Review Article

Litchi waste: An important Sources of Health Beneficial

ABSTRACT

Tropical fruits like litchi (*Litchi chinensis* Sonn.) are prized for their nutritional value and sweet flavour. Nevertheless, eating it produces a large quantity of waste, mostly in the form of pulp, peel, and seeds. The potential health advantages of these waste materials, which are abundant in bioactive chemicals including polyphenols, flavonoids, and vitamins, have been brought to light by recent studies. This review investigates the nutritional makeup of litchi waste and possible uses for improving human health. Litchi waste contains bioactive chemicals with anti-inflammatory, antibacterial, antioxidant, and anticancer effects that have been extracted using a variety of techniques. Additionally, using litchi waste in pharmaceuticals, nutraceuticals, and functional meals offers a sustainable way to lower food waste and improve nutritional value. Prospective study avenues encompass refining extraction methodologies, assessing bioavailability, and executing clinical trials to authenticate the ameliorative impacts of litchi waste-derived compounds. To sum up, litchi trash is a valuable and underutilized resource that has the potential to improve health and the environment while also enhancing human well-being.

Keywords: Litchi; Bioactive compounds; Nutraceuticals; Pharmaceuticals; Health benefit

1. INTRODUCTION

An important member of the Sapindaceae family, which has a strong mycorrhizal relationship, Litchi (*Litchi chinensis* Sonn.) is an evergreen subtropical fruit tree [1-2]. Evergreen subtropical fruit crops known as litchi are rich in nutrients and have therapeutic properties. It has phenolics [3] and vitamin C [4-5] in good amounts. The by-product litchi has notable concentrations of flavonoids and phenol, both of which have been linked to a range of biological functions. With genotype IC-0615587, the total by-product in litchi fruit was 19.85%, but with genotype IC-0615595, it was 59.54 percent. The genotypes Coll.38 (22.58%) and IC-0615595 (369.6%) had the highest percentages of seeds and pericarps, respectively [6]. The nutritional value of litchi fruits is well-balanced, with roughly 60–80 calories per 100 g fruit and good levels of vitamins, antioxidants, and dietary fiber. Fruits are low in saturated fats and cholesterol, and for a very long time, people have used decoctions of tree bark, flowers, and roots to treat tumors, gland enlargements, coughing, and throat

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problems [7]. Thanks to its anti-oxidants, dietary fiber, and vitamins, litchi comes in many forms and can be used to treat a wide range of illnesses, including immune modulation, oxidative stress, hyperuricemia, fatigue, analgesics, visceral fat, viral diseases, cancer, neurodegenerative disorders, cataracts, and cardiovascular and brain diseases [8-10]. Eating phenolic-rich food reduces the risk of degenerative illnesses such cancer, heart disease, inflammation, arthritis, brain damage, and cataracts [11]. Because litchi contains a variety of nutritious substances, including vitamins, dietary fiber, linoleic acid, amino acids, trace minerals, and additional unsaturated fatty acids, it can be used to benefit human health in a variety of ways [12]. The wounds can be healed with litchi pieces.

Ayurvedic evidence suggests that various portions of the litchi fruit, leaf, and inflorescence have been utilized to cure a variety of illnesses, with digestive, excretory, and reproductive system issues being the most common conditions treated [13-14]. China has been using litchi fruit as an alternative medicine for more than a millennium. The seed of litchi is used to treat hernias and stomach troubles; the pericarp is used to treat dysentery, metrorrhagia, and eczema. Litchi seeds and pericarp have been used to treat a variety of ailments, such as cough, flatulence, stomach ulcers, diabetes, obesity, testicular swelling, hernia-like conditions, epigastric and neuralgic pains, and anti-cancer, antibacterial, antihyperlipidemic, antiplatelet, antitussive, analgesic, anti-pyretic, hemostatic, diuretic, and antiviral properties [15]. The primary constituents of litchi fruit include flavonoids, phenolic acids, anthocyanins, coumarin, lignans, chromanes, sesquiterpenes, fatty acids, sterols, and triterpenes. One significant class of secondary metabolites found in plants are phenols, which have a number of beneficial qualities for human health. Traditional medicine has employed litchi fruit and its secondary metabolites as anti-diabetic, anti-cancer, anti-inflammatory, antifungal, antiviral, antiplatelet, and anticoagulant agents. In addition, the plant includes a number of organic acids, including fumaric, succinic, phosphoric, levulinic, malic, lactic, and glutaric acids. The edible portion of litchi is called aril, whereas the waste materials-seed, bark, blossom, and leaves are valuable sources of nutrients. Flowering is also controlled by variations in the phenolic content of litchi leaves [16]. The sunburn and fruit cracking are serious issues in litchi [17-19] and these conditions are being made worse by climate change [20-22]. Fruit with cracks and sunburn are a waste product of litchi since the fruit is unfit for consumption. The following lists several waste products' significant health benefits:

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2. PERICARP

The total by-product (pericarp and seed) in litchi fruit ranged from 19.85 to 59.54% [6]. The phenolic compounds (51–102 g kg^{-1} DW) have been found in pericarp [23]. These

compounds have been shown to have bioactivities such as high ferric reducing anti-oxidant power (FRAP), 1, 1-diphenyl-2-picryhydrazyl (DPPH) scavenging, inhibition of lipid peroxidation, and protection against oxidative DNA damage. Tannins, epicatechin, anthocyanidin A2, anthocyanin, quercetin 3-rutinoside, and quercetin glucoside are the primary phenolics [24]. Kaempferol, isolariciresinol, stigmasterol, butylated hydroxytoluene, 3,4-dihydroxyl benzoate, methyl and ethyl shikimate, and a new phenolic, 2-(2-hydroxyl-5-(methoxycarbonyl) phenoxy) benzoic acid were separated from litchi pericarp [25]. Litchi pericarp contains considerable amount of polysaccharides with strong antioxidant properties [26]. Studies have demonstrated that the pericarp of litchi fruit has antioxidant properties. According to multiple studies [27-28], the pericarp contains polyphenolic chemicals and polysaccharides that have a high degree of free radical scavenging properties. The proanthocyanidins from the pericarp also demonstrated strong antioxidant activity. By preventing cancer cells from proliferating uncontrollably and triggering the signalling pathways associated with apoptosis, several extraction methods of the pericarp of the litchi fruit have also been shown to have anti-cancer effects against human embryonic lung fibroblast and breast cancer [29]. The aqueous extract of the pericarp of the litchi fruit also shown hepatoprotective properties by gradually reducing the number of apoptotic cells with morphological alterations [30]. Flavonoids found in the pericarp have been shown to have anti-inflammatory properties [31].

In addition to one magnificent macrocyclic analogue, macrolitchtocotrienol A, and one new meroditerpenechromane, cyclolitchtocotrienol A, seven new δ-tocotrienols, called litchtocotrienols A–G (1–7) have been discovered with anti-cancer activity against gastric adenocarcinoma and hepatoma carcinoma cell line [32]. The antioxidant properties of epicatechin from litchi and bis (8-epicatechinyl) methane have been documented [33]. It has been observed that cyclins were suppressed, the Bax/Bcl-2 ratio was raised, and caspase-3 activity was increased in a dose-dependent way to induce apoptosis, cell death, and cell cycle arrest in colorectal cancer cells [34]. Following bioconversion by Aspergillus wamori, it has been demonstrated increased antioxidant activity and DNA protective impact of litchi pericarp extract [35]. According to studies conducted on the phytochemical analysis of litchi pericarp, benzoic acid which has seven recognized compounds is a new molecule that has strong antioxidant action [36]. Numerous researchers have thoroughly characterized the anti-oxidant activity of litchi skin [37-40]. Ascorbic acid, glutathione, carotenoids, polysaccharides, and other free-radical scavenging components are present [41-42]. It also includes rich phenolic substances, such as flavonoids (flavonols and anthocyanins) and

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phenolic acids. In the epidermis of litchi, epicatechin, procyanidin B2, epigallocatechin, and procyanidin B4 have been discovered [43]. Procyanidins, or polymerized tannins, were found to be the most prevalent in 'Guiwei' skin (0.4% fresh weight), followed by epicatechin (0.17%), procyanidin A2 (0.07%), anthocyanins (0.04%), and flavanols (0.04%) [24].

The majority of the anti-oxidant activity of litchi skin is attributed to two flavonoids, specifically anthocyanins and procyanidins [44]. Procyanidin B2 was discovered to be more effective than procyanidin B4 [28] and epicatechin in scavenging hydroxyl free radicals and superoxide anion, whereas epicatechin was shown to be more active in eliminating DPPH. Changes in phenolic compounds and other chemical compositions occur with the development of litchi fruits [41. As a result, the skin's antioxidant activity varies depending on skin maturity. Fruit's skin exhibited a significantly higher level of antioxidant activity when it was still young [45].

Litchi skin contains 40% dry weight of insoluble fiber, which helps prevent diabetes, hemorrhoids, and rectum cancer. Human hepatoma cell growth was greatly reduced in vitro by a water soluble alcohol extract from litchi skin [46]. The litchi skin extract is also useful in suppressing breast cancer [47]. They discovered that litchi skin extract altered the pattern of gene expression, produced programmed cell death, and inhibited the growth of cancer cells [46-47]. It makes up about 15% of the weight of the entire fresh fruit and has a significant phenolic content. Although the pericarp is typically thrown away as waste [28], that is the source of bioactive phenolics and flavonoids. In dried litchi pericarp, the total phenolic content varied between 51 and 102 g k g^{-1}. The procyanidin content is high in litchi pericarp [48]. During storage at 25 °C, the quantities of procyanidin-A2 and (−)-epicatechin in the pericarp of postharvest litchi fruit declined as the skin browning index increased [49]. Ten cultivars of litchi that were gathered over the course of two production seasons have also shown seasonal fluctuations in the phenolic contents of their pericarp [13].

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The total amounts of flavonoids and phenolics in fresh weight (FW) varied from 7.12 to 23.46 mg of catechin equivalents/g FW and 9.39 to 30.16 mg of gallic acid equivalents/g, respectively. Between 1.77 to 20.94 mg cyanidin-3-glucoside equivalents/100 g FW were the overall anthocyanin levels. The three anthocyanins that were identified were cyanidin-3-rutinoside, cyanidin-3-glucoside, and malvidin-3-glucoside. Of these, cyanidin-3-rutinoside was the most abundant, accounting for 68.8% to 100% of the total anthocyanins. The total procyanidin levels were 4.35 to 11.82 mg epicatechin equivalents/g FW [48].

3. SEED

Litchi seeds have demonstrated a number of pharmacological actions, including the ability to relieve pain and dissipate cold. Seed has been used to treat epigastric pain, liver stagnation, hernia pain, blood stasis in women, testicular swelling, blood glucose and lipid modulation, and liver injury [50] as well as anti-oxidant, anti-virus, and antitumor properties [51]. Additionally, studies on the CNE-2Z of the nasopharynx [52], cervical, and lung cancer have been demonstrated the anti-tumor efficacy of litchi seeds [53]. Litchi seeds contain minerals like Mg (0.28%), Ca (0.21%), and P (0.11%), as well as starch (40.7%), crude fiber (24.5%), and proteins (4.93%). The twenty-one amino acids were identified of which four were unknown [54]. The detection of volatile chemicals in litchi seeds, such as ketones, aldehydes, esters, alcohols, enes, and terpenoids, some of which had unclear activities [55]. The amount of crude saponin in litchi seeds were assessed [56].

Traditional Chinese medicine describes dried litchi seed as mildly bitter, warming, cold-driving, pain-relieving, and tonifying of the kidneys and liver [57]. Flavonoids found in litchi seeds enhance the seed's antioxidant properties. Water and ethanol extracts from litchi seeds were discovered [58] to decrease free radical damage and increase SOD activity in mice treated with alloxan monohydrate (ALX). The litchi seed pellets or water extract were useful in suppressing tumor and hepatoma growth [59-60]. Litchi seed extract prevented hepatoma cells from forming telomeres and, consequently, from dividing [59].

According to research, litchi seeds can lower blood sugar and cholesterol while also improving liver function [37-38]. The litchi seed water extracts lowered blood sugar levels in rats with ALX-induced diabetes [61]. The litchi seed extract was safer than biguanides and that its effects persisted for more than a week [62]. Litchi seed extract decreased blood sugar levels by promoting glucose uptake in surrounding tissues while inhibiting blood capillary glucose uptake [58]. Litchi seed's ability to lower blood lipid levels is due to its high content of unsaturated fatty acids [63]. The litchi seeds' α-methylenecyclopropylglycine effectively reduced blood sugar and glycogen levels in the liver of mice treated with ALX [64]. Saponins had a role in the antidiabetes activity of litchi seeds [65].

Many studies have documented the antiviral properties of litchi seed extracts against a variety of viruses, including the hepatitis B virus [66-67] , the influenza virus [68], the respiratory syncytial virus (RSV) [69] and the SARS coronavirus [70]. Of the 1000 herbal remedies studied, litchi seed was determined [71] to be the second most efficient in controlling hepatitis B. The beneficial ingredient in litchi seeds was their saponins [66, 68, 70] ascribe the anti-virus action of litchi seed extracts to their flavonoids. ~~Powdered~~ litchi seed is used to ease discomfort and treat cold stagnation. Litchi seeds are used to treat

postpartum and premenstrual stomach pain [72]. Litchi seeds are also helpful in treating digestive problems, ulcers, hernias, lumbago, neurological diseases, and arthritis.

Chinese tribal communities utilize a mixture of litchi seeds, cumin, and peels to relieve the pain associated with hernias or swelling in the testicles [14]. Litchi fruit and seed parts have been utilized as medicinal tablets to treat many forms of diabetes, especially pregnancy-related diabetes. In Taiwan, the floral mixture is consumed as a cheery or refreshing beverage. Litchi is used by a sizable population in Vietnam to relieve small intestine and stomach pain [73]. In India, people drink tea made from powdered litchi seeds to relieve digestive problems, as well as to lessen nerve irritation and neuralgic pain [29]. In Indian and Chinese traditions, the seeds macerated in alcohol are used to heal digestive disorders. Malays utilize bark for severe tongue illnesses and root decoction for fever. In Palau, a combination of seeds is used to treat coughs.

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4. BARK

Bark of litchi contains 42.0% fatty acids, including cyclopropanoic, 27.0% oleic, 12.0% palmitic, and 11.0% linoleic, as well as organic acids, fatty acids, amino acids, saponins, flavonoids, and sugar [74]. In addition to its possible medical benefits, it is utilized in the cosmetics sector and as biopesticides, or fertilizers made from the leftover peels, seeds, and extraction process wastes [75]. The peel and bark of the fruit are boiled and consumed as tea to treat diarrhea and eruptions of the pox [76].

5. LEAVES

Leaf paste and extract are used for the treatment of ulcer, heat stroke, stomachache, flatulence, and detoxification [51]. Litchi leaves can be used to prepare moisturizing gel for the treatment of skin disorders. Poisonous insect attacks have been treated with the outer layer of litchi fruit and leaves [77]. Litchi leaves possess potent antimicrobial properties. The components of litchi that were separated into methanol, 1-butanol, aqueous, and ethyl acetate fractions all shown high DPPH and peroxyl radical scavenging activity. The study's findings showed that every component under investigation has the ability to provide natural antioxidants [50]. By enhancing natural antioxidant defense mechanisms, the methanol and chloroform extracts of litchi leaf may provide hepatoprotection against paracetamol-induced liver damage and restore biochemical parameters in rats in a way that makes sense [78]. According to the extracts' initial phytochemical study, terpenoids, flavonoids, phenols, tannins, and saponins were present. Rats' paw edema model caused by carrageenan was used to assess the anti-inflammatory activity, while mice's writhing test and hot plate method were

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used to assess the analgesic effect. Significant anti-inflammatory efficacy was shown by oral HLCL treatment, with the greatest effect occurring four hours after carrageenan administration. According to the antimicrobial activity tests, luteolin was found to have the most antibacterial activity against Salmonella, Bacillus thuringiensis, Shigella dysenteriae, Escherichia coli, and Staphylococcus aureus. The epicatechin, procyanidin A2, and rutin exhibited comparatively poor antibacterial properties [51].

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6. FLOWERS

Phenols, flavonoids, and tannins are present in litchi flower water extract (LFWE). Phenolic acids, flavonoids, condensed tannins, anthocyanins, and proanthocyanidins are only a few of the phytochemicals found in the aqueous extracted of litchi flowers [79]. Owing to the presence of phenolic components, the acetone extract of floral extract demonstrated DPPH radical scavenging action and inhibited low density lipoprotein (LDL) oxidation. Evaluations were conducted on the effects of flower extract on hepatocyte toxicity induced by cadmium (Cd) and lead (Pb), as well as on the activation of hepatic stellate cells (HSCs) mediated by transforming growth factor b1. The main flavonoids are proanthocyanidin A2, gentisic acid, and epicatechin, in that order. ~~Phenolic acid is the primary flavonoid~~. The addition of LFAE may, in a dose-dependent manner, reduce the DNA fragmentation and lipid peroxidation caused by Pb and Cd while increasing cell viability. LFAE has the ability to inhibit TGFb1-induced HSC activation, as evidenced by the downregulation of smooth muscle aactin (aSMA) expression. These findings ultimately proved the litchi flower's potent antioxidant potential [10].

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7. CONCLUSION

Litchi waste, which includes peels, seeds, and other by-products, represents a valuable resource with significant potential for health benefits. Traditionally, these components have been discarded, contributing to environmental waste. However, recent studies and research have highlighted their rich content of bioactive compounds, which offer numerous health-promoting properties. Litchi waste, often overlooked, is an important source of health-beneficial compounds. Its potential applications in various fields make it a promising area for future research and development. By converting waste into valuable products, we can promote health, support sustainable practices, and contribute to economic growth.

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