



# UTILIZATION OF CITRUS WASTE AND BY-PRODUCTS

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## ABSTRACT

Citrus fruits are one of the most popular fruit crops cultivated throughout the world. Citrus fruits are highly consumed worldwide as fresh produce, juice. Comprising nearly forty to fifty percent of the fruit portion, citrus waste which contains peels, pulp, membrane residue, and seeds is a by-product of citrus fruit processing. The citrus waste is often discarded to nature. The significance of valorization of citrus waste to develop a sustainable bio-economy and to reduce detrimental effects of citrus waste on environment have been thoroughly evaluated. Recently, functional utilization of citrus waste has been investigated for producing value-added products, innovating future materials, and promoting zero remaining waste for nature using by innovative technology.

Citrus waste are rich for essential oils, and natural antioxidants (i.e., phenolic acids, flavonoids, carotenoids) which can be used for food, cosmetic, personal care and pharmaceutical products and medical industries. Also, organic acids derived from citrus waste are transformed into biodegradable polymeric materials, carbohydrate polymers (such as pectin, a soluble dietary fiber). Through fermentation process, citrus wastes can be transformed into biogas, bioethanol, or volatile compounds, which harbor commercial importance.

## REVIEW QUESTION

Citrus fruits are in high demand product and with a production all around the world. However, this level of production and consumption generates enormous amounts of citrus waste (e.g. citrus peel, etc.). All these enormous amount of citrus waste is created opportunities for efficient treatment and valorization. Recent investigations have been focused on developing newer techniques to explore various applications of the chemicals obtained from the citrus wastes. The poster reviews investigations to produce valuable products from citrus wastes and possibilities of innovating future materials and promote zero remaining waste (12,13).

## RESULTS

### ❖ The citrus waste is rich in many chemicals.

- ✓ Citrus waste is promising source of phytochemicals (such as phenolic compounds) that may be employed in foods for the reduction or treating diseases. Pharmaceutical and food applications (specifically as bioactive compounds and dietary fiber source) are attractive ways of citrus waste valorization as it is a good source of antioxidants (10, 12).
- ✓ Citrus by-products could be used as prebiotic ingredients and promoted the highest growth of strains. Among these fruits by-products are the substrates with the greatest potential to be used as prebiotic ingredients (3).

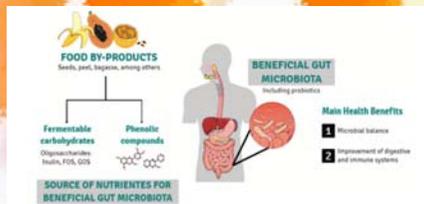


Figure 1. Roles of probiotics and potential prebiotic from food by-products in the gut health. Adapted from the reference (3).

## RESULTS

- ✓ According to the Abou Baker et. al.(2020), research research is encouraged to use of bitter orange (*Citrus aurantium*) seeds as food additives for preventing Alzheimer Disease, especially for individuals at risk of developing age-related neurodegenerative diseases as those with the previous history of head trauma, strokes or at continuous risk of exposure to heavy metals as AlCl3 or lead or mercury (2).
- ✓ Citrus peels have been extensively used in medicine to treat skin disorders. Researches support the suitability and safeness of citrus essential oil to be incorporated in skincare formulations with a preventive action in skin inflammatory disorders. The essential oil from citrus peels contain high amounts of volatile aromatic compounds as d-limonene. This bioactive compound has been used as compound of fragrance in cosmetics. Also, the citrus essential oils have been largely used as antibacterial, anti-inflammatory, and antioxidant agents (6,7,12).

## RESULTS

- ✓ In recent years, the research for developing biodegradable polymers or plastics from renewable resources, such as starch, hemicelluloses, etc., that can replace the apparently non-biodegradable plastic materials. One of the very easily available cross-linking agents is citric acid which can be obtained commercially from citrus wastes as a by-product. Furthermore, limonene is another important chemical obtained from citrus wastes which has been found to generate biodegradable polymers (1)

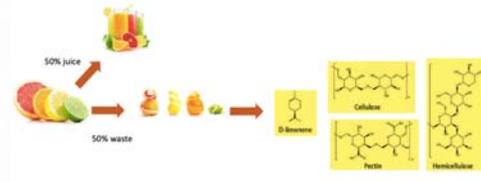


Figure 3. Conversion of food waste into bioplastics.

### ❖ Biogas, bioethanol, or volatile compounds could be produced from the citrus waste.

- ✓ Biogas is gaseous material produced during anaerobic digestion of organic compound. Conversion of orange peels wastes into fuel is attractive, since it gives benefits in terms of both energy recovery and environmental aspects. Orange peel waste contains both soluble and insoluble carbohydrates that can be digested to biogas. However, the main challenge to produce biogas from orange peel is the presence of an antimicrobial compound "D-limonene." Recently, investigations have been focused to inhibition challenges by limonene (4,5).

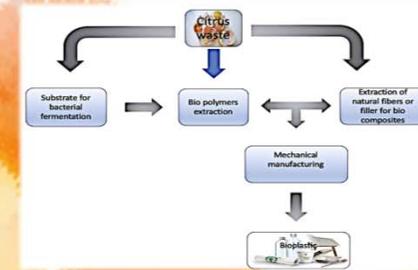


Figure 2. Structure of various components of citrus peel waste.

### ❖ Biodegradable polymeric materials and biosorbents could be produced from the citrus waste.

- ✓ Industrialization has led to increased amounts of heavy metals being dumped into the environment. These kinds of substances are stable and persistent environmental contaminants since they cannot be degraded or destroyed, and therefore tend to accumulate in the soils, seawater, freshwater and sediments. The bio sorbent generated from lignocellulosic plays an important role in eliminating trace poisonous metals from wastewater. Citrus waste is one of the most important sources for the lignocellulosic biomass because it is rich in carbohydrates and had low lignin content (8,11).

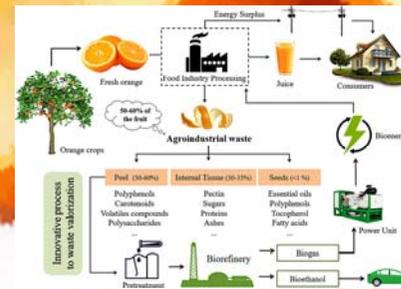


Figure 4. Industrial waste generation by the citrus industry. Adapted from the reference (5).

## RESULTS

- ❖ **Fibers, fabrics, etc. could be produced from citrus waste.**
- ✓ Generally speaking; citrus fruit peels can be used for the production of reactive printing thickeners, manufacturing of handmade paper, textile dyeing, printing, print transfer medium by different extraction methods. Recently, fiber is made by extracting the cellulose from the fibers that are discarded from the industrial pressing and processing of the oranges. The fiber, through nanotechnology techniques, is also enriched with citrus fruit essential oil (9).

## CONCLUSIONS

- ✓ Using food waste is important to the world since it involves sustainability, economy, science, technology and health. Recently researches related to development of innovative extraction techniques to increase usage of chemicals and valuable products, via biological-/biochemical/chemical/physicochemical/physical transformation from citrus waste.

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