]. The antioxidant compounds from waste product of food industry could be used for increasing the stability of foods by preventing lipid peroxidation and also for protecting oxidative damage in living systems by scavenging oxygen free radicals (Makris *et al.,* 2007) [20] Studies have shown that the residues of certain fruits can present a higher antioxidant activity than the pulp (Gorinstein *et al.* 2001) [13] Antioxidants are the substances that are able to prevent or inhibit oxidation processes in human body and food products as ascorbic acid, phenolics and flavonoids. Thus, although these residues are usually discarded, it could be used as an alternative source of nutrients to increase the nutritive value of poor people's diets and to help reduce dietary deficiencies as functional food market is one of the top trends in the food industry (Helkar *et al.,* 2016) [16]. Apart from these bio-active compounds, many researchers have identified that food processing by-products have different potential applications in various industries. The objective of this review is to highlight the potential applications of some selected fruit by-products which are generated in fruit processing.

By-products of fruit after processing and functional benefits of fruit pomace

Pineapple

The pineapple (*Ananas comosus*) is one of the most important fruits in the world and is the leading edible member of the family Bromeliaceae. This fruit juice is the third most preferred worldwide after orange and apple juices (Cabrera *et al.*, 2000) [6]. Pineapple by-products are mainly the residual pulp, peels, stem and leaves. Peel is the major bio-waste generated during pineapple processing. The second major bio-waste is the core and can be used for the production of pineapple juice concentrates, alcoholic, nonalcoholic beverages or vinegar. Bromelain is already commercially available enzyme, which is often derived from the pineapple stem. Due to its strong proteolytic activity, this enzyme has been used in numerous industrial applications such as a meat tenderizer, a bread dough improver, a fruit anti-browning agent, a beer clarifier, a tooth whitening agent. Bromelin can be extracted from different wastes of pineapple including stem, core and peel (Ketnawa *et al.*, 2012; Chaurasiya *et al.* 2013; Bresolin *et al.* 2013) [20, 7, 3] using different extraction and purification techniques. The pineapple by- products contain significant amounts of dietary fiber especially insoluble dietary fiber. Fibers from pineapple by- products are considered high quality due to the physiological effects associated with both soluble and insoluble fibers, and may be used in the development of food reduced in calories and dietary fiber enriched food products (Huang *et al.* 2011) [17]. The increase in demand for the natural flavours has triggered the research in production of natural vanillin from natural raw material through microbial biotransformation (Priefert *et al.* 2001) [26]. Vanillin (4- hydroxy- 3- methoxybenzaldehyde) which is the main component in vanilla produced from the vanillic acid. Pineapple peel waste contains ferulic acid, a precursor for vanillic acid. Therefore vanillin can be synthesized from pineapple peels from a series of bio chemical reactions.

Functional benefits of pineapple pomace

Pineapple pomace contains considerable calcium, potassium, fibre, and vitamin C. It is low in fat and cholesterol. Vitamin C is the body's primary water soluble antioxidant, against free radicals that attack and damage normal cells. It is also a good source of vitamin B1, vitamin B6, copper and dietary fibre. Pineapple is a digestive aid and a natural Anti-Inflammatory fruit. Fresh pineapples are rich in bromelain used for tenderizing meat. Bromelain has demonstrated significant anti-inflammatory effects, reducing swelling in inflammatory conditions such as acute sinusitis, sore throat, arthritis and gout and speeding recovery from injuries and surgery.

Apples

Apple (*Malus domestica*) cultivated in temperate regions, and one of the most widely cultivated and consumed fruits worldwide (Sinha *et al.* 2012) [33]. Apples processing generates skin, stems, and residual flesh which are considered as a potential value-added food ingredient. Apple pomace is the main by-product of apple cider and juice processing industries and accounts for about 25% of the original fruit mass at 85% (wet basis) moisture content. It is considered a rich source of dietary fiber, especially pectin, with content in the range of 10-15%. According to (Younis and Ahmad, 2015) [37], apple pomace has versatile functional properties like glucose diffusion retardation index, emulsifying activity, water-oil-holding capacity, and antimicrobial activity. Apple pomace consists of approximately 10–15% pectin on dry weight basis. Apple pomace also contains a significant amount of non- starch polysaccharides (35–60% dietary fibre), with a high amount of insoluble fiber (36.5%) as well as soluble fiber (14.6%) (Chen *et al.* 1988; Sudha *et al.* 2007) [8, 34]. A number of fibre enriched bakery products were prepared by adding dried apple pomace powder on a wheat flour replacement basis (Sudha *et al.* 2007) [34].

Functional benefits of apple pomace

Apple pomace contains many compounds with pro-health action like micro and macro-elements, dietary fibre, polyphenols and unsaturated fatty. Apple pomace showed high antioxidant activity mostly from polyphenol group. Consequently, has also high radical-scavenging activity and antiglycation activity what help prevent oxidative stress, and may therefore help prevent chronic disease. It is also high source of phloridzin, which has anti-diabetic potential (Kruczek *et al.* 2017).

Citrus

Citrus (*Citrus* spp.) is one of the most important fruit crops around worldwide. Citrus fruits are highly consumed worldwide as fresh produce, juice and most often the peel is discarded as waste which contains a wide variety of

secondary components with substantial antioxidant activity in comparison with other parts of the fruit (Manthey *et al*.2001) [23]. Citrus peels are subdivided into the epicarp which is colored peripheral surface and mesocarp which is white soft middle layer. Food industry uses citrus peel as a source of molasses, pectin (Pinheiro *et al*. 2008; Seixas *et al*. 2014) [1, 30] oil and limone, and has been studied because it contains several bioactive compounds, such as flavanones, polymethoxylated flavones, flavonols and phenolic acids; these compounds have a lot of uses as a natural antioxidants for pharmaceutical, biotechnological and food industries. Orange is the main citrus fruit investigated and commercialized. Orange juice is the most important product of citrus species throughout the world and causes a higher amount of by-product that could be used as a good source of bioactive compounds. (Gorinstein *et al.* 2001) [13] Found that the total phenolics content in peels of lemons, oranges, and grapefruit were 15% higher than those in the peeled fruits. Lime and lemon peel oils are widely used as aroma flavor enhancers for soft and alcoholic beverages and food.

Functional benefits of citrus fruit pomace

The functional properties of citrus by-products especially peel low cost and easy availability of fruit residues which other-wise would be discarded as waste in the environment should be regarded as potential nutraceutic resources, capable of offering significant low-cost, nutritional dietary supplements. Rich in bioactive compounds, these unwanted cast-offs of manufactur-ing could be recycled as value added food supplements, that provide advantageous dietary fibre and polyphenols. They serve as non-caloric bulking agents, enhance water and oil retention, improve emulsion and could prevent us from a wide range of diseases caused due to oxidative stress (Shafiya Rafiq *et al*. 2018) [31].

Carrot and beet root

Carrot being perishable and seasonal, it is not possible to readily make it available throughout the year. Dehydration of carrot during the main growing season is one of the important alternatives of preservation to further develop value added products throughout the year. Processing of carrots into products like canned slices, juice, concentrate, pickle, preserve, cake, and halwa are some of the methods to make this important vegetable available throughout the year. Carrot pomace containing about 50% of the carotenoids and important fibers could profitably be utilized to develop value added products. Further, supplementation of foods like bread, cake, and biscuits with dried pomace is other alternatives to curtail the price of main products like juice and concentrate resulting in direct benefit to the consumers. The nutritional compositional analysis of carrot and beet root pulp wastes indicates that both pulp wastes are good source of beta carotene and minerals, dietary fibre which includes specially the soluble fiber. Even a 25 g portion would provide 11.38 and 15.21 g of fibre which is equivalent to 29% and 38% of recommended intake. The pulp wastes are a good source of calcium contributing 30-50% of calcium recommendation, and as the antinutrient content is very low, calcium absorption from these samples can be high. Carrot pulp waste had high iron content with 11 mg/100g, and if used as a supplement, the pulp waste can provide fair amounts of natural iron and calcium. Among the two pulp wastes, carrot pulp waste exhibited high antioxidant activity. The antioxidant activity found in by-products used may not only be due to the presence of polyphenol compounds, but also due to the presence of other phytochemical components. The antioxidant activity of pulp wastes could be correlated positively with tannins and polyphenols. Thus it can be concluded that the pulp wastes of the vegetable industry could be utilized as a source of supplement or further exploited for value addition as these were rich in nutrients, antioxidant components and exhibited antioxidant activity. In addition, inhibitory components such as oxalates and phytates were present in low amounts indicating higher bio-accessibility of nutrients from such materials (Shyamala and Jamuna, 2010) [32].

Functional benefits of carrot and beet root pomace

Biochemically carrot is a rich source of β-carotene, fiber and many essential micronutrients and functional ingredients. Due to the presence of high concentrations of carotenoids, especially β-carotene in carrot roots makes them to inhibit cancers, free radical scavengers, anti-mutagenic and immune-enhancers (Krishan 2012 *et al*.) [21] Beetroot is also being considered as a promising therapeutic treatment in a range of clinical pathologies associated with oxidative stress and inflammation. Its constituents, most notably the betalain pigments, display potent antioxidant, anti-inflammatory and chemo-preventive activity (Clifford *et al*. 2015) [9].

Conclusions

Fruit and vegetable wastes (FVW) are produced in large quantities in markets and their recovery could be employed for the production of nutraceuticals and functional foods. In this chapter, we described the use of different plant and vegetable food residues as nutraceuticals and functional foods. Different nutraceuticals were explained. Their uses are well addressed along with their disease management and their action as nutraceutical delivery vehicles. Different vehicles have been described, such as liposomes, phospholipid-based, emulsion-based delivery vehicles, niosomes, microemulsions/nanoemulsions, ethosomes and nanoencapsulation.

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