



Potential Pericarp: A Review on Therapeutic benefits of Some Fruit Peels

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ABSTRACT

The outer rinds or peels of many fruits are not eaten and are thrown as a waste. Similarly in food industry, processing of fruits results in the formation of agro waste in high amounts and is common in the form of peels. This waste has to be managed efficiently as they pose serious problems to environment. Till now agro waste is used as livestock feed or as fertilizer but recently strategies have been developed to explore the bioactive components from the peels as well as their therapeutic benefits. Many scientific investigations reported the isolation of constituents with promising antioxidant, antimicrobial, antiproliferative activities from the peels of various fruits.






Keywords: Agro waste, Fruit peels, Therapeutic benefits, Bioactive components





INTRODUCTION

Since many years fruits been consumed as a part of normal diet. These fruits have a number of medicinal properties to keep us healthy. This is further supported by the statements in Ayurveda regarding the health promoting potential of fruits and their role in the control of diseases. Many of the phytochemicals isolated from fruits are able to reduce oxidative damage to our cells and are effective in controlling chronic diseases such as diabetes, cancer, heart and neurological diseases [1,2]. In recent times there has been increasing interest in the study of bioactive components from the peels, seeds and flowers and also using agro waste therapeutically is a new idea which is gaining popularity [3].

This review is an attempt to present some of the fruit pericarps and their reported phytochemicals and biological activities (Table 1).

Table 1: List of fruit peels with reported activities

S. No.	Botanical name	Common name	Reported activity	
1.	<i>Ananas comosus</i>	Pine apple	Antimicrobial Antioxidant	
2.	<i>Punica granatum</i>	Pomegranate	Antimicrobial Anti-inflammatory Antiallergic Antidiabetic	
3.	<i>Citrus sinensis</i>	Orange	Antimicrobial Antioxidant Anti-inflammatory Anticarcinogenic	
4.	<i>Musa paradisiaca</i>	Banana	Antimicrobial Antioxidant	
5.	<i>Citrus lemon</i>		Antimicrobial Antioxidant Anti-inflammatory Anticarcinogenic	

6.	<i>Annona squamosa</i>	Sugar apple	Antimicrobial Antioxidant Antitumor	
7.	<i>Annona reticulata</i>	Netted Custard apple	Antimicrobial Antioxidant	
8.	<i>Artocarpus heterophyllus</i>	Jack fruit	Antioxidant Anti-inflammatory	
9.	<i>Mangifera indica</i>	Mango	Antioxidant Antiproliferative Antidiabetic	

Ananas comosus* (Pine apple)Family-Bromeliaceae*

The root and fruit of pineapple are either eaten or used as an anti-inflammatory and a proteolytic agent. In Philippine it is traditionally used as an anthelmintic agent. This fruit is rich in sugars, vitamin C and bromelain, a proteolytic enzyme that breaks down protein and potassium. For many years the medicinal benefits of *A. comosus* are not recognized [4]. The antimicrobial activity of *A. comosus* peel extracts were tested against various pathogens. The extract were found to be effective against *Staphylococcus aureus*, *Corynebacterium rubrum*, *Enterobacter aerogenes*, *A. hydrophila*, *Candida albicans* etc [5,6]. It is reported to have antioxidant activity [7]. Emmanuel *et al.*, reported *in vitro* antioxidant and anti hyperlipidemic activity of pineapple peels [8].

Punica granatum L* (Pomegranate)Family-Punicaceae*

Pomegranate peels are an interior network of membranes constitutes 26-30% of total fruit weight and are rich in phenolic compounds, flavonoids (Anthocyanins, catechins and other complex flavonoids) and hydrolysable tannins (Punicalin, pedunculagin, punicalagin, gallic and ellagic acid). These compounds are responsible for antioxidant activity of fruit as well as peel [9-11].

Pomegranate is among the most investigated fruits in recent year. Antioxidant [12], antihypertensive [13] and anticancer [14] effects of pomegranate juice are studied and published.

Pomegranate peels remain as a byproduct after pomegranate juice production. Antibacterial, anti-inflammatory and antiallergic activities of pomegranate peel extracts have been studied [15].

Antimicrobial activities of pomegranate peel extracts have been proved against [16]. Hydro alcoholic extracts of pomegranate peels showed antidiabetic activities *S. aureus*, *Listeria monocytogenes*, *Escherichia coli* and *Yersinia enterocolitica* by significantly reducing blood glucose levels [17].

Citrus sinensis* (Orange)Family-Rutaceae*

A plethora of biological properties of citrus peels having importance in health and disease have been identified after the establishment of advanced flavonoid isolation methods [18-20]. Compounds isolated from citrus peels are investigated for inflammation inhibition [21-24], hypolipidemia [25,26], regulation of metabolic syndrome [27-30], delayed onset of Alzheimer's disease [31,32] and more. Characterization of citrus peels indicated that they are an abundant source of Polyhydroxyl Flavonoids (PHFs) such as hesperidin, neohesperidin and naringin and polymethoxyflavones represented by nobiletin, tangeretin, sinestatin, 3,5,6,7,8,3,4-heptamethoxy flavone and 3,5,6,7,3,4-hexamethoxy flavones [18,33,34]. The phytochemical screening of *C. sinensis* peels revealed the presence of flavonoids, quinines, alkaloids, protein, aminoacids and phytosterols [35]. These constituents are responsible for antioxidant, antimicrobial, anti-inflammatory and anticarcinogenic properties. Orange peels has the potential to make natural origin antibiotics and supplements [36].

Musa paradisiaca* (Banana)Family-Musaceae*

Banana is a tropical fruit grown in over 122 countries worldwide [37]. The potential application of banana peel is explored because of the phytochemical constituents found in it. Phytochemical compounds with antioxidant activity are enormous in banana peel [38]. Ascorbic acid, tocopherol, betacarotene, phenolic groups, dopamine and gallic acid are antioxidant compounds identified in banana peel [39]. Bankar *et al.*, mentioned that the presence of natural polymers in banana peel such as lignin, hemicelluloses and pectin helped in the synthesis of silver nanoparticles [40].

Antifungal and antibiotic principles are found in banana peel [41,42]. A fungicide in the peel and pulp of green fruits is active against a fungal

disease of tomato plants [43]. The ripe peel and pulp are rich in norepinephrine, dopamine that elevate blood pressure and serotonin which inhibit gastric secretion and stimulates the smooth muscle of intestine [44,45].

The preliminary screening of banana peels explored secondary metabolites such as glycosides, alkaloids, saponins, volatile; oils, flavonoids and tannins. The peel extract was found to be effective against *Micrococcus spp.* and *P. aeruginosa* which can cause opportunistic infections like bronchopneumonia, bacterial endocarditis and meningitis [46].

Citrus lemon (Lemon)

Family-Rutaceae

Hesperidin, naringin, neohesperidin, narirutin, eriocitrin, didymin and rutin are the common flavonoids present in citrus and citrus peels [47-49]. Their medicinal properties including antioxidant, anti-inflammatory and anticarcinogenic have been demonstrated by numerous studies [48-51]. A part from flavonoids citrus peels are the sole and rich source of PHFs which were found to exert anticancer and anti-inflammatory activity [18,21-24] either in single molecules or in multiple [52-54]. Various phytochemicals such as alkaloids, phenols, flavonoids, diterpenes, cardiac glycosides, tannins and saponins are present in ethanolic extracts of lemon peel and pulp [55-57]. The dried citrus peels have a promising antimicrobial activity against Gram-positive *S. aureus* and Gram-negative *E. coli* and fungus like *C. albicans* and *T. rubrum* [58].

Annona squamosa (sugar apple)

A. squamosa belongs to the family Annonaceae, a fruit native to Central America and is commonly known as sugar apple [59-61]. Phytochemical studies conducted on the various extracts explored the presence of alkaloids, flavonoids, phenols and saponins [62]. Rajendran et al., synthesized silver nanoparticles from the peel extracts of *A. squamosa* [63]. Recent studies on the peel of *A. squamosa* fruit revealed antimicrobial activity [62] and antioxidant activity [64] and the presence of antitumor constituents, (-)-ent-kaur-16-en-19-oic acid and 16a, 17-dihydroxy-ent-kauran-19-oic acid [65].

Annona reticulata (Netted custard apple)

A. reticulata Linn., is one of the most important medicinal plant belongs to the family Annonaceae [66]. The plant *A. reticulata* is closely related to the cousins, *A. squamosa* and *A. cherimola* [67]. *A. reticulata* is widely distributed all over India, roughly 10-20 ft long with nutritious fruits [68,69]. The bark is used as a powerful astringent, vermifuge and antidiysenteric [68,70]. Previous phytochemical studies with *A. reticulata* raw fruit peel extracts showed alkaloids, cholesterol, coumarins, flavonoids, phenols and saponins. In addition steroids are present in ethyl acetate and terpenoids are present in aqueous extracts. *A. reticulata* raw fruit peel methanol extract showed good activity against *P. aeruginosa*, *E. coli*, *E. faecalis*, *B. subtilis* and *A. niger*.

Previous phytochemical studies with *A. reticulata* raw fruit peel extracts showed that the all tested extracts (Methanol, ethanol, ethyl acetate, distil water) contains alkaloids, cholesterol, coumarins, flavonoids, phenols and saponins, In addition steroids are present in ethyl acetate and terpenoids are present in aqueous extracts. It was showed that *A. reticulata* raw fruit peel methanol extract showed good activity against *P. aeruginosa*, *E. coli*, *E. faecalis*, *B. subtilis* and *A. niger* [71].

Artocarpus heterophyllus (Jack fruit)

Jack fruit production is higher in South India and so a significant amount of peel is expected to be discard as agricultural waste [72]. The fibrous outer peel is rich in calcium and pectin and constitutes about 59% of the ripe fruit [73]. Shrikanta et al., have estimated the total polyphenol, flavonoid content and anti-oxidant activity of ethanolic extract of frozen skin of Indian jack fruit [74]. Previous studies suggested the presence of alkaloids, flavonoids, glycosides, phenols, saponins, sterols and terpenoid. Studies also indicated that the peel extract of jack fruit possess significant anti-inflammatory activity [75].

Mangifera indica (Mango)

Mango is the one amongst widely consumed tropic fruits worldwide. Different parts of mango tree are found to possess medicinal properties [76]. Parts of the mango such as stem bark, leaves and pulp are known for antioxidative and free radical scavenging [77,78], anti-inflammatory [79] and anticancer [80] properties. Mango peel is a major by-product of fruit processing and is discarded as waste and can be threat to environment [81]. The mango peel is a good source of polyphenols, carotenoids, vitamin E and C [77]. It has good antioxidant properties [81]. Recently polyphenol profiles of mango peel have been reported using HPLC-MS analysis [82] and they are more when compared to flesh [83,84]. Kim et al., reported that mango peel exhibited good antioxidant activity by effectively scavenging free radicals such as DPPH radicals and alkyl radicals and is a potential antiproliferative agent [84]. Prasada Rao et al., study revealed that mango peel extract gas ability to ameliorate diabetes. The peel extract may protect against type I and type II diabetes and its complications by decreasing the glucose release by inhibition of carbohydrate hydrolysing enzymes, its absorption, by increasing insulin levels in plasma, protect against lipid peroxidation [85].

CONCLUSION

From the plethora of extensive preliminary phytochemical studies conducted it is evident that the fruit peels are repositories of a number of bioactive constituents. These bioactive compounds have the potential to act as anti-oxidants, antimicrobials, anti-inflammatory and even anticarcinogenic etc. Hence there is a further need to identify, isolate and characterize bioactive components occurring in fruit peels. A more integrated approach is needed to assess the health promoting potential of agro waste (fruit peels). Scientific investigations have stated that fruit peels provide consecutive rich sources of antimicrobials and antioxidants; this may open up avenues for research in the development of drugs from agro wastes. This review demonstrates the therapeutic benefits of some fruit peels and the responsible phytochemicals and highlights the antimicrobial activity. This may be useful information for developing phytomedicine from agro waste.

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