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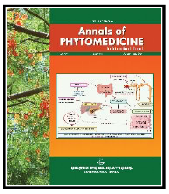

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A review on phytochemical potential and enormous nutraceutical benefits of Sand pear (*Pyrus pyrifolia* L.)

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Abstract

Sand pear (*Pyrus pyrifolia* L.) also known as Asian pear and Korean pear, has wide climatic adaptability and is found in both temperate and subtropical regions of the world. It has been traditionally used as folk medicine and functional food owing to the presence of diverse bioactive compounds that confer medicinal and health promoting benefits. These bioactive compounds comprise polyphenols like phenolic acids and flavonoids, triterpenes, and glucosides, among others, which are credited with various health beneficial properties. The Sand pear can be considered to be an undermined fruit crop species since the production is limited to indigenous growing areas and the processing of Sand pear fruit is not very pronounced. However, it has extensive potential as a functional food and can be utilized in various food formulations and pharmacological products. Sand pear fruit is also rich in fibers and these fibers act as prebiotics, supporting the growth and activity of the beneficial microbial species in gut microbiota conferring various health benefits. This review provides a complete description of the nutritional profile, antioxidant activity and various health promoting compounds present in Sand pear along with their various positive health effects.

1. Introduction

Pear belongs to the family Rosaceae and is the second most cultivated fruit crop stand next to apple (Silva *et al.,* 2014). The fruits have been farmed in Europe and Asia for over 5,000 years. China has the highest area under cultivation of pear and accounts for 69 to 70 per cent of production. Worldwide, over 85 countries have been producing pears commercially which comprises of mainly five species; namely, Asian pears (*Pyrus pyrifolia, P. bretschneideri*, *P. ussuriensis* and *P. sinkiangensis*) and the European pear (*P. communis*). Asian pears are round and have a sandy texture, while European pears are elongated and have a full-bodied texture (Chandel *et al.,* 2023).

Sand pear or Asian pear or Oriental pear or Korean pear is also popularly known as "Patharnakh" in Northern India. The origin of Sand pear is believed to be Western and South Western China (Ouni *et al.,* 2020). It is widely distributed in both temperate and sub-tropical regions of the world because of its greater climatic adaptability. In India, it extensively grows wildly in North-Western Himalayas in regions including Jammu and Kashmir, Uttrakhand, Himachal Pradesh, Punjab, some parts of Niligiris and North Eastern states (Raj *et al.,* 2010). The Kashmiri Valley is home to the greatest area of Sand pear cultivation in India and the cultivar known locally as "Kashmiri Nakh" is thought to be one of the naturalized indigenous cultivars which that have been cultivated in India since ancient times (Verma *et al.,* 2014).

On the basis of geographical distribution, the cultivated Sand pear has been categorized into three groups: the Chinese Sand pear group, the Chinese white pear group, and the Japanese pear group (Jiang *et al.,* 2017). The Sand pear's trunk can reach a height of 9 cm, and its branches grow quickly before falling (Chandel *et al.*, 2023). The trunk is light brown in color, rough, and shredded. The leaves have a round base, acuminate apex, and serrated margins, measuring 10-12 cm in length. Round or pyriform in shape, the fruits need only 250-300 chilling hours to flower and fruit. It can also be grown at low elevations because it stores heat units for 6-9 weeks after full bloom.

Sand pear also contains various functional phytochemicals and nutraceutical properties including phenolic compounds and also exhibits diverse anticarcinogenic properties, demonstrating antiproliferative effects against cancer cells in breast and liver tissues, inflammation, hyperglycemia, fertility related complications and hypertension. Fully mature pear fruits are considered a good source of monosaccharides and minerals as well. They have abundant macronutrients and are additionally endowed with health promoting compounds like antioxidants and other bioactives such as sterols and carotenoids. In addition to these, the fruit also contains primary active compounds (phenols) that possess antioxidant properties which decrease the incidence of coronary diseases. Among the many

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classes of phenolics, three major categories of phenolic acids, flavanols and anthocyanins have been associated with pear fruits. The fruits of pear are rich sources of potassium in combination with being sodium free, fat and cholesterol free, all of which play an important role in the prevention of cardiovascular diseases Baniwal and Hathan (2017). For such nutraceutical potential, pear has also been utilized in pharmaceuticals for many years.

2. Nutritional and quality characteristics of Sand Pear

The Sand pear fruits have a somewhat rough texture in comparison to cultivated pears due to the stone cells present in the fruit, and hence known as Patharnakh. Sand pear fruits are seasonal in nature. Pears especially Sand pears have thick peels with thick, lignified wall of lignin and cellulose containing pectin, and stone cells (Yan *et al.,*2014; Lee *et al.,* 2015). The fruits are rich in monosaccharide and have a distinct aroma as well as a sweet, juicy, astringent flavor.

A major component of pears is moisture, with around 80 per cent, followed by carbohydrates in the form of sugars which may go up to 15 per cent and fiber content of around 2 per cent. A slightly higher amount of potassium has been reported in Sand pear (*P. pyrifolia*) while European pear (*P. communis)* has been found to contain slightly higher levels of calcium and fiber (Li *et al.,* 2016).

Baniwal and Hathan (2017) studied the fruit's biochemical characteristics, which are grown in Northern India and reported that the pH of the fruit was acidic with a value of 3.9, an energy value of 52 kcal and approximately 11.9 g of carbohydrates were present in 100 g of edible portion. The fruits were high in sugar and low in fat (0.2 g) and protein (0.6 g). Besides the nutritional content, the fruits are also rich in bioactive ingredients like plant sterols and carotenoids and in nutritional components like vitamins, minerals, and antioxidants (Andreotti *et al.,* 2006). The nutritional value of Sand pear is shown in Table 1.

Table 1: Nutritional value of Sand pear

Parameter	Content	References
Carbohydrates	13.2 g	Lee *et al.* (2012)
Fiber	4.30 - 7.32 g	Hudina *et al.* (2012)
Protein	0.61 - 0.70 g	Hussain *et al.* (2013)
Fat	0.20 - 0.24 g	Baniwal and Hathan (2017)
Vitamin C	7.5 mg (8% of the daily value)	Duan *et al.* (2019)
Potassium	174 mg (4% of the daily value)	Koirala and Shrestha (2020)
Calcium	15.9 mg (2% of the daily value)	Sharma *et al.* (2020)
Moisture	84.95-88.23 %	Chandel *et al.* (2023)
pH	3.8-4.7	
TSS	8.00-13.2 ºB	
Titratable acidity	0.02-0.10 %	
Total phenols	150.33 mg/100g	
Minerals (mg/ 100g)		
K	104.04-190.01	
Ca	10.34-16.59	
Mg	12.69-76.00	
P	8.13-18.20	

Minerals identified in Sand pear are sodium, magnesium, potassium, phosphorous, calcium, copper, zinc, iron, selenium, manganese, and fluoride.

3. Bioactive compounds

Pears have been traditionally used as a functional food and folk medicine for more than thousands of years due to the presence of different bioactive compounds which are responsible for the various medicinal and health promoting qualities (Yang, 2018; Hamid *et al.* 2020). Many bioactive substances, including triterpenes, glucosides, and polyphenols (phenolic acids, flavonoids), have been discovered. The amount of these active substances varies which is depending on the part of the plant; leaves have the highest concentration of polyphenols, followed by fruits. Table 2 represents the comparison of total phenols and antioxidant activities between *P. pyrifolia* (Sand pear) and *P. communis* (European pear).

In fruits, the concentration of these bioactive compounds is slightly higher in peels than in the pulps. The pear skin is comparatively rich and different in terms of phenolic contents with respect to fruit flesh (Cui *et al.* 2005; Lin and Harnly, 2008). Further, phenolic monomer compounds like, arbutin, ursolic acid, oleanolic acid, epicatechin, chlorogenic acid and rutin have been observed to be majorly present in different cultivars of pear with peel and flesh and the various functional compounds can help in the reduction of various diseases like bronchitis, asthma, cold, flu, fever, cancer, CVD's and ultimately boost up the immunity (Bhatt *et al.,* 2021). The flowers of *Pyrus.* spp. are reported to have 28 types of phenolic compounds, in which hydroquinone showed the maximum content (He *et al.,* 2015). Moreover, it is also reported that the leaves contain 17 kinds of polyphenolic compounds, which include arbutin, chlorogenic acid, neochlorogenic acid, cryptochlorogenic acid, isochlorogenic acid A, rutin, quercetin-3-galactoside, quercetin-3-glucoside, and luteolin-7-O-glucoside (Dong *et al.,* 2018). The chlorogenic acid and arbutin are the main dominant phenolic compounds reported in fruits, which also exist in leaf buds, floral buds, and flowers in considerable amounts (Cui *et al*., 2005). Each of the phytochemicals present has a variety of health-promoting qualities, including anti-inflammatory, antihyperglycemic, antifungal, anticancerous, immunomodulatory and wound healing capabilities (Forni *et al.,* 2019). The bioactive compounds of different parts of Sand pear and their potential health benefits have been presented in Table 3. While, the important individual bioactive compounds present in Sand pears are discussed in following subheads.

Table 2: Total phenols, ABTS$^+$ and DPPH radical scavenging activity of cultivars of *P. pyrifolia and P. communis*

Species	Cultivars	Origins	Total phenols (mg/ 100 g DW)	ABTS$^+$ radical scavenging (%)	DPPH radical scavenging (%)	References
P pyrifolia	Yali	China	210.0	94	45.0	Yim and Nam (2016)
	Niitaka	South Korea	240.0	88	50.0	
	Chuwhang	South Korea	180.0	62	35.0	
P communis	Kirmzi	Turkey	216.8	-	50.0	Abac *et al.* (2016)
	Limon	Turkey	230.5	-	34.5	

Table 3: Bioactive compounds present in Sand pear and their health benefits

Phenolic compounds	Concentration (mg g^{-1})	Plant part	Health benefit	References
Hydrochalcones				
Arbutin	7.87	Leaf, fruit	Alcohol detoxification, antioxidant, antibacterial reduction in blood pressure, reduction in LDL oxidation.	Dong *et al.* (2018); Stompor *et al.* (2019); Hong *et al.* (2021)
Arbutin derivative	1.29	Leaf, fruit		
Phenolic acids				
Neochlorogenic acid	0.60	Leaf, flower, fruit	Antidiabetic, anti-inflammatory, antilipidemic, and antihypertensive.	Vinayagam *et al.* (2016); Santana-Galvez *et al.* (2017); Dong *et al.* (2018); Zhou *et al.* (2020)
Chlorogenic acid	1.15	Leaf, flower, fruit		
Cryptochlorogenic acid	0.23	Leaf, flower, fruit		
Isochlorogenic acid A	2.48	Leaf, flower, fruit		
Chlorogenic acid derivative 1	1.10	Leaf, flower, fruit		
Chlorogenic acid derivative 2	0.50	Leaf, flower, fruit		
Flavanol				
Catechin derivative	0.32	Fruit	Reducing cardiovascular disease, antiviral, antiallergic.	Narayana *et al.* (2001); Tanwar *and* Modgil (2012); Dong *et al.* (2018); Ballard *et al.* (2019)
Total (polyphenols)	20.88	Fruit		

3.1 Arbutin

The structure of arbutin is formed of one molecule of D-glucose bound to hydroquinone. Arbutin (hydroquinone-β-D-glucopyranoside), degrades into hydroquinone which has a bleaching activity and therefore is popularly used in the cosmetics industry as a skin whitening agent and melanin polymerization inhibitor. Tyrosinase (TYR) activity is inhibited by hydroquinone, which also contributes to the degradation of melanosomes and melanocytes by altering their membrane structures (Pillaiyar *et al.,* 2017). Pear skins, especially those of *P. pyrifolia*, are one of the richest food sources of natural arbutin (Hong *et al.,* 2021).

3.2 Chlorogenic acid

The chlorogenic acid, (5-O-caffeoylquinic acid) is the second most major phenolic compound present in pears following arbutin

(Kolniak-Ostek, 2016). Chlorogenic acid is associated with anti-inflammatory, antioxidant and antidiabetic properties (Farah *et al.,* 2008; Hwang *et al.,* 2014; Ma *et al.,* 2015). The clinical trial has shown that chlorogenic acid reduces TNF-α, down regulates IL-8 production in Caco-2 cells and RAW 264.7 cells, improves wound healing *in vivo*, and has neuroprotective and anti-inflammatory properties (Hwang *et al.,* 2014; Liang and Kitts, 2015).

3.3 Malaxinic acid

Malaxinic acid, the most abundant glucoside found in *P. pyrifolia*, is reported to have abundant antioxidant properties and can reduce the development of cancerous cells like BAEC. Lee *et al.* (2017) found that malaxinic acid provides anti-oxidative defense in blood circulation, while Moon *et al.* (2017) reported that the isoprenyl side chain in malaxinic acid may have an inhibitory effect on a protein (21-26 kDa) involved in cancerous cell proliferation. Additionally, the concentration of malaxinic acid is highest in immature pears and decreases as the pear matures.

3.4 Triterpenoids

Triterpenoids such as ursolic acids, oleanolic acids, and betulinic acids have been identified in *Pyrus* spp. It has been reported that peels contain the highest concentration of triterpenoids, which is approximately 17 times higher with respect to the flesh (Kolniak-Ostek, 2016). Studies conducted in vivo and in vitro have demonstrated the strong anti-inflammatory properties of triterpenoids. They can inhibit the production of pro-inflammatory cytokines and enzymes, such as tumor necrosis factor-alpha (TNF-α) and cyclooxygenase-2 (COX-2), respectively (Yu *et al.,* 2020). In addition to this, hepatoprotective activity has been reported which protects liver cells from damage induced by toxins or drugs. They can increase antioxidant defenses, reduce inflammation, and enhance liver function (Cao *et al.,* 2020).

3.5 Caffeic acid

Caffeic acid has been observed to have enormous health benefits like antioxidant, anti-inflammatory, and anticancer properties (Espindola *et al.,* 2019). Additionally, it has been demonstrated to help in retarding neurodegenerative diseases and cardiovascular illnesses (Toyoda *et al.*, 2009). Caffeic acid also has a chemopreventive potential, for example, it induces apoptosis and ROS generation along with a reduction in mitochondrial membrane potential in HCT 15 colon cancer cells (Jaganathan, 2012).

3.6 Protocatechuic acid (PCA)

Protocatechuic acid (PCA) has been reported with enormous human health effects including antioxidant, anti-inflammatory, anticancer, and antidiabetic properties (Datta *et al.*, 2022). In addition, it has a protective effect against oxidative stress induced neurodegenerative diseases as reported by Guan *et al.* (2006). Additionally, PCA has been found to improve glucose tolerance and insulin sensitivity in animal models of type 2 diabetes (Abdelmageed *et al.,* 2021). PCA is observed to suppress melanogenesis through the inhibition of tyrosinase as well as the co-inhibition of expression of other melanogenesis-related enzymes in rat melanoma cells treated with Korean pear extracts (P. *pyrifolia* cv. *Chuhwangbae*) (Truong *et al.,* 2017).

3.7 Flavonoids

Flavonoids are abundant in Asian pears (*P. pyrifolia*) with a range of 182.5-368.9 mg/100 g of fresh weight (Cho *et al.,* 2015). The major flavonoids present include quercetin, isorhamnetin, epicatechin and proanthocyanidins (Fischer *et al.,* 2007; Kolniak-Ostek, 2016). Quercetin is found in significant amounts in both leaves and fruits. Flavonoids play an essential role in determining the color, quality and resistance of plants. *In vitro* studies have shown that flavonoids exhibit free-radical scavenging and enzymatic modulation activities and can inhibit cellular proliferation. Flavonoids possess antibiotic, antitumoral, antiallergic, antidiarrheal, antiulcer and anti-inflammatory activities due to which their consumption is highly beneficial for human health (Panche *et al.,* 2016; Estrela *et al.*, 2017).

3.8 Other compounds

Pears are rich in fibers and these fibers act as prebiotics, which selectively stimulate and support the growth and activity of the beneficial microbial species in gut microbiota and hence, confer different benefits of health (Slavin, 2013). Insoluble cellulose, hemicellulose, pectin and sorbitol in pears provide for the anthelmintic properties of pears (Kolniak-Ostek, 2016; Hong *et al.,* 2021). Moreover, other health benefitting compounds such as, ascorbic, citric, and malic acids, and minerals, such as magnesium, potassium, calcium, and iron, in pears support blood pH and ionic homeostasis (Brahem *et al.,* 2017).

4. Pharmacological actions associated with Sand pears

Nowadays, the consumption of fruits and vegetables has increased due to their role in human health which is primarily due to the presence of phytochemicals with pharmacological potential (Sharma *et al.,* 2019; Hamid *et al.,* 2021). Different researchers and their findings cleared that fruits and vegetables have good health properties and due to their different bioactive compounds which help in curing different diseases by improving the immune system (Kaushal *et al.,* 2022). In China and Korea, Sand pear is used as an ingredient in traditional medicines for lung moistening, cough, constipation and alcoholism. A fruit used for antimicrobial, diabetic, cancer, inflammatory, gastric ulcers and used to cure skin diseases (Farzaei *et al.,* 2013; Salhei *et al.,* 2019). The different bioactive compounds present in Sand pear along with their health effects have been depicted in Figure 1.

4.1 Antimicrobial activity

The bioactive compounds present in Sand pear like flavonoids, triterpenoids, malic acid, chlorogenic acid impart various antimicrobial properties to this fruit. Arbutin the major phytoconstituent present has bacteriostatic properties. Moreover, the arbutin further gets converted into hydroquinone in the body, which itself possesses antibacterial activity, enhances biochemical processes and serves as a barrier against microbial invasion. Young shoots of pear contain hydroquinone, the reason for the antibacterial activity (Jin and Sato, 2003; Guven *et al.,* 2006). In a study Sand pear fruit extracts had moderate to strong inhibition effects with respect to the growth and activity of several disease causing pathogenic bacteria, like *Staphylococcus aureus*, *Escherichia coli*, and *Salmonella typhi* (Zhang *et al.,* 2003).

4.2 Antioxidant activity

The numerous bioactive phytoconstituents present act as scavengers of reactive oxygen species, and hence possess antioxidant activity (Thakur *et al.,* 2020). The fruit of pear is a good resource of vitamin C, quercetin, phenols, flavonoids and minerals, which defend cells from injury by free radicals. Lee *et al.* (2015) compared the antioxidant activities of Sand pear's flesh and peel. The peels were observed to have higher free radical scavenging activities in the *in vitro* models of DPPH, $ABTS^+$, nitrite radicals and falling capabilities as compared to flesh. Pear fruit extracts significantly reduced the H_2O_2-induced oxidation of 3T3-L1 cells in rats with the effect being more pronounced in rats administered with peel extracts. When the peel extract was induced in the rats' blood plasma, the antioxidative activity was higher with respect to the consumption of flesh extract.

4.3 Anticancerous activity

The consumption of various fruits can reduce various types of cancer and Sand pears are believed to have antimutagenic and anticarcinogenic effects (Thakur *et al.*, 2019). The basic mechanism involved is the inhibition of cancer development of polycyclic aromatic hydrocarbons (PAHs) like benzopyrene. These benzopyrene structures lead to the development of DNA adducts and the invention of ROS (Tarantini *et al.,* 2011). The Asian pear is speculated to reduce the retention of carcinogens by accelerating the rate of PAH excretion from the body. The pears also reduced the malondialdehyde levels in urine which is a biomarker of lipid peroxidation and oxidative stress. The pears were also found to protect from PAH-induced oxidative stress (Yang *et al.*, 2005).

4.4 Cholesterol lowering activity

The high content of pectin reduces LDL, triglycerides and VLDL levels and hence contributes to suppression of cholesterol. The consumption of *Pyrus* spp. has been found associated with the reduction of total cholesterol (TC), triglyceride (TG), and LDL-C in hyperglycemic rats and increased levels of high density lipoprotein cholesterol (HDL-C) (Velmurugan and Bhargava, 2013).

The IDFs extracted from the pears also exhibited antiobesity effects like reduction of levels of LDL-C by promoting the growth of beneficial gut microbiota (Chang *et al.,* 2017). Furthermore, pre-adipocyte maturation into adipocytes was reduced in the groups treated with pear extract (PE) and *Garcinia cambogia* extract (GE) by 4.1 and 14.7 per cent, respectively, while the combined effects of PE and GE showed a 26.9 per cent inhibition, suggesting their use to prevent weight gain (Hong *et al.*, 2021).

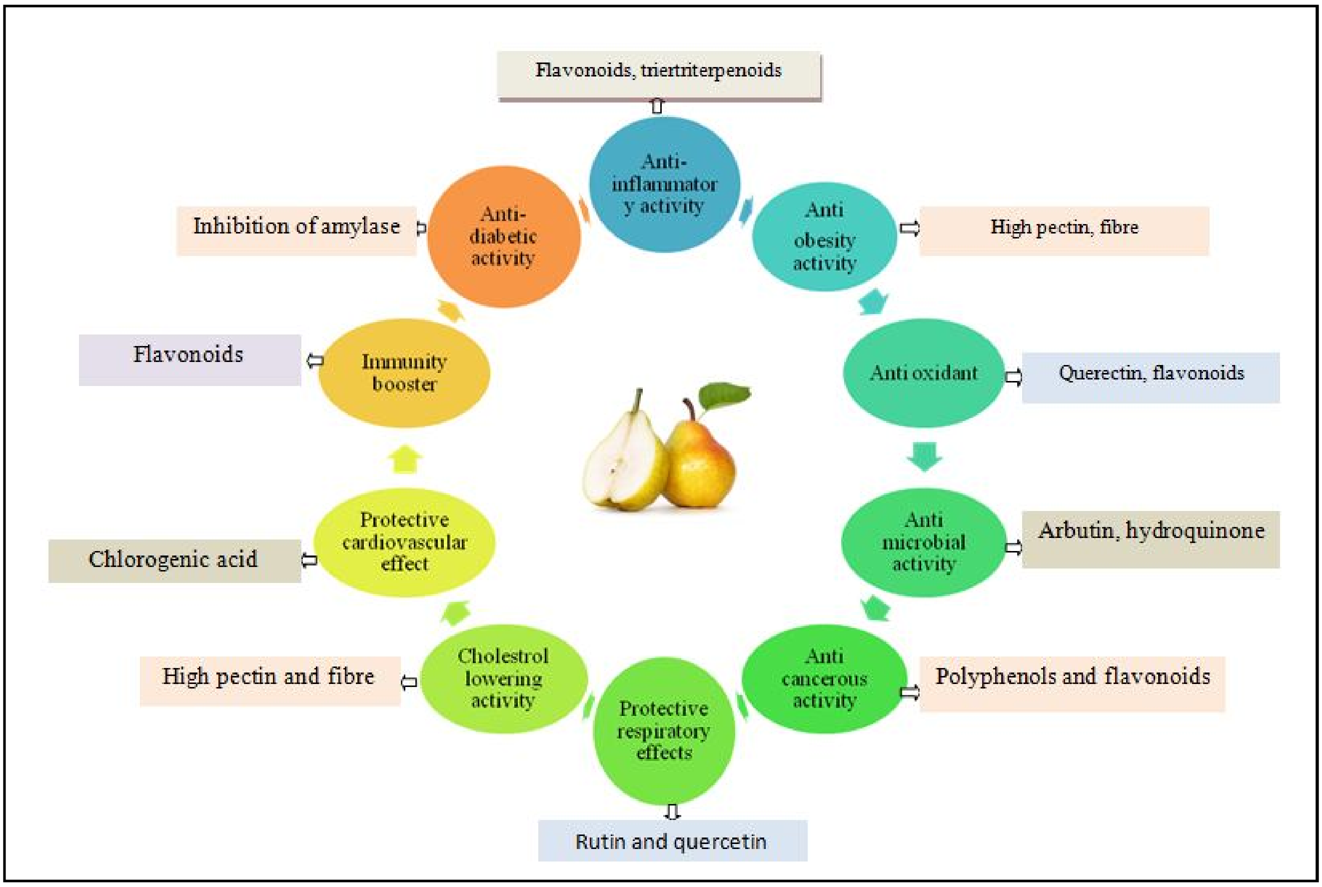

Figure 1: Bioactive compounds of Sand pear along with various health benefits.

4.5 Anti-inflammatory activity

Increased levels of flavonol and anthocyanin in the diet are linked to anti-inflammatory benefits. Carotene, zeaxanthin and vitamin C, are also reported to have anti-inflammatory effects. These bioactive phytoconstituents are believed to reduce the concentration of C-reactive proteins, which cause inflammation (Henriques *et al.,* 2020). Hong *et al.* (2021) conducted an animal study where they reported that treatment with pectins from Asian pear resulted in decreased sensitivity of tracheal smooth muscle in mice to electrical field stimulation and acetylcholine. Additionally, there were fewer indications of tracheal inflammation in the treated mice, including thicker bronchial mucosa, abnormal cilia loss or proliferation, and sticky mucus plugs along the bronchi. In addition, the immunoglobulin E(IgE) levels specific to allergens in the serum were reduced by 70 per cent as a consequence of the treatment. According to these results, pectin from Asian pears may have a vital role in the treatment of respiratory disorders by acting as an anti-inflammatory and antiallergic agent.

4.6 Antidiabetic activity

The fruits help in the regulation of postprandial hyperglycemia as it inhibits α-amylase and α-glucosidase enzymes responsible for digestion, absorption, and metabolism of dietary carbohydrates. Furthermore, the fruit contains a high amount of fiber, which helps in maintaining low blood glucose levels in diabetics. Ansari *et al.* (2022) found that quercetin reduced blood glucose levels in diabetic rats and enhanced tolerance of glucose.

4.7 Immune booster

The immune boosting properties are relatively linked to the antioxidant nutrients of the pear. The presence of various phytoconstituent groups, including triterpenoids, anthocyanins, flavonoids, and phenols, aids in the development and stimulation of the immune system. The flavonoids present were found to increase the proliferation of immune cells and the production of cytokines (signaling molecules involved in immune response) in mouse splenocytes (Maleki *et al.,* 2019).

4.8 Cardiovascular disease

The various bioactive compounds present in Sand pear have cardioprotective effects. The hydroxycinnamic acid content (caffeic, chlorogenic, feluric and *p*-coumaric acids), improved endothelial function, which is a key factor in the enlargement of cardiovascular disease, in rats with high blood pressure (Fuentes and Palomo, 2014). In another study, an anthocyanin rich diet reduced blood cholesterol levels and improved lipid metabolism in rats which were fed a high-fat diet (Lee *et al.,* 2016). In addition, Sand pear is an important resource of dietary fiber, which is observed to reduce the risk of heart disease by lowering blood cholesterol levels and improving blood glucose control. It has been reported in studies that fiber rich diet reduced cholesterol absorption and increased fecal bile acid excretion in rats (Pushpass *et al.,* 2021). Chlorogenic acid was reported to reduce oxidative endothelial cell damage and is linked to increased production of nitric oxide (Kang *et al.,* 2009). Cardioprotective functions of pear *via* ACE inhibition have also been reported *in vivo* systems.

4.9 Respiratory disease

There have been reports of respiratory disease prevention benefits from Sand pear. Findings have shown Sand pear contains compounds such as quercetin and chlorogenic acid which have anti-inflammatory and antioxidant properties that can decrease inflammation in the respiratory tract and protect against respiratory diseases. Hong *et al.* (2021) reported that treatment with Sand pear pectins decreased the tracheal smooth muscle's sensitivity to acetylcholine and electrical field stimulation in mice. This led to a decrease in inflammatory signs, including thicker bronchial mucosa, abnormal cilia loss or proliferation, lymphocyte proliferation, and sticky mucus plugs along the bronchi.

4.10 Antiobesity activity

The various beneficial effects associated with the consumption of fruits of genus Pyrus on obesity management have been observed by many researchers. The pears are rich in fiber and have a low energy density. The IDFs (insoluble dietary fibres) present have anti-obesity effects such as decreased levels of low density lipoprotein-cholesterol (LDL-C) and total cholesterol (TC) by enhancing the growth and activity of Bacteriodetes in the gut microbiota of rats (Velmurugan and Bhargava, 2013). IDFs are also speculated to accelerate the rate of fat metabolism and are also found to reduce the expression of genes which is associated with adipogenesis, or the formation of fat cells.

4.11 Urinary diseases

In another study, Sand pear may have been reported with a beneficial effect on urinary health. In a study, the effects of quercetin on rats with bladder damage induced by cyclophosphamide, a chemotherapy drug that can cause hemorrhagic cystitis were investigated. In a study, treatment with quercetin reduced bladder inflammation and improved bladder histology, suggesting a protective effect against cyclophosphamide-induced bladder damage (Sekeroðlu *et al.,* 2011).

4.12 Hepatoprotection

The pear pomace extracts have been reported to suppress hepatic lipid peroxidation and liver damage due to free radicals in rats which were fed with a high fat/cholesterol diet (Caliceti *et al.,* 2022). Furthermore, in mice having an acute liver injury, the antioxidants found in various fruits and spices considerably reduce the rise in aspartate aminotransferase and serum alanine aminotransferase levels (Wang *et al.,* 2019). Hence, Sand pear may help shield the liver from alcohol-related and non-alcoholic damage.

5. Conclusion

Sand pear is traditionally used as holistic medicine and functional food owing to the higher activity and presence of diverse bioactive compounds that confer medicinal and health promoting benefits. However, fruits have a somewhat rough texture and sandy in comparison to cultivated pears, which makes them less acceptable to people. To solve this problem, breeding must aim to reduce the stone cell content and improve the organoleptic properties of fruits. Further, efforts must be made to process and add value to the fruits to produce a diverse range of health products. Apart from fruits, the leaves and the flowers of Sand pear are also rich in numerous phytochemicals and the extracted bioactive compounds can be further utilized in functional foods, nutraceuticals or pharmaceutical products. Arbutin is the major phenolic compound in Sand pear with great potential to be used in value added food products or nutraceuticals. Another area of research remaining unexplored is the development of bioprocessed products. Bioprocessing may lead to release of certain bound phenolics hence improving the bioactivity of biopocessed products. Therefore preparation of bioprocessed products like wine, vinegar and fruit yoghurts seems to be a very feasible option, and hence must be explored for increasing the utilization of the fruit.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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