Article ID 240205-S-02

Citrus Fruit Waste and Its Utilization

Sonia Sorout, Arun Kumar Pandey and Hanu sharma
Amity institute of biotechnology, Amity University Jaipur Rajasthan
*Corresponding Author: soniasoroth@gmail.com

Citrus is one of the most important fruit crops in the world . Citrus L. is the scientific name for citrus, and it belongs to the Rutaceae family. In addition to many other regions, it is widely grown in tropical and subtropical climates, jointly producing over 100 million tons each year. Citrus fruits have a strong preference among consumers due to their eye-catching hues, delightful scents, and delectable flavors. Citrus fruits are the most widely grown crops in the world. Around the world, citrus fruits are a basic food that is consumed by many people. In the world at large, these fruits are essential for nutrition and business.

Citrus fruits were previously only exchanged and eaten when they were still fresh, even in areas where they were not grown. This is because citrus has unusual post-harvest stability that facilitates international trade, and in the majority of citrus cultivars, the fruit may be left on the tree beyond maturity for an extended period of time without going bad. However, the industrialization of citrus fruits has become essential due to the continuous growth of plantation areas and crop sizes. There have long been citrus fruit-based essential oil extraction facilities and industries that make jams, jellies, and marmalades. According to historical accounts, the establishment of fruit juice businesses in California and Florida during the 20th century marked the beginning of the widespread use of citrus fruits. Approximately 18% of citrus fruits produced worldwide are used in industry (FAO, 2017), primarily for juice manufacturing. In the canning business, citrus fruits are also processed to make marmalade, mandarin segments, and to extract bioactive essential oils and flavonoid components.

Waste from citrus processing is strategically and significantly important to the agro-industrial sectors, the pharmaceutical, cosmetic, and animal feed industries. Around 50–60% of the world's total productivity and economic significance can be derived from its widespread and extensive land-based harvesting. Depending on the technology used and the fruit cultivars chosen with purpose, the amount of waste produced during citrus processing ranges from roughly 50% to 70% of the fruits that have been processed. The global annual production of citrus is roughly equal to or less than 10 million mg. The processing of citrus waste clearly shows a low pH and a higher concentration based on its organic compounds, of which the primary impediment to biological management options based on their antimicrobial properties is the availability of essential oils (EO), of which D-limonene is the principal constituent. Due to economic and environmental concerns, there are still significant limitations on the management of citrus processing. Juice can also be produced from citrus waste, which is an essential and abundant supply of vitamin C for processing nutrient-dense drinks. Moreover, it contains 50% of pure, pleasant juice that is extracted; these remnants (seeds, pulp, and peel) make up almost 80% of the moisture content. Such a waste management technique results in extremely contaminated waste water, may even cause significant soil quality degradation, and seriously harms the superficial waterways in such places. Citrus waste may include essential oils composed of compounds such as α-terpinolene, α-pinene, D-limonene, β-Citronellol, and citronellol. Citrus trash can yield essential oils that are widely used in the food, pharmaceutical, and cosmetic industries as flavoring agents in the creation of beverages, soaps, cosmetics, and food additives. Extracts from citrus processing waste may contain penicillin and metacillin, two medicines that are used to treat pathogenic bacteria such salmonella typhi, bacillus subtilis, Escherichia coli, staphylococcus aureus, and klebsiella pneumonia. The efficient use of citrus trash has reduced environmental issues and provided a sustainable method of reclaiming many bio-based goods, including enzymes, organic aids, and biofuels. Food and beverage quality can be enhanced and prolonged by using citrus processing waste as a rich source of phenols and carotenoids, which can be utilized as biofertilizers.

Citrus fruit production, import, export, and processing worldwide

About 82% of all citrus fruits produced are oranges, which make up nearly 98% of all industrialized crops .In 2020, the total citrus fruit production worldwide was estimated to be 158.49 million MT. Asia accounted for the largest portion of this production, with 47.7%, followed by Africa (43.7%), America (8.1%), Europe (0.4%), and Oceania (0.1%). China is the top producer of citrus fruits, with

44.63 million MT produced in 2020, or 28.16% of the total citrus fruit produced worldwide. Other significant producers of citrus fruits are Brazil, India, and Mexico, each of which contributes more than 5% of the total production worldwide. About 10.07 million hectors of land are used worldwide to grow citrus fruits. The world's leading citrus-growing nations are China, India, Nigeria, Brazil, and Mexico; An estimated 14.57 million MT of citrus fruits were imported globally in 2015, with oranges accounting for around 47% of the total, followed by tangerines (29%), lemon/lime (17%), and grapefruit (7%). With 10.63% of worldwide citrus fruit imports, the Russian Federation is the world's top importer. Other significant importers of citrus fruits are the United States of America (6.44%), Germany (7.54%), France (7.19%), and the Netherlands (6.72%). Figure 2(c). With an annual export of 3.64 million MT, or 24.06% of the world's total citrus export in 2015, Spain is the leader in the worldwide citrus fruit export market (Fig. 2(d)) (FAO, 2017). Citrus fruits are expected to be exported for 15.62 million MT globally, with oranges accounting for 44.00%, tangerines for over 30.50%, lemon/lime (18.50%), and grapefruit (5.00%) in order of importance. Oranges (1.58 million MT), tangerines (1.48 million MT), and lemons and limes (0.52 million MT) are among the top exports from Spain. Spain, South Africa, Turkey, Egypt, China, and the United States of America account for 5% of the world's citrus fruit exports (FAO, 2017).

3.Citrus fruits: Types, composition, and structure
Types of citrus fruits produced

The varieties and sizes of citrus fruits grown affect one another. They all have special qualities that are beneficial to a variety of food and non-food industries. They can be categorized as limes, citrus, mandarins, grapefruits, pomelo, andoranges based on their various kinds and sizes. Citrus fruits are high in pectin and contain a variety of secondary plant metabolites, including coumarins, carotenoids, flavonoids, alkaloids, essential oils, phenolic acids, and limonoids. These metabolites have a few biological activities, including anti-inflammatory, anti-cancer, neuroprotective, and cardiovascular protective effects.

limes

They began to gain popularity in Asia and the Middle East. Limes have the power to treat liver, heart, and bone disorders as well as prevent urinary tract infections. Limes are the third largest citrus horticulture group and may be grown anywhere in the world in all inter-tropical, sub-tropical, and Mediterranean regions, yielding approximately 15 million tons of fruit annually.

Citrons

Citrons (Citrus medica) are aromatic fruits with a thick, broad skin that resembles lemons but has less acidic flesh. It has been shaped to resemble an original feature of the three citrus fruits that were developed in a proper manner without the use of artificial or synthetic hybridization. It's easy to characterize it as a citrus fruit with a thicker peel than the others. There have been reports of wild kinds of citrons in Bhutan and Assam, and some of these forms may have adapted to Thailand.

Mandarins

Mandarins (Citrus reticulate) are a fruit that has a high vitamin and mineral content, with 684 of them being linked in The Pharma Innovation Journal http://www.thepharmajournal.com. While some can be used appropriately to create delicious juice, others should be eaten right away. Mango juices are clear, clean, and occasionally hazy. Mandarin output, which accounts for 22% of global citrus production, is placed second only to sweet orange production (FAO 2016). The citrus family includes the mandarin, which has a somewhat acidic and sweet flavor. The eastern Indies, Japan, India, and the southern region of China are the nations where the Mandarin family was lastly raised.

Orange

Oranges (Citrus sinesis) are rounded in shape and have pulpy carpels. It can be employed in enterprises that make citrus-flavored sweet drinks. It comes in two varieties: bitter orange and horned orange. Its reddish yellow tint makes it easy to identify and separate after it has reached ripeness. In Myanmar, Northeast India, and Southern China, orange gained popularity. Oranges are a good source of flavonoids, phenolic compounds, vitamin C, and pectins.

Citrus waste utilisation

In terms of global crop production, citrus fruits are considered as the crop that is consumed the most, followed by grapes. Citrus is thought to be the highest source of vitamin C and has eye-catching colors and unique flavors. Workers conducted and gathered impressive research studies on the consumption of citrus fruits to meet the needs of the food processing industry. The food industry uses the raw ingredients from the processing of citrus fruits to make marmalades, pasteurized concentrates, frozen canned juices, candied peels, flavoring oils, and cordials and soft beverages. Global citrus production reached 137.8

million tons in 2014, and the number continues to rise annually. 11.3 million tons of citrus were produced in Europe, with Greece (9%), Spain (62%), and Italy (24%), in the top three positions. Because citrus is used to make so many various products, like orange juice, marmalade, citrus honey, and essential oils, it has a significant impact on the global economy. Only 50 to 65 percent of the waste produced by citrus fruits—which produce about 70% more garbage—is handled. Citrus waste consists of membrane remnants, seeds, and peels. Processing the enormous volumes of citrus trash is essential to preventing major environmental contamination. There are several ways to use the citrus trash, which are described below-

Citrus waste and its production in biofuel

Waste from citrus oranges contains soluble and non-soluble polymers of carbohydrates that can be processed to produce ethanol and biogas. Anaerobic digestion can produce methane from orange peel pressing liquid and citrus debris, and orange peel degradation can produce cow feed. Citrus waste can be treated in a variety of ways, including co-digestion, mesophilic or thermophilic bacterial treatments, using other vegetable and fruit wastes as co-substrates to produce usable biomass products, and municipal garbage. Most of our food spoils and losses are done by oxidation during processing, transportation and storage, and microbial contamination. However, preservatives are added these days to prolong the shelf life of food items. Most of the time, we utilize artificial or chemical preservatives, which have been shown to have negative impacts on human health in addition to problems with the agricultural and natural environments.

***Citrus* Waste and Food Preservation against Spoilage Microbes**

However, preservatives are added these days to prolong the shelf life of food items. Most of the time, we utilize artificial or chemical preservatives, which have been shown to have negative impacts on human health in addition to problems with the agricultural and natural in the agro-industrial sector, cultivated lemon, mandarin, lime, and grapefruit account for between 50 and 60 percent of global citrus production. Numerous sources of essential oils can be found in citrus fruit plants. The US Food and Drug Administration classifies these volatile plant secondary metabolites, or essential oils, as generally recognized as safe (GRAS). Biological actions of essential oils include anti-inflammatory, anticancer, antibacterial, and antioxidant effects. Citrus lipid components have been shown to contain over 200 different components, most of which are acids, terpenes, alcohols, ketones, esters, and aldehydes. In the food business, essential oils have been used extensively to combat bacteria that cause food degradation or contamination.

Citrus waste and Bioactive compounds

The most common waste of processing citrus was peel waste, which had a high-water content as well as significant levels of biomass and essential oils. In light of economic and environmental considerations, citrus peel wastes have found a wide range of applications and potential uses, including the food industry's production of pectin and dietary fibres, animal feeds to add nutritional value, organic soil conditioners, and compost production substrates to increase the soil's organic matter content. Waste citrus peels can be converted into citric acid, flavonoids, and flavourings for use in the pharmaceutical and cosmetic industries.

The extraction of value-added polyphenols from various citrus peels—a quick, sustainable, and economical technique—with low instrumental needs and operating simplicity has been developed. The proposed extraction approach may be simpler to carry out than alternative extraction procedures such as UAE, MAE, or ASE, particularly on a large scale, and may also have reduced economic expenses. Temperature should be set at 90°C for the maximum extraction efficiency for all examined analytes; however, for a specific polyphenol, temperature might be set at 62°C and the ethanol ratio dropped to 20% under some extraction conditions.

Citrus waste and food, pharma, and other applications

The majority of agricultural wastes are processed using fundamental waste management and valorization techniques to create compost, animal feed, fertilizer, and biogas through anaerobic digestion of waste. Recycling these wastes is an essential procedure because of the significant expenses associated with their transportation, storage, and drying, in addition to the environmental concerns. Solid waste can be used to produce by-products, which are more valuable than the primary products because agricultural companies only produce between 10% and 60% of their primary products from raw materials. As they are typically thrown away and can be turned into valuable byproducts, the skins, leaves, seeds, useless pulp, and wastewaters make up 40% of the total plant food in citrus fruits, mangos, pineapples, papayas, artichokes, and asparagus. Newer ways of using citrus trash for chemical

industry uses have been the focus of recent investigations. The number of pulps, peels, seeds, and membrane leftovers (40–60% of the entire fruit) in citrus waste worldwide surpasses 110–120 million tons annually. Biodegradable polymers and useful materials have been produced by the food processing, pharmaceutical, and chemical sectors using organic acids derived from citrus wastes. Research on peel microstructures is currently being conducted to create methods for bioinspired materials and to produce significant compounds from citrus waste that are both affordable and environmentally beneficial.

Table 1: Value added products from citrus waste

Sl. No.	Citrus fruit waste	Citrus based source	Disease
1.	Lemon	Peel and pulp	Antioxidant, risk of cardiovascular disease
2.	Citron	Pulp and peel	Anti-hyperlipidemic
3.	Pomelo	Peel	Gastroprotective, anti-ulcerogenic
4.	Sweet orange	Pulp and peel	Antioxidant, antibacterial, anticancer
5.	Lime	Peel and pulp	Improve immunity, kidney stone

In underdeveloped nations, agricultural waste is frequently dumped into the environment untreated, leading to the removal of agricultural byproducts and pollution. By treating biowaste as a rich resource of highly valued materials and reusing it through biowaste-to-resource (BTR) systems, recycling efficiency and economic costs can be reduced. Additionally, since citrus trash cannot be transported over great distances, producers must make silage from the waste that is gathered at the farm level in order to store it for later processing. Furthermore, because silage is easily contaminated by certain weather conditions, such humidity, it needs to be stored with greater caution and sealed tightly.

Future perspectives

As more people become aware of the possible health benefits of consuming citrus processing trash, which is a good source of naturally occurring nutrients derived from plants, food containing chemicals steadily loses ground to citrus processing waste. A rise in the demand for natural food items because of the potent nutraceuticals obtained from plants, which will replace pricey synthetic food additives. Citrus has immense and promising health benefits, making it a good source of functional compounds. Because of this, the management of citrus waste and its application in the food, cosmetic, and pharmaceutical industries have received increased attention.

Conclusion

In summary, citrus waste (peel and wastewater) is very important in many businesses, particularly the food, cosmetic, and medicinal ones. Given the enormous amount of citrus waste, more attention should be paid to it in order to manage the waste and optimize financial gain. By using citrus biomass as a non-synthetic conditioner for the manufacture of compost specifically in agricultural areas, waste from the processing of citrus can increase the nutritional content and organic matter of agricultural soil.

I want to use this platform to strongly encourage people to stop throwing away citrus waste and to help educate others about its many benefits and uses, which will also help reduce the amount of garbage produced, improve health, and reduce the need for excessively synthetic products. This is because citrus processing waste has many promising uses and health benefits.

* * * * * * * *