Bioactive Compounds from Fruit Waste and Its Importance

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Abstract

Diseases are most dangerous and spread rapidly. Hundreds of the people are affected with bacteria, viral and fungal diseases and its prevention is difficult even though many drugs were developed. Fruits consist of phytochemicals, vitamins and dietary fibers that help in treating different diseases in man. Diets rich in fruits prevent man from dread full diseases like cancer, cardiovascular and other chronic diseases. Dumping of fruit waste from industries, commercial areas, houses and markets became serious environmental issue today. So utilization of the fruit waste rich in bioactive compounds can help to prevent the diseases and benefit the society. This paper reviews the bioactive compounds present in Ananus comosus (Pineapple), Malus domestica (Apple), Musa acuminata (Banana), Mangifera indica (Mango), Vitis vinifera (Grapes), Psidium guajava (Guava), and Manilkara zapota (Sapota) their extraction techniques and throws light on its benefits.

Key words: Introduction of bioactive compounds, extraction, conventional and non-conventional techniques, benefits of bioactive compounds

INTRODUCTION

Consumption of fruits is increasing today which improves health. Fruits like apple, banana, pine apple, mango, guava and sapota are the most popular fruits with highest levels of nutrients. Mostly fruits consist of antioxidants, vitamins, polyphenols, carotenoids, carbohydrates and fiber. Antioxidants maintain blood pressure, resist immunity, controls cholesterol and show antibacterial, antifungal, antiviral, antithrombotic and anti-inflammatory properties (1). Highest quantities of fruit waste produced from household, markets and food processing units and dumping of this waste contribute to immense environmental problems that may release harmful greenhouse gases (2). Fruit waste like seeds, pomace, skin, rind has good source of bioactive compounds and the production of these bioactive compounds from fruit waste move towards sustainable development (3). According to Gupta and Joshi 2000 (4) 35% of banana peel, 20% of skin, stem and seeds from grapes, 10% of core and seed from guava, 45% of peel and stone from mango, 33% of core skin from pine apple (5) were wasted. These fruit wastes rich in bioactive compounds can be used to prevent chronic disorders. It was discussed in many published papers that edible and non-edible parts of tropical fruits are the sources of bioactive compounds like carotenoids, sterols and stanols, phenolic compounds like flavonoids and non-flavonoids phenolics (6, 7, 8). The different parts of the fruits and its waste should not be disregarded. Bio active compounds in the fruit waste are required to treat diseases benefit our health and attain sustainable development. So there is a need to learn about all the bioactive compounds and use them for the benefit of our health in future. The bioactive compounds of Ananus comosus (Pineapple), Malus domestica (Apple), Musa acuminata (Banana), Mangifera indica (Mango), Vitis vinifera (Grapes), Psidium guajava (Guava), and Manilkara zapota (Sapota) were reviewed in this paper and highlighted their importance.

Extraction of bioactive compounds

Extraction process varies based on bioactive compounds being extracted. Bioactive compounds extraction depends on several factors like extraction techniques, raw materials and utilization of extraction solvents (9). After extraction of bioactive compounds, they are used in food, pharmaceutical and cosmetic industries.

Extraction techniques are of two types: conventional and non-conventional

Conventional technologies

Percolation: Here the material powder is placed in the percolation tank and continuously the extraction solvent is added and collect the percolation extract simultaneously.

Decoction: Here the plant material is dried made in to pieces and boiled in the water to extract the oil. It’s the process of boiling the plant dried material to dissolve the chemicals of that material.
**Soxhlet technique**: The dry sample is placed on the equipment where the solvent passes through and the process is repeated until the extraction gets complete.

**Maceration**: This process helps to remove bioactive compounds and essential oils. Here the sample is grinded and made into tiny particles to increase the surface area for a good mixture with the solvent. Maceration process made extraction easier by increasing the diffusion process and remove the concentrated solution from the surface of the sample.

**Hydro distillation**
Volatile fraction in the foods can be extracted from hydro distillation process. It is performed with water and takes 6-7 hours without using organic solvents. There are three main processes like hydrolysis, hydro diffusion and decomposition by heat. Both volatile organic and non-volatile organic compounds can be removed by this process.

**Non-conventional techniques**
Non-conventional techniques are the eco-friendly techniques as they reduce energy consumption and implement organic solvent and benefit environment (10). Super critical extraction, microwave assisted extraction, ultrasound assisted extraction, electric high voltage discharge, pulse electric field and high hydrostatic pressure are used in extraction of bioactive compounds.

**Super critical fluid extraction**
This method is characterized by changes in the temperature and pressure that changes the gas in supercritical fluid as gas and liquid phases are different. Here supercritical fluids called extracting solvents used for separation of one component called extractant from another i.e. matrix. Examples of supercritical fluids: carbon dioxide, methane, ethanol, propane, nitrous oxide, n-butene, n-pentene.

**Microwave assisted extraction**
In this method the microwave energy is used to heat the solvent in contact with the sample to separate analytes from sample matrix in to the solvent. Micro wave energy can be converted in to heat energy which makes the mass transfer from inside to outside of plant cell.

**High voltage electric discharge**
In this the energy is directly introduced in to the aqueous solution through plasma channel that is formed from the high electric discharge between the two submerged electrodes (11). The electric field intensity induce the electrons that are used for starting the spread of positive streamer for the negative electrode. Bubble cavitation, pressure shock waves damage the cell resulting in the release of compounds and extraction of biomolecules from cytoplasm of the cell (12).

**Pulse electric field assisted extraction**
PEF increase the extraction by inducing the electroporation of cell membrane. Electric potential enters through cell membrane and separates molecules. This repulsion forms pores and increase their permeability (12, 13). This tool recovers valuable compounds from fruits due to its capacity to soften and disrupt cell membrane and release intracellular compounds (14). All the extraction methods are mentioned in the figure-1.
Benefits of bioactive compounds

Actually tropical and subtropical fruits have highest content of bioactive compounds. Vitamin C, flavonoids and phenols are present in apples show antioxidant activities. Phenolic compounds present in the apple treat colon cancer (15). They treat neurodegenerative disorders. 50% of coronary heart disease reduced with high flavonol and flavone from apple (16). Carotenoids, phenolics, biogenic amines, phytotheres shows positive effects on man due to antioxidant activities. Pineapple consists of many bioactive compounds in crown, peel, stem and core. Myricetin, Salicyclic acid, trans-cinnamic and p-coumaric acid, tannic acid from pineapple shell show anti-oxidant properties. Ferulic and syringic acid have anti-microbial and anti-oxidant properties. Bromelain in core, stem, peel and crown shows anticanecer, anti-inflammatory and immunomodulatory properties. Ferulic acid treats atherosclerosis and lowers cholesterol levels in man. Citric acid prevents liver injury. Consumption of grapes shows antioxidant (18,19) anticancer (20) and anti diabetic activity (21). Bioactive compounds like polyphenolic compounds having proanthocyanidins, anthocyanins, flavonols, phenolic acids and stilbenes are present in grapes (22). Previously banana was used to treat chronic degenerative diseases (17). Recent studies indicate that banana fruit consumption result in retardation of aging and prevents cancer and heart diseases. In banana the bioactive compounds like alkaloids, phenols, flavonoids, tannins, saponins have antibiotic, anticanecer, anti-inflammatory and antimicrobial activities. Flavonoids present in pineapple can prevent the spread of bacterial and tumor metastases. They inhibit the enzymes that initiate cancer (23) Husk of banana consists of flavonoids and polyphenols having plenty medicinal properties. Mango pulp consists of mangiferin, gallic acid, catechin, quercetin, propyl and methyl gallate, kaempferol, anthocyanins and hexoside, galloyl glucose (24, 25). Carotenoids and polyphenols in mango show antioxidant activity and prevents coronary atherosclerosis.

Bioactive compounds in sapota are ellagitannins, gallolestatins, phenolic acid, depsides and flavonoids that shows antioxidant activity. Both edible and non-edible portions of sapota act as anticancer, antitumor, antimicrobial, analgesic and hepato protective agent. The bioactive compounds present in Guava treats different types of cancer, diabetes, cardiovascular disease and obesity. Guava extract have powerful antioxidant properties that treats hepatic diseases and cancer. Benefits of bioactive compounds in pineapple, apple, banana, mango, grapes, guava and sapota are shown in Table-1.

Table-1 Bioactive compounds and its benefits in pineapple, apple, banana, mango, grapes, guava and sapota

<table>
<thead>
<tr>
<th>Name of the fruit</th>
<th>Bioactive compounds</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malus domestica (Apple)</td>
<td>Vitamin C, flavonoids and phenols</td>
<td>show anti-oxidant properties</td>
</tr>
<tr>
<td></td>
<td>Phenolic compounds present in the apple</td>
<td>treat colon cancer (15) and neurodegenerative disorders</td>
</tr>
<tr>
<td></td>
<td>flavonol and flavone from apple</td>
<td>coronary heart disease (26)</td>
</tr>
<tr>
<td></td>
<td>Kaempferol</td>
<td>antioxidant and anti-carcinogenic property</td>
</tr>
<tr>
<td>Ananas comosus (Pineapple)</td>
<td>Myricetin, salicylic acid, trans-cinnamic and p-coumaric acid, tannic acid from pineapple shell</td>
<td>show anti-oxidant properties</td>
</tr>
<tr>
<td></td>
<td>Ferulic and syringic acid.</td>
<td>have anti-microbial and anti-oxidant properties</td>
</tr>
<tr>
<td></td>
<td>Ferulic acid</td>
<td>treats atherosclerosis and lowers cholesterol levels in man</td>
</tr>
<tr>
<td></td>
<td>Citric acid</td>
<td>protects liver</td>
</tr>
<tr>
<td></td>
<td>Bromelain in core, stem, peel and crown</td>
<td>anticancer, anti-inflammatory and immunomodulatory properties</td>
</tr>
<tr>
<td></td>
<td>Flavonoid compounds like catechin and epicatechin</td>
<td>Antioxidant activity</td>
</tr>
<tr>
<td>Vitisvinifera (Grapes)</td>
<td>fruit peel consists of Pectin chemicals</td>
<td>Act as dietary fiber provider (27) Help in digestion and prevents constipation</td>
</tr>
<tr>
<td></td>
<td>Resveratrol from grape peels</td>
<td>Reduces cellular damage and mitochondrial dysfunction</td>
</tr>
<tr>
<td></td>
<td>Flavonoids in grape peels</td>
<td>Prevents cardiovascular events</td>
</tr>
<tr>
<td></td>
<td>kaempferol</td>
<td>Antioxidant and anti-carcinogenic property</td>
</tr>
<tr>
<td></td>
<td>Grape pomace (Cabernet sauvignon) consists of phenolic compounds, flavonoids and monomeric anthocyanin</td>
<td>Antioxidant properties</td>
</tr>
<tr>
<td>Musa acuminata (Banana)</td>
<td>Dopamine and L-dopa, catecholamines</td>
<td>Antioxidant activity</td>
</tr>
<tr>
<td></td>
<td>alkaloids, phenols, flavonoids, tannins, saponins</td>
<td>Show antibiotic, anticancer, anti-inflammatory and antimicrobial activities</td>
</tr>
<tr>
<td></td>
<td>Flavonoids</td>
<td>Prevent the spread of bacterial and tumor metastases. Inhibit the enzymes that develops cancer (23)</td>
</tr>
<tr>
<td>Mangifera indica (Mango)</td>
<td>Carotenoids and polyphenols in mango</td>
<td>show antioxidant activity and prevents coronary atherosclerosis</td>
</tr>
<tr>
<td></td>
<td>Polyphenolics in mango pulp</td>
<td>antioxidant activity</td>
</tr>
<tr>
<td>Psidium guajava (Guava)</td>
<td>Polyphenols</td>
<td>increases the level of lipoprotein</td>
</tr>
<tr>
<td></td>
<td>Guavinosides and quercetin glycosides from ethanolic extract of guava</td>
<td>cytotoxic activity (30). Inhibits the proliferation of cells from gastric carcinoma cells</td>
</tr>
<tr>
<td>Manilkara zapota (Sapota)</td>
<td>ellagittannins, gallollatibins, phenolic acid, depsides and flavonoids</td>
<td>antioxidant property</td>
</tr>
</tbody>
</table>
CONCLUSION

Fruits are most important for its beneficial health properties. This review discusses the wastage of pine apple, banana, mango, grapes, guava and sapota fruits containing bioactive compounds and their benefits. More fruit waste is generated from fruit processing industries, houses and markets. Instead of wasting them bioactive compounds can be extracted for further use which prevents health issues and benefit our society. Many suitable techniques were developed to extract valuable bioactive compounds from the fruit waste. In some cases, bioactive compounds are interesting alternative to prevent the diseases and act as antibacterial, anti-inflammatory and antioxidant agents. Extension of research is required and more innovative should be developed to extract bioactive compounds from fruit waste

CONFLICTS OF INTEREST

Author declares no conflict of interest

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