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Original paper

Citrus Peels: Health Benefits and its Functional Ingredients

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Introduction

Citrus fruits are the most widely cultivated fruits in the world and contain significant, advantageous compounds. They are regarded as one of the world's largest plant species and are widely distributed in tropical, subtropical and temperate regions of the planet. They are members of the Rutaceae family and comprise 40 different species. The most important citrus crops grown for industrial purposes are oranges, grapefruits, mandarins, lemons and limes because of their high nutritional content. In the list of the top 10 citrus producing nations in the world are Brazil, China, the United States, Mexico, India, Spain, Iran, Italy, Nigeria and Turkey. One-third of all citrus fruits are processed and hundreds of tonnes of peels generated during the production of citrus juice are frequently regarded as agro-industrial waste. Due to fermentation and microbial deterioration processes, citrus peel (CP) may become a source of problems for environment. On the other hand, citrus peel is a useful by-product of the citrus sector that is used in the food, drug and cosmetic industries. The availability and affordability of citrus peel industrial waste as a source of renewable biomass are its main benefits (Kaur and Singh, 2021).

Citrus peel is a good source of limonene, molasses and pectin. It is typically dried, combined with dried pulps and sold as cattle feed. The epicarp or flavedo (coloured periphery surface) and mesocarp or albedo (white, soft center layer) are two subgroups of citrus peels. After juice extraction, the citrus fruit peel accounts for over 50% of the wet fruit mass and is highly rich in polyphenols, pectin and natural colours as well as aromatic chemicals and nutritional fibers. Essential oils (EOs), which are found in the oil sacs of both

peels and cuticles, are the main reason that citrus fruit peel is used. Limonene is the main component of essential oils (EOs) that are derived from citrus by-products and utilised as flavourings in food, cosmetic and pharmaceutical goods (Russo *et al*., 2021).

Health Benefits of Citrus Peels:

- Citrus peels are excellent source of bioactive substances like phenolic acids and flavonoids. In order to prevent diseases brought on by reactive oxygen species, citrus flavonoids work as strong antioxidants and free radical scavengers.
- Citrus flavonoids have anti-inflammatory, cardioprotective, antioxidant and other health-promoting characteristics.
- Hesperidin and naringin, two flavanone glycosides found in citrus peel, have potent anticancer properties.
- Orange peel is used as a traditional remedy for ringworm infections, respiratory tract infections, stomach issues and skin inflammation.
- The peel of a mandarin orange possesses antibacterial properties against germs that cause acne.
- Kinnow peel hot alcoholic extract shown excellent in vitro antioxidant and anti-enzymatic activities demonstrating the potent antiaging capacity of peel that can be employed in skin care formulations (inhibition of collagenase).
- Lemon peel extract prevents the development of calcium oxalate stony concretions and protects the urinary tract from harm brought on by stones, which aids in the prevention and control of calcifications in the urinary system.
- Diabetes can be effectively managed by using the hexane extract of lemon peel, which lowers blood sugar.
- Many neurological illnesses linked to inflammation can be treated with tangerine peel as a dietary supplement (Singh *et al*., 2020).

Functional Ingredients of Citrus Peels:

1. Flavonoids:

Flavanones, flavones and flavonols are the three forms of flavonoids that are most frequently found in citrus fruits. Traditional Chinese medicine uses dried tangerine peel, also known as *chen-pi*, to treat a variety of illnesses include bronchial asthma, indigestion and poor cardiac circulation. Several scientific studies claim that it is a rich source of numerous flavonoids, particularly flavanone glycosides and polymethoxy flavones, which are crucial in the prevention of serious disorders including cancer and atherogenesis. Hesperidin is the flavonoid that is most prevalent in tangerine peel, followed by tangeretin and nobiletin. Individually, hesperidin, nobiletin and tangeretin have inhibitory action against neuroinflammation (Rafiq *et al*., 2018).

2. Phenolic Compounds:

Phytochemicals and specifically phenolics found in fruits and vegetables, are important bioactive molecules that have been linked to positive health effects. Plant phenolics have been found to be present in both edible and non-edible plant components and they have been linked to a variety of biological functions. Free radical scavenging and metal chelation activities are two key mechanisms for phenolics antioxidant effects in functional meals. By scavenging free radicals and quenching ROS, phytophenols offer efficient strategies for preventing and treating free radical-mediated diseases like cancer, diabetes, neurodegenerative illnesses, the ageing process and cardiovascular dysfunctions (Kaur and Singh, 2021).

3. Dietary Fiber:

Dietary fiber, which is frequently divided into soluble and insoluble types, is made up of a variety of oligosaccharide and polysaccharide plant carbohydrate polymers, including cellulose, hemicelluloses, pectin compounds, gums, resistant starch and inulin. In addition to preventing hydrolysis, digestion and absorption in the human small intestine, dietary fiber also improves colonic fermentation, maintains insulin levels, lowers pre-prandial cholesterol levels and increases faecal bulking efficiency. The majority of dietitians and diet specialists advise that 20–30% of the daily recommended fiber consumption come from soluble fiber. Dietary fiber also demonstrates several useful features, such as the ability to hold water or oil, to generate gels or viscosity, to bind bile acids, to stabilize emulsions and to lengthen shelf life. By-products from the daily production of huge quantities of cereal, fruit and vegetables can be used to create goods with added value (Rafiq *et al*., 2018).

Conclusion:

Citrus fruit residues that would otherwise be dumped as waste in the environment should be considered potential nutraceutical resources because they are inexpensive and readily available and can provide considerable, affordable nutritional dietary supplements. These waste products from production that are high in bioactive components can be repurposed into food supplements with additional value that include healthy dietary fiber and polyphenols. They function as non-caloric bulking agents, improve water and oil retention, enhance emulsion and may shield us from a variety of illnesses brought on by oxidative stress. Therefore, potential sources of bioactive chemicals, fruit peel extracts show promise in the food and would aid in reducing pollution issues brought on by improper disposal of these leftovers.

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