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Phytochemical and pharmacological properties of rambutan (*Nappecium lappaceum L.)* and its industrial usage: A mini review

Yasmin A. C. Yahaya; Normaiza Zamri ✉; Aini Norhidayah

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Phytochemical and Pharmacological Properties of Rambutan (*Nappecium lappaceum L.)* and its Industrial Usage: A Mini Review

Yasmin A.C. Yahaya[1, a)] and Normaiza Zamri[1, b)] Aini Norhidayah[1, c)]

[1] *Faculty of Industrial Sciences and Technology, Universiti Malaysia Pahang (UMP), Lebuhraya Tun Abdul Razak, 26300 Gambang, Kuantan, Pahang, Malaysia.*

[a)] *yasminamirah92@gmail.com,*
[b)] *Corresponding author: maiza@ump.edu.my,*
[c)] *ainin@ump.edu.my*

Abstract. Rambutan, a famous tropical fruit, contains a high concentration of bioactive chemicals. Most of the components from this plant including leaves, pulp and seed have many uses and are thought to have medicinal properties.Bioactive components or phytochemicals (such as polyphenols, flavonoids, vital minerals, and vitamins) are found in most tropical fruits, as well as their bioactivity. Thus, this review study aims to give a general description of the phytochemical contents, medicinal qualities of rambutan trees and prospective industrial applications.

INTRODUCTION

Rambutan, a famous tropical fruit, contains a high concentration of bioactive chemicals. The rambutan is a much-loved exotic tropical fruit whose flavour is greatly enjoyed in the growing regions [1]. Several plants are used in various traditional medical systems, and the rambutan tree is included for promising bioactive chemicals that have remained effective in modern medication therapy. Traditional herbs and fruits have been utilised as an immunity booster for humans in China and other Asian countries for thousands of years [15,20]. Rambutan (*Nephelium lappaceum L.*) is a fruit mostly available in tropical places such as Indonesia, China, India, Australia, Malaysia, Mexico, and Thailand, and belongs to the Sapindaceae family [7]. *Nephelium lappaceum* (rambutan), *Nephelium mutabile* (pulasan), and *Nephelium philippinense* are the three primary species in the genus Nephelium (bushan). The tropical non-climacteric fruit-bearing tree *Nephelium lappaceum L.* (family Sapindaceae) has almost 2,000 subspecies. Rambutan is divided into three botanical variants based on leaf characteristics: *Nephelium lappaceum* var. *pallens*, var. *lappaceum*, and var. *xanthiodes* [1]. *Nephelium lappaceum L.* is a kind of family of Sapindaceae, Grayish brown branches 2-4, around 10-12 m tall. The Malay word 'rambut,' which means "hair," is derived from the presence of numerous hairy protuberances [1,15,20].

Rambutan is a tropical fruit that is grown in Malaysia, Indonesia, and Thailand [3]. The tree is native to Malaysia; however, it is also found in other regions of the world. Plants have traditionally been the world's primary source of energy. The leaves are complex and shiny green. Blooms are self-pollinating or bisexual, tiny, yellowish-green to white, without petals, and found in huge bunches. They are also rich in nectar and draw bees. Inflorescences are many branched, flowers are yellowish-green to white, small and occur in large bunches, petalless, with a mild sweet scent, dioecious (male and female flowers on separate trees) or bisexual, six to eight stamens are seen in each bloom. With a single style, the superior ovary has one to two lobes. Twice a year, the tree blooms. The edible fruits are oval to spherical drupes with leathery skin and flexible hairy spines that mature from green to crimson. Aril is white, meaty, delicious, and sweet, and it encircles one huge seed [5].

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PHYTOCHEMICAL SCREENING

Rambutan has many uses, and all parts of the plant, including the leaves, skin, and seeds have been shown to contain significant phytochemical contents. The most important phytochemical ingredient studied was phenolic compounds. The phytochemical analyses revealed the existence of reducing sugar, monosaccharides, carbohydrates, phenols, proteins, tannins, alkaloids, flavonoids, steroids, saponins, and glycosides, among other phytoconstituents [3,13,15,21].

Leaves

The phytochemical data provided proof that a variety of phytoconstituents, including reducing sugar, monosaccharides, carbohydrates, phenols, proteins, tannins, alkaloids, flavonoids, steroids, saponins, and glycosides, were present. As this tropical plant is widespread throughout many Asian countries, including its traditional and therapeutic properties, there is a need to further research the rambutan leaves' medicinal properties, which have not yet been thoroughly explored [3].

Seed

Depending on the variation, the oval, single seed of the rambutan makes up 4–9% of the entire fruit. It is protected by a white basal scar. The seed measures 1-1.3 cm in length and is brown in colour. Rambutan seed has narcotic qualities and is rather bitter [10]. It is abundant in protein, carbohydrates, and fat. This seed is handled as a result of the industrial processing of rambutan fruit, which is used to make cans, juice, jam, jelly, marmalades, and spreads in Malaysia and Thailand. Rambutan seeds contain some phenolic chemicals, including corilagin, geraniin, and ellagic acid, which may have positive effects on one's health Minerals like calcium, zinc, iron, magnesium, and manganese are also abundant in rambutan seeds [6]. Rambutan seed extract in 70% ethanol was shown to have the highest concentration of terpenoids, according to the phytochemical analysis. The lowest levels of alkaloids were found in seed extract in all fractions. The extract and fractions from rambutan seeds did not contain any tannin, steroids, saponin, or flavonoids. Triterpenoid levels were modest in the hexane, ethyl acetate, and water fractions. A substantial amount of phenol was also present in the extract's hexane, ethyl acetate, and butanol fractions [17].

Peel

Rambutan fruit peels are said to contain substantial amounts of carbohydrates (up to 21%), vitamin C, and polyphenols, as well as only modest amounts of protein (0.6%), dietary fibre (0.9%), and fat (0.21%) in dry matter. Tannins, flavonoids, saponin, gallic, caffeic, coumaric, syringic, and ellagic acids are only a few of the polyphenolic substances found in fruit peel. An ethanolic skin extract was discovered to contain epigallocatechin-3-gallate. Epigallocatechin-3-gallate, which is found in the peel, may have anti-hyperglycemia characteristics [1].

Pharmacological Properties

Rambutan parts including leaves, peel and seed have been shown to have several biological properties, including antioxidant, antibacterial, anti-inflammatory, hypoglycemic, anti-diabetic, and anticancer properties. [13]. However, rambutan leaves are not fully discovered yet and in addition because this tropical plant is so common in many Asian nations, there is a need to further research the therapeutic potential of the rambutan leaves [4].

ANTIMICROBIAL AND ANTIFUNGAL AGENT

Leaves

According to Maradona's research, the rambutan leaf ethanol extract (*N. lappaceum Linn*) includes secondary metabolites such as flavonoids, saponins, tannins, and hydroquinone and possesses antibacterial action against *S. aureus* ATCC 25925. The microorganism used in this experiment is *Pseudomonas aeruginosa* multiresistant (PAMR). The results indicated that rambutan leaves of water and ethyl acetate fractions had antibacterial activity against PAMR as the PAMR did not exhibit any antibacterial activity in the n-hexane fraction [21].

Seed

There are claims that rambutan seed extracts have antibacterial, antinociceptive, Central Nervous System (CNS), and antifungal properties [5,6]. The antibacterial effects of aqueous rambutan seed extract against human pathogens like *S. aureus*, *S. pyogenes*, *B. subtilis*, *E. coli*, and *P. aeruginosa* have recently been studied by [1,5]. They said that aqueous rambutan seed extract moderately inhibits both Gram-positive (*S. aureus*, *S. pyogenes*, and *B. subtilis*) and Gram-negative (*E. coli* and *P. aeruginosa*) pathogenic microorganisms. The phenolic substances, tannins, and saponins that give distinct rambutan varieties their antinociceptive, CNS-depressant, and antibacterial properties should be further studied. The antibacterial activity of methanol extracts of raw and boiling seeds is efficient against *S. epidermis*. A second investigation verified that the seeds' aqueous extract has antibacterial activity against *E. coli*, *S. pyogenes*, *B. subtilis*, and *S. aureus* [20].

Peel

The crude extract from yellow rambutan peels may have antibacterial effects on gram-positive bacteria such *S. pyogenes* and *S. aureus*, according to a study by [20]. It has been discovered that the extract of the rambutan peel exhibits antibacterial action against *E. coli* and *S. aureus* at Minimum inhibitory concentration (MIC) values of 0.5 percent. Rambutan peel extract contains antibacterial activities that are effective against methicillin-resistant *S. aureus*. The flavonoids, polyphenols, saponins, and tannins in this extract and its fractions against PAMR are likely what gives it its antibacterial activity [21]. Another study done by [11] using the technique of determination of zone of inhibition by disc diffusion showed that *Pseudomonas auerogonesa* did not exhibit any activity, the methanolic extract of *Nephelium lappaceum* epicarp showed a modest zone of inhibition against *Aspergillus fumigatus* and stronger antibacterial activity against *E.coli*, *Klebsella pneumoniae*, and *Proteus vulgaris* and for antifungal activity, methanol extract showed moderate zone of inhibition against *Aspergillus fumigatus*. Other findings showed that, apart from *P. aeruginosa*, all of the tested microorganisms were resistant to the extracts [20]. [11], reported the antibacterial properties of several extracts from *N. lappaceum* (NL) seeds and peel in a different investigation except for *E. coli*, *Klebsiella pneumonia*, and *S. typhi*, all peel extracts showed potential antibacterial action against *P. aeruginosa*, *Vibrio cholerae*, *Enterococcus faecalis*, *S. aureus*, and *Staphylococcus epidermidis*. The methanol extract inhibited the most delicate strain, *S. epidermidis* with MIC 2.0 mg/mL. Researchers investigated the antibacterial effects of a methanol extract of *N. lappaceum* peels on *S. aureus*, *Methicillin-resistant Staphylococcus aureus* (MRSA), *Streptococcus mutans*, *E. coli*, and *Candida albicans*. The test results showed that *S. aureus*, MRSA, and *S. mutans* were positively inhibited, but the other microorganism showed no activity.

ANTIDIABETIC AGENT

Leaves

According to [3] there is effect of *Nephelium lappaceum* and regular acrabose in inhibiting α -amylase and α-glucosidase. The highest concentration (1000 g/mL) of *Nephelium lappaceum* showed an inhibition of α -amylase α-glucosidase and 80% and 86.8%, respectively. For α -amylase and α -glucosidase, the inhibitory concentration (IC_{50}) values of *Nephelium lappaceum* were discovered to be 2.62±0.07 and 2.42±0.06 g/mL, respectively. The inhibitory concentration (IC_{50}) values for the common acarbose were 2.25±0.15 and 2.22±0.04 g/mL. One of the crucial digestive enzymes in humans, pancreatic α-amylase breaks down starch into oligosaccharides and disaccharides, the released glucose, which is subsequently absorbed into the bloodstream. Inhibiting the enzymes that break down carbohydrates would slow down the digestive system's breakdown of starch. The amount of postprandial hyperglycemia may then decrease.

Seed

[1] showed that the methanolic extract of the seed had cytotoxic effects on Cellosaurus cell line (CLS-354), human oral cancer cells, with inhibitory concentration (IC_{50}) values of 305g/mL, respectively. Overall, it is critical to assess and confirm the current gap in scientific understanding of the molecular mechanisms underlying the biological actions of rambutan fruits. Rambutan seed extract was found to have a high concentration of α-glucosidase inhibitory activity, with an inhibitory concentration (IC_{50}) value of 9.92 g/mL relevant to hypoglycemic activity [15]. Furthermore, at a dose of 50 g/mL, it was demonstrated that the rambutan seed extract and the hexane fraction can inhibit Glucose-6-phosphate dehydrogenase (G6PDH) and α-glucosidase as well as the triglycerides level in 3T3-L1 cell lines. A rambutan seed infusion, according to a different study, had an impact on reducing the body weight and blood glucose level of rats with alloxan tetrahydrate-induced diabetes. The dose of rambutan seed infusion used for this treatment was approximately 3.12 g/kg [8].

Peel

The "geraniin," a potent molecule that inhibits α -amylase and α -glucosidase activities, has been identified as the primary peel component [19]. The anti-diabetic activities of rambutan peel extract were investigated for type 2 diabetes in a diabetic rat model that was experimented with geraniin. A high-fat diet and injections of 55 mg of streptozotocin and 210 mg of nicotinamide were administered to male Sprague Dawley rats. Rambutan peel extract was given to diabetic rats for 28 days in doses of 500 and 2000 mg. 200 mg of metformin was administered to the positive control rats. The yield from the ethanolic rambutan peel extract was 41.1%, and the amount of geraniin in the extract was measured at 33.0±0.2 mg/g extract. According to the study [12] diabetic rats given 2000 mg of rambutan peel showed similar changes in insulin levels and a decrease in blood glucose levels as the rats that were treated with metformin. In addition, the histology of the pancreas from rats treated with rambutan peel is healthier than the metformin treated group. Additional evidence of α-glucosidase inhibitory activities of peel ethanol extract was obtained IC_{50} values of 0.106 and 7.02 g ml/L, respectively). [15] found that an ethanolic extract of fruit peels lowered blood glucose levels in alloxan-induced rats at doses of 125, 250, and 500 mg/kg reported with, respectively, 22.65%, 49.05%, and 61.76% activity. Anti-hypercholesterolemic action was also detected at the same dose, with values of 21, 39, 31, 15, and 60, 75, respectively. Rambutan peel extracts used in a study by [12], in diabetic rats were given dosages of 500, 250, and 125 mg/kg for 11 days. The biggest percentage reduction in blood glucose levels was shown with rambutan peel extract at a dose of 500 mg/kg, which exhibited a reduction of 61.76 ±4.26%; the activity change was larger than that of the positive control at a dose of 500 mg/kg, which reduced glucose levels by 50.19± 3.66%. The rambutan extracts showed anti-diabetic effects at doses ranging from 125 to 500 mg/kg.

ANTIOXIDANT AGENT

Fruit contains phytochemicals such as phenolic compounds, which function as strong antioxidants and help to prevent diseases caused by oxidative stress. According to [8] plants contain substantial amounts of flavonoids and phenolic acids, two important categories of phenolic chemicals. They are the main sources of plant foods' overall antioxidant activity.

Leaves

[3] stated that *Nephelium lappaceum* gives results of about 89.6% and 85.81% of inhibition of 2,2-diphenyl-1-picrylhydrazyl (DPPH) and 2,2′-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) free radical at the concentration at 1000 μg/mL of crude, and for IC_{50} are about 1.52 ± 0.03 and 1.295 ± 0.05 μg/mL for DPPH and ABTS assays respectively. The rind and leaves of *Nephelium lappaceum* had the highest DPPH radical-scavenging activity, with the ethanolic rind extracts exhibiting the highest $1/IC_{50}$ value. The ethanolic rind extracts' efficacy is better than grape seed extracts and comparable to that of vitamin C [23] stated that there is a limitation of study on *Nephelium lappaceum* leaf compare to their seed and peel.

Seed

Rambutan seed extract has 40.49 ± 0.01 mg of GA/100 g of total polyphenols, according to [9] paper on the phenolic component concentration in rambutan seed extract. Then, the antioxidant activity DPPH (diphenyl-1-picrylhydrazyl scavenging) of a mixture of cocoa butter and rambutan seed extract was determined with a value of 60.16 ±0.23 mol trolox/100 g fat. According to the study, rambutan seed fat can replace cocoa butter to a maximum of 40%. Another study by [6], revealed that the rambutan peel had a high phenolic content, a low pro-oxidant capacity, and robust antioxidant activity. Extract from methanol results showed that *Nephelium lappaceum* peel outperformed the BHT (butylated hydroxytoluene) control in terms of lipid peroxidation activity is between 77–186 times and DPPH is around 42–87 times. In addition, a significant number of flavonoids (13.3 mg/g1) were found in the seed's ethanolic extract. Larger overall variation for seeds, phenolics range from 3.05 to 124.14 mg/g1 when extracted with different solvents in literature [12].

Peel

The number of antioxidant chemicals in the peel is higher than in rambutan seed extracts and leaves as they are primarily polyphenolic compounds known for their biological activity, such as ellagic acid, corilagin, and geraniin. Geraniin is the predominant ellagitannin contained in the rambutan peel [16,11, 5]. According to a study, the peel has a high total phenolic content whereas the seed extract has a greater total flavonoid content than the peel [8]. As a result of suppressing the expression of the peroxisome proliferator activating receptor (PPAR), rats fed orally with the peel extract demonstrated a decrease in malondialdehyde (MDA) and fat accumulation in the liver. This suggests that the peel may be able to stop oxidative stress from causing liver damage. The Fluorescence Recovery After Photobleaching assay (FRAP) was used to evaluate the plasma's antioxidant capacity. According to [14] the FRAP test is one of the quickest and most practical for routine studies of hydrophilic antioxidants. As a result, the antioxidant activities of crude and purified peel were assessed and compared in this work using these in vitro model systems. The effective concentration (EC_{50}) values for the crude, purified, and rambutan peel phenolic (RPP) and vitamin C in the FRAP assay were respectively 1.56, 0.87, and 2.33 lg/mL. This indicates that the crude and purified have higher values of oxidation compared to vitamin C, as a control.

Industrial Usage Of Rambutan Tree

The seeds of rambutan have a rather high fat content (17-39%), and they may one day serve as a source of naturally occurring edible fat for the food product production industry. The obtained fat from rambutan seeds can be utilized to make foods like candles, soaps, fuels, and such. Currently, with the price of cocoa rising being the only constant fat component in chocolate, the chocolate production industry may want to consider using fat produced from rambutan seeds [3]. It has been said that to produce fully fermented rambutan seeds, eight days of fermentation are sufficient, which can then be processed to form a substance that resembles cocoa powder. The pulp of the rambutan contains carbohydrates, primarily sucrose, fructose, and glucose, which give microorganisms nutrition to flourish and perform fermentation [2]. The usage of natural ingredients in cosmetics has greatly increased during the last few decades. This is due to increased public awareness of the advantages of using herbs in everyday products like cosmetics. Herbal cosmetics are becoming more popular and in demand, largely because it is thought that they are risk-free and have no negative effects. Polyphenols, antioxidants, and moisturizing compounds were isolated from rambutan leaves to create the rambutan cream. The rambutan cream's protection benefits the hair greatly. It illustrated the enormous potential of the cosmetics sector. In HepG2 cells, which are frequently used for new treatments and screening for toxic effects and have an epithelial-like shape, phenolic peel extracts from rambutan have been shown to protect against H_2O_2-induced oxidative damage in a dose-dependent manner [15].

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