THE SCIENCE WORLD
A Monthly e Magazine
ISSN:2583-2212
Sept, 2023; 3(09), 2475-2480

Popular Article

Significance and mileage of Valorization of fruits and vegetables in modern era

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https://doi.org/10.5281/zenodo.8396859

Abstract

Valorization of fruit and vegetables refers to the process of maximizing the value and utility of these horticultural products. It involves various strategies and techniques aimed at optimizing the economic, nutritional, and environmental aspects of fruit and vegetable production, processing, and consumption. As for vegetable products, in the developing countries the greatest generation of vegetable waste takes place during the harvesting and processing stages, while the consumption stage barely produces 10% of the fruit & vegetable waste. Poor storage and processing facilities and lack of infrastructure are among the main causes for that situation. An enormous amount of waste is generated during the industrial processing of fruits. This waste has become a serious challenge as it affects the environment and needs to be either managed or valorized. Being a source of functional ingredients, extensive research is required for the utilization of the fruits byproducts from processing industries.

Introduction

Fruits and vegetables, a significant segment of food sector and produce large volume of wastes annually. They constitute an excellent source of several valuable components (carotenoids, polyphenols, etc.), also known as bioactive compounds. These bioactive compounds have a positive impact on health and are known to modulate the metabolic processes as well as influence the cellular activities in the human health due to their antioxidant, anti-cancer, anti-inflammation, anti-allergenic and anti-atherogenic properties; depending upon the pathway and their bioavailability in the body. Some of these compounds are hydrophobic in nature and therefore are less bioavailable in the body. Valorization of Fruit and Vegetable Wastes (FVW) is challenging owing to logistic-related problems, as well as to their perishable nature and heterogeneity, among other factors.

Valorization of fruit and vegetables refers to the process of maximizing the value and utility of these horticultural products. It involves various strategies and techniques aimed at optimizing the economic, nutritional, and environmental aspects of fruit and vegetable production, processing, and

consumption. By implementing these valorization strategies, fruit and vegetable producers can enhance their economic returns, reduce waste, and promote sustainable practices, ultimately benefiting both farmers and consumers.

Importance of Valorization of fruit and vegetables

The FAO has estimated that around 1.3 billion tons per year of edible parts from foods destined to human consumption are discarded and wasted worldwide. Among the total food waste, 50% is produced from fruits, vegetables, and root crops. Most of these wastes contain colourful peels which have a rich content of different natural pigments, high iron/mineral content as well as several concomitant ions. These properties will facilitate their use in simultaneous natural pigment extraction as well as bio adsorbents. These natural pigments have several benefits over currently used chemically synthesized pigments, including, biocompatibility, low toxicity, economic along with eco-friendly production and disposal. Several reports suggest the use of extracted pigments from different fruit wastes for health benefits, for example, carotenoids extracted from pomegranate peels and tomato skin are used as food colorants and have numerous health benefits in the form of vitamin A precursor, skin health enhancer and boosting our immune system. Anthocyanin, another food additive with health benefits is used in pharmaceuticals and cosmetics, has been extracted from grapes and common fig. Peels of *Opuntia Stricta* (commonly known as erect prickly pear) has been found to be a rich source of betacyanins including betanin and isobetanin. Vegetable wastes from Basella rubra, commonly known as Malabar spinach, are a potential source of betacyanin and betaxanthin. Keramycin, widely used in pharmaceuticals, is extracted from mulberry fruit wastes which reduce its production cost. Lycopene, produced from tomato skin has been successfully applied as a food additive and cosmeceutical compound (Lenucci et al., 2015). These findings are convincing enough to concrete the idea that the food wastes are more than just wastes and are a humongous source of different value-added products.

Huge economic losses emanating from poor postharvest management practices and growing awareness about the benefits of processing of perishable commodities has led to an increase in the processing of horticultural commodities worldwide. Increase in processing of horticultural commodities also results in generation of a huge quantity of residues. The nonedible portion of fruits and vegetables after processing (waste), such as peels, pods, seeds, skins, etc., accounts for about 10–60% of the total weight of the fresh produce. Such waste poses increasing disposal and potentially severe pollution problems and represents a loss of valuable biomass and nutrients. Fruit and vegetable processing waste is rich in organic matter, phytochemicals, and compounds with nutraceutical properties. However, due to non-availability of proper infrastructure to handle such a large quantity of biomass and in the absence of any established commercial use for such an invaluable biomass, it is poorly disposed of, leading to environmental pollution problems. Because of the significant presence

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Published: **30.09.2023**

of cellulose, hemicellulose, pectin, minerals, vitamins, and low lignin content, this waste offers a huge potential for its conversion into useful products, such as enzymes, ethanol, and biocolors. Orange peels, banana peels, cauliflower waste, peapods, apple pomace, pineapple waste, etc. have been exploited as substrates for production of industrially important enzymes such as cellulases, amylases, pectinases, proteases, etc. through fermentation at a laboratory scale, however, commercial application of such wastes has not been fully realized. This chapter comprehensively covers the various aspects of enzyme production using the renewable fruit and vegetable processing wastes.

Valorization is the process of adding value to a product, service, or idea by finding innovative ways to commercialize or utilize it. It involves transforming knowledge, research, or intellectual property into tangible and marketable outcomes. The importance of valorization can be understood from several perspectives:

- **Economic Impact:** Valorization plays a crucial role in driving economic growth. By turning research and ideas into practical applications, valorization creates new products, services, and industries. This, in turn, leads to job creation, increased productivity, and higher economic output. Valorization helps to stimulate innovation and entrepreneurship, attracting investment and fostering a thriving business ecosystem.
- **Knowledge Transfer:** Valorization facilitates the transfer of knowledge and technology from academia and research institutions to the broader society. It bridges the gap between theoretical research and real-world applications. By translating scientific discoveries and innovations into practical solutions, valorization enables society to benefit from the expertise and advancements developed in academic and research settings.
- **Collaboration and Partnerships:** Valorization often requires collaboration between various stakeholders, including researchers, industry experts, entrepreneurs, and investors. It promotes interdisciplinary approaches and fosters partnerships between academia, industry, and government. Such collaborations facilitate the exchange of ideas, resources, and expertise, leading to synergistic outcomes and innovative solutions that would not be possible through isolated efforts.
- **Return on Investment:** Valorization allows organizations and individuals to monetize their intellectual assets and generate a return on their investments in research, development, and innovation. By commercializing their intellectual property, organizations can secure licensing deals, patents, or create spin-off companies, leading to financial gains and sustainability.
- **Competitive Advantage:** Valorization enhances the competitiveness of regions, industries, and organizations. By harnessing their intellectual capital and turning it into marketable products or services, they gain a competitive edge. Valorization enables companies to

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Published: 30.09.2023

differentiate themselves, seize market opportunities, and stay ahead in a rapidly evolving global economy.

Methods of fruit and vegetables can be valorized:

- **Diversification of Products**: Fruit and vegetables can be processed into a wide range of products such as juices, jams, sauces, frozen products, dehydrated snacks, and ready-to-eat meals. By diversifying the product range, farmers can target different market segments and extend the shelf life of their produce.
- **Value-Added Processing**: Adding value to fruit and vegetables through processing can increase their market value. For example, creating unique blends of fruit juices, developing innovative packaging, or producing organic and specialty products can attract premium prices.
- **Food Waste Reduction:** Valorization involves reducing food waste by utilizing surplus or imperfect fruits and vegetables. These can be transformed into value-added products like compost, animal feed, or used in the production of biofuels and natural fertilizers.
- **Sustainable Farming Practices:** Employing sustainable agricultural practices, such as organic farming or integrated pest management, can enhance the value of fruit and vegetables. Consumers are increasingly willing to pay more for products that are grown using environmentally friendly methods.
- **Local and Direct Marketing**: Selling fruit and vegetables directly to consumers through farmers' markets, community-supported agriculture (CSA) programs, or farm-to-table initiatives can increase the value of the produce. This allows for higher margins and a closer connection between farmers and consumers.
- **Product Differentiation:** Developing unique varieties of fruit and vegetables or highlighting specific qualities, such as heirloom or heritage varieties, can differentiate products in the market. This can attract consumers who appreciate the distinct flavors, nutritional benefits, or cultural significance of these products.
- **Nutritional Awareness and Education**: Educating consumers about the nutritional benefits and culinary uses of various fruits and vegetables can increase their demand. Promoting healthy eating habits and providing recipe ideas can encourage consumers to incorporate more fruits and vegetables into their diets.
- **Collaboration and Partnerships:** Collaboration among farmers, processors, retailers, and researchers can lead to improved value chain management, innovation, and knowledge sharing. Working together can result in better post-harvest handling, storage, processing techniques, and marketing strategies.

The valorization of fruits and vegetables by producers in the food, pharmaceutical, and

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Published: 30.09.2023

cosmetic industries involve utilizing these agricultural products to create value-added ingredients, extracts, and formulations. Here are some examples of how fruits and vegetables are valorized in these industries:

Valorization of fruits and vegetables in Food Industry:

- Extracts and Concentrates: Fruits and vegetables can be processed into extracts and concentrates that are used as natural flavors, colorants, and functional ingredients in various food products. For example, tomato extracts can be used as a natural source of lycopene in food supplements or as a coloring agent in sauces and dressings.
- Functional Foods: Incorporating fruits and vegetables into functional food products can enhance their nutritional profile and health benefits. Examples include fortified fruit juices with added vitamins, vegetable-based protein bars, or vegetable powders used in smoothies and meal replacements.
- Snacks and Ready-to-Eat Meals: Valorizing fruits and vegetables by creating healthy snacks and convenient ready-to-eat meals can cater to consumers' demand for nutritious on-the-go options. This can involve processes like freeze-drying fruits for snacks or packaging pre-cut vegetable mixes for salads.

Valorization of fruits and vegetables in Pharmaceutical Industry:

- Active Ingredients: Fruits and vegetables contain bioactive compounds with potential health benefits. Extracts or isolated compounds from these sources can be used as active ingredients in pharmaceutical formulations. For example, the antioxidant properties of berries can be utilized in the production of dietary supplements or nutraceuticals.
- Natural Medicines: Traditional medicinal knowledge often includes the use of fruits and vegetables for therapeutic purposes. By extracting and formulating these plant-based compounds, pharmaceutical companies can develop natural medicines and herbal remedies.

Valorization of fruits and vegetables in Cosmetic Industry:

- Natural Extracts and Oils: Fruits and vegetables are used to extract natural compounds such as essential oils, fruit extracts, and seed oils that have cosmetic benefits. These ingredients can be incorporated into skincare products, hair care products, and fragrances.
- Natural Colorants: Fruits and vegetables can be a source of natural pigments and dyes used in cosmetic formulations. For instance, beetroot extract can be used to provide a natural red color to lipsticks or blushes.
- Antioxidant and Nutrient-Rich Ingredients: Fruits and vegetables known for their high antioxidant content, such as berries or citrus fruits, can be used to develop skincare products that provide anti-aging and protective benefits. Extracts and oils from these sources can also be used in hair care products to nourish and revitalize the hair.

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- The processing industries, on the other hand, are the chief sources of by-products and waste generation in huge amounts (Blakeney, 2019). This has made fruit safety and management the major concern, globally. Since these materials are prone to microbial spoilage it may cause high level of environmental contamination.

Conclusion

An enormous amount of waste is generated during the industrial processing of fruits. This waste has become a serious challenge as it affects the environment and needs to be either managed or valorized. Being a source of functional ingredients, extensive research is required for the utilization of the fruits byproducts from processing industries. Besides this, increased environmental concern has also made the valorization of these by-products a promising field and a global requirement for sustainable development. Fruit by-products, which are treated as waste are known to have an enormous potential for the extraction of valuable components like pectin, bioactive compounds, and other useful phytochemical compounds. There is thus a need to search for alternative scientific technologies in place of the conventional extraction techniques to extract out these compounds from the fruit waste. These extracted valuable compounds can then be utilized in pharmaceutical, food, chemical, and cosmetic industries, and can furthermore be used in the development of functional food products which in turn will be an effective and sustainable solution for the fruit by-products valorization.

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