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UTILIZATION OF FRUITS AND VEGETABLES WASTE PEELS AS A POTENTIAL BIOMASS: A GREEN APPROACH TOWARDS ENVIRONMENTAL SUSTAINABILITY

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ABSTRACT

Fruits and vegetables are the most consumed products for sustenance as well as medicinal purposes amongst the horticultural crops. Huge consumption leads in to generation of a large amount of peel waste from fruit and vegetable-based industries, agricultural processes, marketplace and household kitchen. Waste peels naturally contain bioenzymes, carotenoids, essential oils, polyphenols, vitamins, minerals and several other valuable bioactive compounds. Therefore application of such a low-cost, easily available potential biomass for production of the value-added products has been emerged as a green step in its sustainable utilization. Such judicious usage of enormous waste peels may also restrict a big nutritional and economic loss as well as control of increasing environmental burdens due to waste dumping.

Keywords: Horticultural Crops, Waste Peels, Low-Cost, Biomass, Sustainable.

INTRODUCTION

Agricultural waste is a significant amount of biomass generated as a result of various agricultural activities. Peels of fruits and vegetables are specifically considered as a type of horticultural waste which includes a notable content of total agricultural waste (Sommer et al 2015).

Horticultural products like fruits, vegetables and seeds are popular consumables among population because of their high nutritional and medicinal value. They are enriched in fibre, carbohydrate, essential oils, significant bioactive compounds, amino acids, bioenzymes, vitamins and minerals, therefore are essential part of our daily food also (Wadhwa, et al 2015). Removal of outer peel of edible fruits, vegetables or seeds before consumption is a common practice in our day to day life. Therefore, a huge amount of peel waste is generated from horticulture, fruit and vegetable based industries, food processing units, potato based industries, fruit juice shops as well as a surplus portion of domestic waste. Peels as a waste product are also indiscriminately discarded during transportation, collection, cleaning, processing, handling, storage or waste segregation at concerned market or non-point sources dealing with fruits, vegetables or agricultural commodities. Generally, peels of banana, pomegranate, coconut, melons, pineapple, orange and other citrus fruits are found in abundance in municipal solid waste (Pathak, et al 2017). Amongst vegetables, waste peels of potato, jackfruit, lemon, onion, garlic, cabbage or broccoli stalks and other green leftovers are plentiful in everyday's waste. Some edible portion of these waste peels are consumed by livestock, stray cattle and other herbivorous animals while maximum portion of waste peels left over in environment. This enormous organic biomass when left untreated and dumped in to surrounding environment may lead to several socio-economic problems like nutritional deprivation, economic forfeiture as well as environmental pollution. Major environmental concerns like carbon emission, evolution of foul smelling gases, release of unwanted materials and contaminants in surrounding environmental matrices may occur due to natural aerobic or anaerobic decomposition of peel waste. This agricultural waste peel can be utilised wisely either by performing its scientific treatment or reuse by following the zero emission concept of sustainability and green chemistry. Agricultural waste specially peels of fruits, vegetables or seeds are superfluous, easily available and low-cost. They are also rich in natural phytochemicals. Therefore, agricultural waste biomass can be utilized in multidimensional perspectives.

WASTE PEELS: POTENTIAL BIOMASS MATERIALS

Waste peels naturally have significant bioactive components. Generally, fruit peels are rich in fibre content, cellulose, hemicellulose, tannin, flavonoids, terpenoids, lignin, pectin, protein, phenols, bioenzymes, minerals etc (Pfaltzgraff, et al 2013). Citrus fruit peels (lemon, orange etc.) are rich in essential oils and fibre content (Aruoma, et al 2012). Peels of jackfruit have high content of calcium and pectin while banana peels contain crude protein and phenolic compounds (Pathak, et al 2017). Existence of these salient biomolecules in waste peels makes them a valuable cost-effective biomass which can be reused in multidisciplinary sectors, thus turning waste peels in to potential resource. Some industries mainly pharmaceutical, food, textile and cosmetics use improvised methods to extract these bioactive compounds from

selected waste peels in controlled environment and utilize them in their respective consumer care products. Waste potato peels enriched in dietary fibres, phenolic compounds and anthocyanins are reused in food and fermentation industry (Wu, D. 2016). Waste onion peel contains alk(en)yl cysteine sulfoxides, flavonols, anthocyanin and bioactive phenols, therefore, nutraceutical and cosmetical units reuse dried onion peels. Some selective phytoingredients of onion peel are also under study to develop eco-friendly pest management system in agriculture sector (Choi, et al 2015). Waste peels are also reutilized in emerging sectors of bioplastic and bioenergy (Yaradoddi, et al 2016).

APPLICATION OF AGRICULTURAL WASTE PEELS IN DEVELOPMENT OF NANOMATERIALS

Waste peels naturally contain bioactive phytochemicals, bioenzymes, minerals, infrastructural elements (carbon, hydrogen, nitrogen and oxygen), silica, sulphur etc. Specific surface and physico-chemical properties viz. presence of surface active groups, specific bulk density (dependent on particle size and shape), porosity, surface charge, thermostability etc. made them appealing biomass for development of nanomaterials and other nano-devices in nanotechnology (Sangeetha, et al 2017). A variety of novel nano silica, nanocellulose, nano-adsorbent materials, nano-composites, carbon dots as well as nano-cementitious additives have been successfully developed by several researchers and applied effectively in different processes (Arunachalam, et al 2011). Therefore, reuse of these low-cost waste peels in development of nanomaterials is a novel step in its sustainable utilization in the field of nanochemistry and nanotechnology.

WASTE PEELS AS NOVEL BIOSORBENTS FOR WATER PURIFICATION

Waste peels of fruits and vegetables have also been used as efficient biosorbent materials for water decontamination, purification of industrial and agricultural wastewater and recovery valuable metals from industrial effluents (Patel, S, 2012). Adsorbents derived from peels of oranges, lemon, banana, jack fruit, cassava, pomegranate, melon, mango, pea, garlic, potato, onion etc. have been successfully used in decontamination of heavy metals, organic dyes, colorants, phenolic compounds and other hazardous organic as well as inorganic pollutants from water and wastewater (Pathak, et al 2015). Biosorbent materials derived from waste peels are lignocellulosic rich materials having activated surface area, easy handling process, cost effective and zero waste generation output, therefore, their utility in water purification techniques are versatile (Bhatnagar, et al 2015).

USE OF WASTE PEELS IN FOOD INDUSTRY

Agricultural waste peels have novel applications in preparation of edible coatings, biofilms as well as biodegradable packaging material in food processing and packaging units (Okonko,et al 2009). Fruit and vegetable peel-based biofilms have contrast amino acid sequence in their microstructure, therefore, possess less water permeability. This moisture retaining property makes them a potent material for synthesis of eco-friendly and non-toxic biofilms/coating materials in food processing industry. Peels of pomegranate, apple, orange and potato are widely used for this purpose (Raghav, et al 2016). Waste peels of fruits and vegetables are also in practice for development of biopolymers and bioplastic films (Sultan, et al 2017).

MISCELLANEOUS SUSTAINABLE PROCESSES AND APPLICATIONS

Antimicrobial potential of some selected fruits peel waste; specially peels of pineapple, custard apple, jackfruit, pomegranate and papaya; were experimentally observed and revealed promising results. This may lead to development of natural antibiotics from waste peels (Roy, et al 2014). Pyrolyzed waste orange peels were successfully utilized as solid biofuel (Santos, et al 2015). In another study citrus fruit biomass have been used for sustainable energy production (Miran, et al 2016). In addition, waste peels of fruits and vegetables have been also applied for production of green chemicals and materials (Xu, et al 2008) viz. industrially significant bioenzymes, biofertilizer, essential oils, pectin, ethanol, methane, as a substrate to produce livestock feed as well as biorefinery feed (Angel Siles Lopez, et al 2010 and Thines, et al 2017).

CONCLUSION

Waste peels of fruits and vegetables are cost-efficient, readily available in abundance, bioactive natural materials enriched with various phytochemicals. They have versatile usage in either raw or processed form in food processing industry, packaging, development of tailor made nanomaterials, modern degradable fabricating materials, impregnated articles, water treatment etc. Their specific use is a great example of green management of agricultural waste in production of value added products leaving behind non-toxic waste. Therefore strategic application of waste peels and related products in various aspects can be a blueprint of sustainable environment exhibiting reduction of agricultural waste and conversion of huge mass of degradable waste into augmented materials and technologies.

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