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Review Article

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A Review on Potential of Bioactive Compounds Obtained from Processing Waste of Various Fruits and Vegetables

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ABSTRACT

Fruits and vegetables are mainly admired due to their nutritional value worldwide and rich sources of beneficial anti-oxidants, minerals, vitamins and fibers, besides these, they are also source of health promoting biologically active compounds. The use of synthetic antioxidants in foods is discouraged due to their high levels of toxicity and carcinogenicity .So; natural antioxidants from fruits and vegetables waste have concerned significant attention due to their safety. Due to the high consumption and industrial processing of the edible parts of fruit and vegetables, the residues are generated in large quantities in big cities. Agro waste has become one of the foremost sources of municipal solid wastes, which is one of the hard-hitting environmental issues. However, inappropriate management of landfill will result in emissions of methane and carbon dioxide and incineration involves the subsequent development and releases of pollutants and secondary wastes such as dioxins, furans, acid gases as well as particulates, which pretext rigorous environmental and health risks. For these reasons, there is a critical need to seek out resource and value-added use for these wastes. Actually, economical and readily available use of agri-food industry waste is highly cost-effective and minimizes environmental impact. One of the most advantageous approaches is to recover the bioactive constituents, mainly the phenolic compounds & antioxidants, utilization of it in the food, pharmaceutical as well as cosmetics industry.

Key words: *Bioactive compounds, Municipal waste, Phenolic compounds, Antioxidants, Methane, Health risk.*

INTRODUCTION

India is the world's 2nd largest producer of fruits and vegetables, production of fruits, vegetables and spices is about 287 MT in 2016-17, according to the Department of Agriculture and Farmers Welfare. Fruits and vegetables are most popular due to their nutritional value global and rich sources of beneficial anti-oxidants, minerals, vitamins and fibers[1]. Vegetables, fruits and legume seeds provide carbohydrates, proteins, minerals and vitamins to our body. Besides these, they are also source of health promoting biologically active compounds[2,3]. Usually fruits are processed into juice, beverage, squash and syrups.

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However by-products can be used as functional food ingredients such as phytochemicals, pharmaceuticals, food products, essential oils, seed oil, pectin and dietary fibers[4]. Therefore, fruits by-products not only good source of bioactive compounds but also could be used as several value-added products[5]. Phenolic compounds, including their subcategory Flavonoids, Anthocyanins, Catechins, Glucosinolates, Isoflavones, Lignans, phenolic acids are exhibit altogether plants. These compounds have the capacity to scavenge free radicals and show synergistic effects contributing to anti-inflammatory, antimicrobial, anti-mutagenic, anti-tumour and neuroprotective properties[6,7].

Habitually, the use of synthetic antioxidants as Butylated Hydroxytoluene (BHT) and butylated hydroxyanisole (BHA) in foods is dispirited due to their high levels of toxicity and carcinogenicity[5]. So; natural antioxidants from fruits and vegetables waste have concerned significant attention due to their safety. In recent years, there is global trend toward the use of phytochemicals from natural resources such as vegetables, fruits, oilseeds and herbs, as antioxidants and functional ingredients; in addition, this research will give new information about bioactive compounds of fruit/vegetables and its waste. The extraction of bioactive compounds present in Pomegranate, mango, grapes, citrus peel, pineapple waste, tomato, potato, sweet potato, beetroot, processing waste which are of economic importance in the national and international market and study of some of their potential beneficial health effects.

Due to the high consumption and industrial processing of the edible parts of fruit and vegetables, wastes such as citrus fruit skins, pineapple residues, sugarcane bagasse ,tomato skin, potato peel and other fruits & vegetable residues (principally peels and seeds) are generated in large quantities in big cities. Agro waste has become one of the main sources of municipal solid wastes (MSW), which have been an ever more hard-hitting environmental issue. Presently, the there are two techniques to dispose MSW i.e. landfill and incineration. However, inappropriate management of landfill will result in emissions of methane and carbon dioxide[8], and incineration involves the subsequent development and releases of pollutants and secondary wastes such as dioxins, furans, acid gases as well as particulates, which masquerade severe environmental and health risks[9]. For these reasons, there is an critical need to seek out resource and value-added use for these wastes. In fact, economical and readily available use of agri-food industry waste is highly cost-effective and minimizes environmental impact. One of the most advantageous approaches is to recover the bioactive constituents, mainly the phenolic compounds, utilization of it in the food, pharmaceutical as well as cosmetics industry.

2. Utilization of Bioactive compounds extracted from Fruits and Vegetable wastes

Fruits are generally processed into pulp, leaving behind a considerable amount of residues in the form of peels. These residues form a bulk of organic waste, which is often disposed in open spaces or in municipal bins leading to environmental pollution. On the other hand, these contain significant amounts of essential minerals as well as bioactive constituents and their utilisation in the production of nutraceuticals will acts as value addition but also help in dropping environmental pollution. The antioxidants from fruit wastes have been suggested to be useful in the food, cosmetic and pharmaceutical industries where these can be used as substitutes of synthetic antioxidants that provide guard against oxidative degradation from free radicals[10].

There are concerns about using synthetic phenolic antioxidants such as butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA) as food additives because of the reported negative effects on human health. Thus, a replacement of these synthetics by antioxidant extractions from various foods has been proposed. More than 8000 different phenolic compounds have been characterized; fruits and vegetables are the

prime sources of natural antioxidants. In order to extract, measure, and identify bioactive compounds from a wide variety of fruits and vegetables, researchers use multiple techniques and methods. Also stated that, plant extracts showed strong antioxidant capacity both in vitro and in vivo, and the extracts can be considered a good source of natural antioxidants and antimicrobials. Natural bioactive compounds have been found to interfere with and prevent all kinds of cancer. Flavonoids have been shown to work as anti-tumor (benign, melanoma) agents involving a free radicals quenching mechanism (i.e., OH, ROO). In fact, many studies have shown that flavonoids play significant multiple roles including mutagenic, cell damage, and carcinogenic, due to their acceleration of different aging factors. In addition to antioxidant activity, the inhibition of cancer development by phenolic compounds relies on a number of basic cellular mechanisms[11].

Fruit peels had higher total phenolic compounds than the respective pulps, indicating greater accumulation of phenolic compounds in peels than pulps. Amongst fruits, pomegranate showed the highest total phenolic compounds for both peel and pulp and the lowest was observed for kinnow; while black carrot showed the highest and orange carrot showed the lowest total phenolic compounds amongst different vegetables[12]. Bioactive compounds contain an excellent pool of molecules for the production of nutraceuticals, functional foods, and food additives. Fruits and vegetables represent the simplest form of functional foods because they are rich in several bioactive components. Fruits containing polyphenols and carotenoids have been shown to have antioxidant activity and diminish the risk of developing certain types of cancer[13].

3. Bioactive compounds in different fruits and Vegetables wastes

Following are some fruits and vegetables reviewed based upon its processing potential in industries- Mango (*Mangifera indica L.*)is highest processing fruit amongst food processing sector, mango peels, wastes generated from fruit can processing(Peel accounts for 15% of the waste, stones 18% and waste pulp accounts for 8 to 10 %.), are a good source of functional ingredients such as phenolic compounds that has potential antioxidant properties. The peel and seed of mango has a significant potential benefit due to its potent antioxidant properties and high content of phenolic compound. The major phenolic compounds of ripe and unripe mango peels were gallic acid, syringic acid, gentisyl-protocatechuic, mangiferin, ellagic acid, and quercetin that these phenolic compounds can be a good source of natural antioxidant[14]. Pomegranate (*Punica granatum L.)* is a delectable fruit consumed worldwide. The fruit is a native shrub of western Asia and Mediterranean countries have a maximum content of health promoting compounds[15]. Interestingly, the nutritional parameters mentioned above are not limited to the edible part of the fruit, the vital role are played by the non- edible fractions of fruit and tree i.e. leaves, barks, seeds, buds, flower and peel. Although, these parts are considered to be waste, they contain enormous amount of nutritional value and biological active compounds compared to the edible portion of the fruit it includes major phenolic compounds, flavanoids as well as bioactive compounds[16]. Citrus fruit (*Citrus aurantiifolia)* is popular due to its characteristic flavor, taste, aroma and numerous health benefits. Citrus fruits are known for different health benefits and prevention of diseases in human[17]. Processing of citrus fruits into different products or their consumption as such produce by-products such as peel, seed, and pulp which are usually wasted. This waste contains various bioactive compounds such as ascorbic acid, phenolic compounds etc [18]. Grape (*Vitis vinifera*) is a fruit widely grown and eaten around the world, mostly utilized in vinery. Since grape and its wastes are rich in nutritional compounds, such as glucose, fructose, several types of phenolics, and organic acids, they have been consumed in most parts of the world for many years.The skin of red grapes is rich in anthocyanin, the

pulp shows high amounts of hydroxycinnamic acids, and flavonols are mainly located in the seeds. Generally, the amount of phenolics in seeds is higher than in the skin and pulp[19]. Pineapple (*Ananas comosus*) is one of the main agricultural commodities, pineapple peel wastes (PPW) are the important issue of waste management of which urgently to be overcame. PPW is therefore converted into highly valuable product, since contains considerable content of antioxidant property, sugar, phenolic compound, high fiber, and protein. PPW also provides high potential bromelain enzyme as functional material[20]. Beetroot (*Beta vulgaris rubra*) and its potential utility as a health promoting and disease preventing functional food , Beetroot is a rich source of phytochemical compounds that includes ascorbic acid, carotenoids, phenolic acids and flavonoids[21]. Potatoes (*Solanum tuberosum*) are, after maize, wheat, and rice, one of the most cultivated crops around the world. Potato peels (PP) (a waste by-product of potato processing) have antioxidant activity; also the Potato peels (PP) contain several bioactive compounds. These compounds are known to provide human health benefits, including antioxidant and antimicrobial properties[22]. Tomato (*Solanum lycopersicum*)is one of the most cultivated and consumed vegetables in the world, important sources of vitamins and minerals in the human diet, as they are rich in antioxidants and bioactive compounds, which are secondary metabolites produced by plants. Phenolic compounds, ascorbic acid, and lycopene, are examples of bioactive compounds found in tomatoes. Lycopene and other bioactive compounds, are responsible for antioxidant activity of tomatoes, which prevents the oxidation of essential molecules caused by free radicals, and contribute significantly to the upholding of human health, together with the prevention of heart disease and prostate cancer.[23]. Onions (*Allium cepa L.*) are the second most important horticultural crop worldwide, an increase in demand for processed onions has led to an increase in waste production, The main onion wastes include onion skins generated during industrial peeling, two outer fleshy scales and roots, and undersized, malformed, diseased or spoilt bulbs. Due to the onions characteristic aroma, onion waste is not appropriate for fodder in high concentrations[24].

Table 1: Types of waste obtained from fruits and vegetables containing phenolic compounds

Commodity	Type of waste	Phenolic compounds	References
Beetroot	Peel	ltryptophane, p-coumaric and ferulic acids, cyclodopa glucoside derivatives	[25]
Grapes	Seeds, Skin	Catechins, anthocyanins, stilbenes, flavonol	[24]
Citrus fruits	Peel and solid residues	Eriocitrin, hesperidin, naringin	[26]
Mango	Peel	Flavonol glycosides	[14]
Onion	Skin	Quercetin 3,40-O-diglucoside and quercetin 40-O-monoglucoside	[27]
Potato	Peel	Chlorogenic, gallic, protocatechuic and caffeic acids, chlorogenic acid isomer II	[28]
Tomato	Peel	Lycopene	[29]
Pomegranate	Seeds, Peel	Anthocyanins, ellagic acid	[16]

Table 2.Various methods of extraction of bioactive compounds from Agro processing waste

Sr No.	Methods	compounds	References
1	Soxhlet extraction	Lipid/fat extraction	[30, 31, 32]
2	Hydro-distillation method	Oil and bioactive compounds	[32, 33]
3	Liquid-liquid extraction (LLE) method	Best for phenolic	[31]
4	Solid-phase extraction	phytochemicals	[31]
5	Supercritical fluid extraction (SFE) method	volatile Compounds	[34,35]
6	Pressurized liquid extraction (PLE) method	Agro-industrial by-products phytochemical	[36,37]
7	Pulsed electric field (PEF) method	polyphenols	[38,39]
8	Enzyme-assisted extraction (EAE)	oil and bounded phytochemicals	[40]
9	Microwave-assisted extraction (MAE) method	polyphenols	[41]
10	Ultrasound-assisted extraction (UAE) method	Phenolic compounds, lipids, chlorophyll, carotenoids	[39]
11	High-voltage electrical discharge (HVED) method	Polyphenols	[39]

Above novel methods of extraction of bioactive compounds from agro-processing waste can be the source to obtain natural and safe additives i.e. antioxidants as well as can propose the alternative to waste management through waste utilization.

CONCLUSION

Agro processing waste is foremost problem to environment as well as processing zone; however agro waste of fruits and vegetable is a source of bioactive compounds and can be utilized to extract, and utilized in techno-economic way in various value added products. On the other hand it could be the cheaper and safe replacer for artificial additives like antioxidants which implies to carcinogenicity. In current scenario waste utilization of agro processing industry will definitely contribute to minimize food losses and for development of novel foods having therapeutic value due to bioactive compounds.

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