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Nutritional and therapeutic benefits of medicinal plant *Pithecellobium dulce* (Fabaceae): A review

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ABSTRACT

Pithecellobium dulce, an evergreen medium-sized, spiny tree, each part of the plant has vast nutritional values; stuffed with essential vitamins, amino acids, and minerals. The fruits of *P. dulce* were widely used in Ayurvedic medicines and home remedies. The plant has also been a rich source of biologically active compounds such as tannin, olein, and glycosides. Totally 38 active phytocompounds like quercetin, kaempferol, and dulcitol were identified from the various parts of the plant. Notably, this plant has catechol type of tannins in the bark. There are polyphenol classes of phytocompounds which have found to hold potent antivenom activity. Their fruits are a rich source of phenols, flavonoids, and saponins reported for their efficacy to treat diabetes, oxidative stress, and gastrointestinal disorders. The plant leaf and seed have an antibacterial, antifungal, and adulticidal activities. Thus, the present review describes on exploiting the medicinal properties of *P. dulce* and its biomedicinal applications in therapeutic development.

INTRODUCTION

Medicinal plants are the rich source of various natural constituents with extensive pharmacological activities. In recent days, nutraceuticals have gained huge attention as nutritional supplements for their positive physiological effects in the human body (Bagchi and Kumar, 2016). From villages to developed cities, traditional ways of natural medication consecutively becoming popular. Notably, the plant-derived compounds hold huge precious values for healthy living, and the tribal and elders have well known about the plants decades ago (Shyur and Yang, 2008). Lot of bioactive phytochemicals with medicinal properties to cure various health illnesses has been revealed every day by researchers (Satheesh Kumar and Nisha, 2014). These plant-derived bioactive compounds have the enormous potentiality to treat diseases like diabetes, cancer, inflammation, etc. (Saklani and Samuel, 2008). Although, there are numbers of allopathic drugs which have been developed every day since, the permanent recovery from the diseases and the secondary complications aroused during the medication remains a matter of debate (Edzard Ernst, 1998). Sometimes it would cause drastic effects like liver failure, kidney failure, raised blood pressure, and several other complications (Pirkle and Freedman, 2013). We have vast diverse flora with unexplored medicinal values (Hooper and Aedin, 2006). *Pithecellobium dulce* (*P. dulce*) is an important fruit of American origin and it belongs to the family of Fabaceae, a native of tropical America, and is cultivated throughout India and Andaman (Rao *et al*., 2011). *P. dulce* is one among the category, which is an evergreen medium-sized, spiny tree. It is locally called "Jungal jalebi," "black bead tree" in English, "Vilayati Babul" in Hindi, and "Kodukkapuli" in Tamil (Orwa *et al*., 2009). This review discusses the overall bioactive constituents and their pharmaceutical properties of the *P. dulce*.

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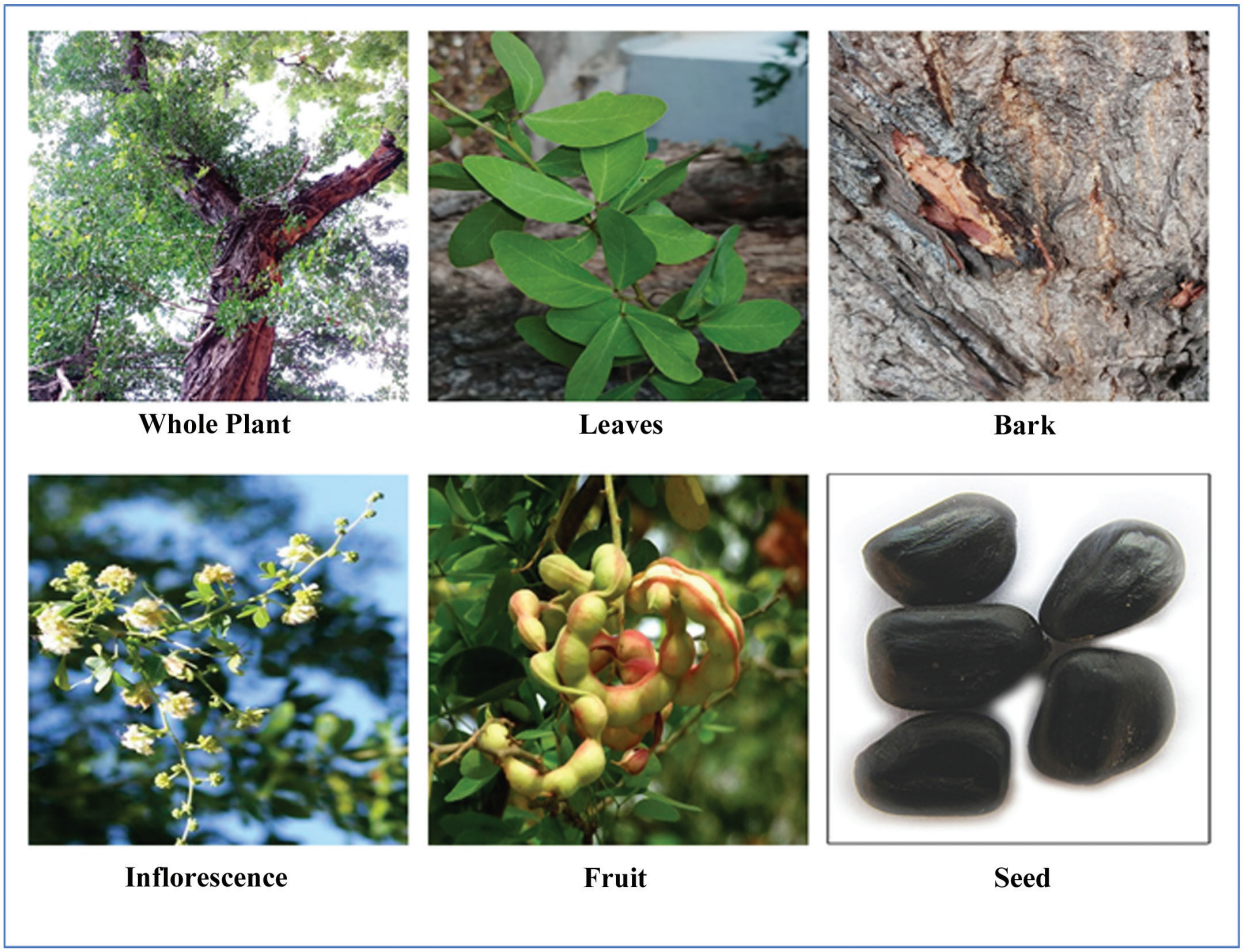


Figure 1. *Pithecellobium dulce* plant.

Botanical description

Domain: Eukaryota
Kingdom: Plantae
Phylum: Spermatophyta
Subphylum: Angiospermae
Class: Dicotyledonae
Order: Fabales
Family: Fabaceae
Genus: Pithecellobium
Species: *Pithecellobium dulce*

Plant morphology

The barks of *P. dulce* are gray in color, they become rougher and eventually start peeling when gets matured. The leaves are 2–2.5 × 1–2 cm in size and have kidney-shaped leaflets with a pair of two leaves. Each leaf has a thin spine of 2–15 mm at the leaf base. Hairy corolla shaped flowers of 1 cm diameter are present with small whiteheads in the *P. dulce*. In the flowers, 50 thin stamens are surrounded in the calyx in a united tube. Each pod size is 10–15 × 1.5 cm and spiral and reddish-brown as they ripen (Orwa *et al*., 2009). The parts of the plant were shown in Figure 1.

Plant distribution

The plant originated from Brazil, Argentina, Bolivia, Colombia, etc., *P. dulce* is one of the species that has become widespread outside from its origin. It is one of 18 species in this genus. It has been distributed naturally in many countries like India, Huawei, tropical Africa, and especially along the coast (Orwa *et al*., 2009). The species distribution map for *P. dulce* is shown in Figure 2.

NUTRITIONAL VALUES

The fruits and seeds of *P. dulce* contain vital vitamins like ascorbic acid, thiamine, riboflavin, and some essential amino acids like lysine, phenylalanine, tryptophan, and valine, as shown in Figure 3 and few essential minerals such as Na, K, P, Fe, and Ca, as shown in Figure 4 and secondary metabolite classes like tannins, 25.36% fixed oil, and 18.2% olein are found in the *P. dulce* (CSIR, 1988). Catechol, a notable type of tannin compound which is present in the bark (37%). Quercetin, afezilin, kaempferol, and dulcitol were identified from the leaf extract of *P. dulce*. Its fruit contains phenols, flavonoids, and saponins. The phenolic and flavonoids have a hydroxyl functional group that possesses radical scavenging ability to prevent oxidative damage (Katekhaye and Kale, 2012). Proteins and peptides with the potential to combat

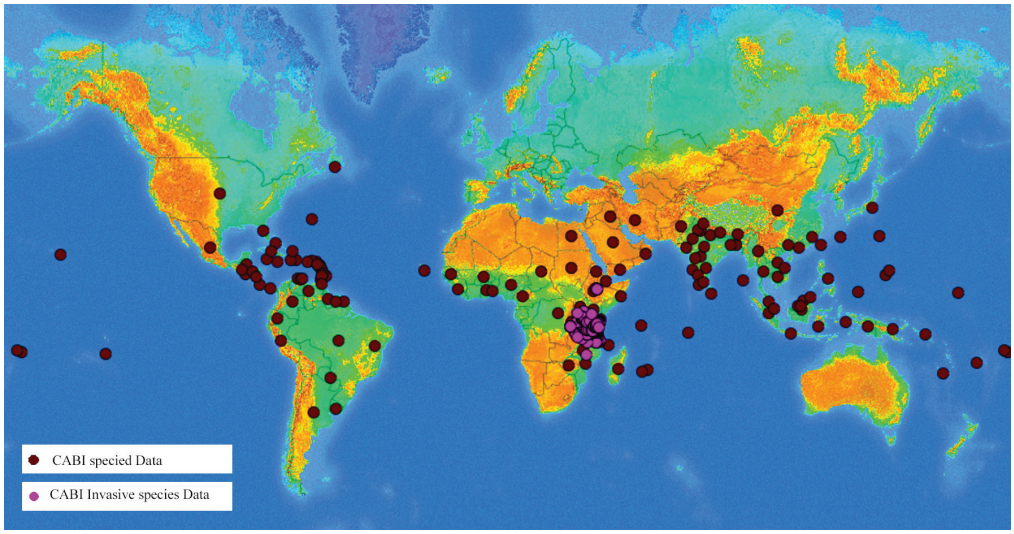


Figure 2. World Distribution of *Pithecellobium dulce*.

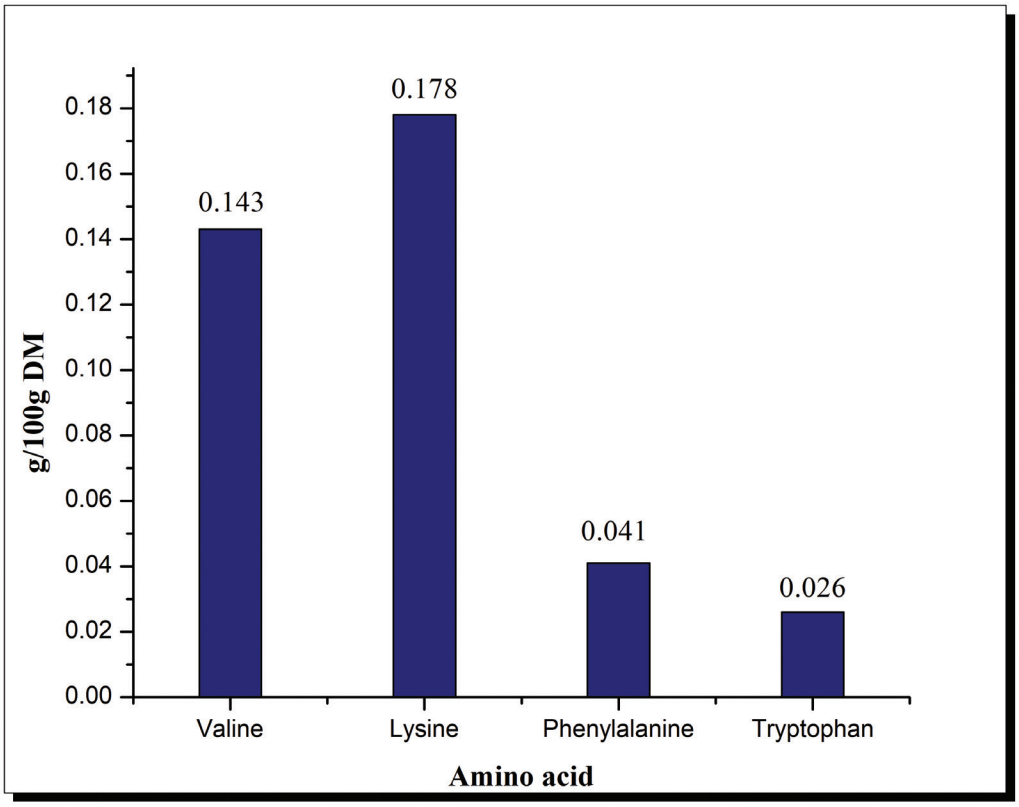
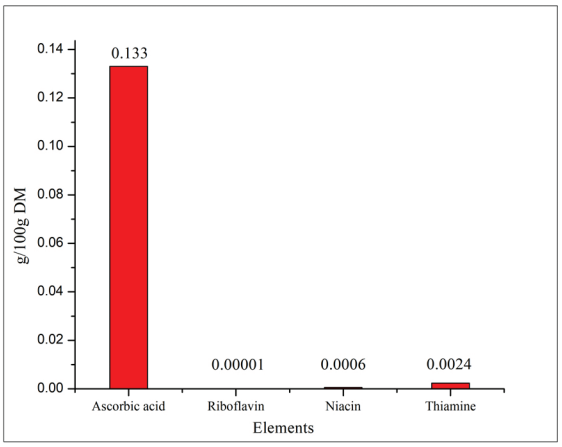


Figure 3. Essential amino acids in *Pithecellobium dulce* fruits.

protein malnutrition are richly present in *P. dulce* seeds. The steroid, saponin, lipids, phospholipids, glycosides, glycolipids, and polysaccharides are present in *P. dulce* seeds. The lists of phytochemical constitutions and their structures were shown in Table 1 and Figure 5. Recently, the alkylated resins were identified from the seed oil. The water-soluble polysaccharides were isolated from the seeds and are used as humanoid ailments; it also has an anti-oxidant activity that prevents the oxidative stress (Bagchi and Kumar, 2016). Three different hetero-polysaccharides are isolated from *P. dulce* fruits; those were used as pharmaceutical adjuvants (Preethi and Mary Saral, 2016). The protein and fiber contents of *P. dulce* are shown in graph Figure 5. The entire plant of *P. dulce* has medicinal values and its leaves are also used as a feed for goat (Kahindi *et al*., 2007) because of its good nutritional content (Olivares *et al*., 2013).



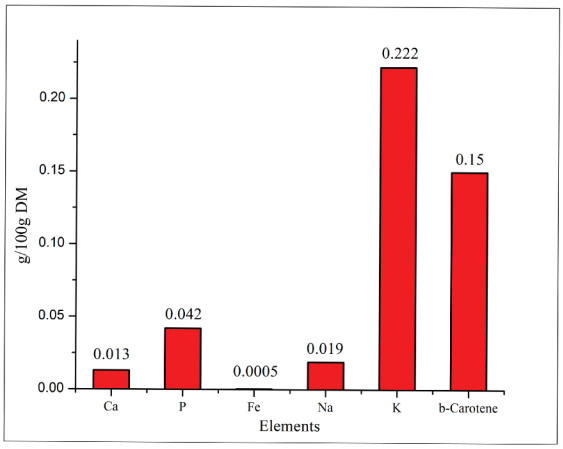


Figure 4. Nutritional composition of *Pithecellobium dulce* fruits.

THERAPEUTIC AND BIOLOGICAL VALUES OF *P. DULCE*

Each part of the plant *P. dulce* contains notable medicinal values, like the estrogenic activity was proposed in the root extracts (Saxena *et al*., 1998), the anti-inflammatory activity of the saponin fraction of *P. dulce* fruits (Bhargvakrishna *et al*., 1970; Sahu and Mahato, 1994), and their various parts have been reported to be as a remedy for earache, leprosy, peptic ulcer, toothache, venereal disease, and it also acts as emollient, abortifacient, anodyne, and larvicides (Govindarajan *et al*., 2012). The bark of *P. dulce* also acts as an astringent for dysentery, febrifuge. In addition, this plant also has a useful remedy for dermatitis eye inflammation. The polyphenols content of the bark extract has reported for their anti-venomous activity by Pithayanukul *et al*. (2005). In seeds, active classes of phytoconstituents like steroids, saponins, lipids, phospholipids, glycosides, glycolipids, and polysaccharides were identified (Nigam and Mitra, 1968; 1970). This plant is a potential source of antioxidant and effective medicine for adulticide problem (Rajeswary and Govindarajan, 2014). The lists of biological therapeutic values were shown in Table 2. Beside of all the above properties, it is a nutritional feed for goats and other livestock (Olivares *et al*., 2013).

Adulticidal activity

The Phytochemicals of *P. dulce* are also used as an insecticide as they have an adulticidal activity against mosquitoes like *Aedes aegypti* (*A. aegypti*), *Culex quinquefasciatus* (*C. quinquefasciatus*), etc. Dengue, filariasis, malaria, and viral encephalitis are major Mosquito-borne diseases in developing countries. *Aedes aegypti* mosquitoes are responsible for dengue fever. Chemical based mosquito repellent spray is usually toxic to other beneficiary life forms, may cause severe breathing problems in human too. To avoid such circumstances, naturally derived repellents can be used (Govindarajan and Rajeswary, 2015). The leaves and seed extracts of *P. dulce* have the tendency to control mosquitoes and are very safe. The larvicidal and ovicidal effects are moderate in the leaf and seeds of this plant. The comparison studies were undertaken and is reported that the leaf extract using methanol has the highest larval mortality and the seed extract using hexane have lower potency towards mosquitoes. The larvicidal and ovicidal activities were proved in *A. aegypti* (Rajeswary and Govindarajan, 2014) and *C. quinquefasciatus* (Govindarajan *et al*., 2012) mosquitoes. *Pithecellobium dulce* derived bioactive compounds are also used as a natural synthetic insecticide. The silver nanoparticles synthesized from an aqueous extract of *P. dulce*'s leaf exhibited larvicidal activity against *C. quinquefasciatus*. Further, the FT-IR report identifies the saponin; a class of phytocompounds in the plant is responsible for the synthesis of the silver nanoparticle (Raman *et al*., 2012).

Anti-diabetic activity

Diabetes mellitus is a very complex and uncontrollable metabolic disorder. There are numbers of the chemical agents that control the insulin and glucose level in the blood. It happens either due to improper secretion or action of insulin in the body during diabetes mellitus (Chaudhury *et al*., 2017). The synthetic pharmaceutical drugs prescribed for these conditions are having more harmful side effects like causing secondary organ damage (kidney failure, liver failure, etc.) on the human body. The plant bioactive chemicals are alternate medicines for diabetes allopathic medication. The methanolic crude extract of *P. dulce* seed was tested in Streptozotocin (STZ)-induced diabetic rat (albino Wistar male model) and the extract has the ability to protect the functional β-cells that produce and maintain the insulin level in the blood (Fu *et al*., 2013). This insulin treatment improves the glycogen content. In the methanolic extract treated STZ induced rats, the liver glycogen level was higher compared with the control group of Wistar rat and the functional glucose metabolism could be due to better insulin secretion from β-cells and the glucose was utilized in the oral glucose tolerance test. Thus, it could be a potential therapeutic for diabetic patients (Nagmoti *et al*., 2015). The *P. dulce* fruit containing a cyclic polyol pinitol and it has reported for having anti-diabetic activity (Gao *et al*., 2015; Kim *et al*., 2007).

Anti-hyperlipidemic

The excess glucose is usually preserved as glycogen and then fat in our body tissues as storage fuel for future. But the continuous accumulation for a longer period may lead to hyperlipidemia. It is one of the major risk factors involved in the development of Type II diabetes, heart disease, etc.

Table 1. List of bioactive compounds reported in *Pithecellobium dulce*.

S. No	Phytochemical name	Molecular formula	Molecular weight (g/mol)	Part of the plant	Reference
1	Catechol	$C_6H_6O_2$	110.10	Bark	CSIR, 1980
2	Campesterol	$C_{28}H_{48}O$	400.68	Wood	
3	Leucofisetinidin	$C_{15}H_{14}O_6$	290.27	Wood	
4	Melacacidin	$C_{15}H1_4O_7$	306.26	Wood	
5	Hederagenin	$C_{30}H_{48}O_4$	472.70	Seeds	
6	Pitheduloside A	$C_{41}H_{66}O_{13}$	766.96	Seeds	Nigam *et al*., 1996
7	Pitheduloside B	$C_{46}H_{74}O_{16}$	883.08	Seeds	
8	Pitheduloside C	$C_{46}H_{74}O_{16}$	883.08	Seeds	
9	Pitheduloside D	$C_{46}H_{74}O_{17}$	899.08	Seeds	
10	Pitheduloside E	$C_{46}H_{74}O_{17}$	899.08	Seeds	
11	Pitheduloside F	$C_{52}H_{84}O_{21}$	1045.22	Seeds	
12	Pitheduloside G	$C_{52}H_{84}O_{21}$	1045.22	Seeds	
13	Pitheduloside H	$C_{100}H_{158}O_{49}$	2144.31	Seeds	Yoshikawa *et al*., 1997
14	Pitheduloside I	$C_{30}H_{48}O_5$	488.69	Seeds	
15	Pitheduloside J	$C_{30}H_{48}O_5$	488.69	Seeds	
16	Pitheduloside K	$C_{52}H_{84}O_{22}$	1061.21	Seeds	
17	Octacosanol	$C_{28}H_{58}O$	410.76	Leaves	Nigam *et al*., 1970
18	α-spinasterol	$C_{29}H_{48}O$	412.70	Leaves	
19	Kaempferol	$C_{15}H_{10}O_6$	286.83	Leaves	
20	kaempferol-3-rhamnoside	$C_{21}H_{19}O_{10}$	431.73	Leaves	
21	β Glucoside–α spinasterol	$C_{35}H_{58}O_6$	574.85	Leaves	
22	Pithogenin	$C_{28}H_{44}O_4$	444.62	Seeds	Nigam *et al*., 1962
23	Ellagic acid	$C_{14}H_6O_8$	302.19	Fruits	Megala and Geetha, 2009
24	Gallic acid	$C_7H_6O_5$	170.12	Fruits	
25	Mandelic acid	$C_8H_8O_3$	152.14	Fruits	
26	Ferulic acid	$C_{10}H_{10}O_4$	194.18	Fruits	
27	Vanillic acid	$C_8H_8O_4$	168.14	Fruits	
28	Coumaric acid	$C_9H_8O_3$	164.16	Fruits	
29	Rutin	$C_{27}H_{30}O_{16}$	610.52	Fruits	
30	Naringin	$C_{27}H_{32}O_{14}$	580.54	Fruits	
31	Daidzein	$C_{15}H_{10}O_4$	254.23	Fruits	
32	Dulcitol	$C_6H_{14}O_6$	182.17	Leaves	
33	Quercetin	$C_{15}H_{10}O_7$	302.23	Leaves, fruits, fruit peel	
34	Stigmasterol	$C_{29}H_{48}O$	412.69	Seeds, fruit peel	Sukantha and Subashini, 2015
35	Pinitol	$C_{15}H_{14}O_6$	290.26	Fruit peel	
36	Prenylapigenine	$C_{32}H_{38}O_{14}$	646.63	Stem	
37	Oleanolic acid	$C_{30}H_{48}O_3$	456.70	Seeds	
38	Echinocystic acid	$C_{30}H_{48}O_4$	472.70	Seeds	

(Nelson, 2013; Zhou *et al*., 2015). High-density lipoprotein cholesterol (HDLC) is mainly involved in protecting us from heart diseases, especially atherosclerosis (Vergeer *et al*., 2010) and it transports excess cholesterol out of the body. Nagmoti *et al*. (2015) checked the methanolic crude extract of *P. dulce* seed on STZ-induced diabetic rat model. The histopathological analysis showed the increased levels of HDLC and the very low-density lipoproteins cholesterol (VLDLC), low-density lipoproteins cholesterol (LDLC), serum cholesterol, and triglycerides level were significantly decreased in the *P. dulce* treated rats. From the results, the bioactive compounds of *P. dulce* seeds have active potentiality against the hyperlipidemic condition. Hence, *P. dulce* could also holding hyperlipidemic activity against STZ induced animal model has been proved (Nagmoti *et al*., 2015).

Anti-oxidant activity

Imbalance of electron on any atom or oxidative stress is one of the key important factors which triggers majority of diseases like cancer, arthritis, diabetes, renal damage, etc. (Ung *et al*., 2017). The unstable radicals cause severe damage to the inner organs, tissues, and cause various health problems. Nitric oxide, hydroxyl, and superoxide radicals are few common free radicals responsible for some autoimmune diseases like rheumatoid arthritis

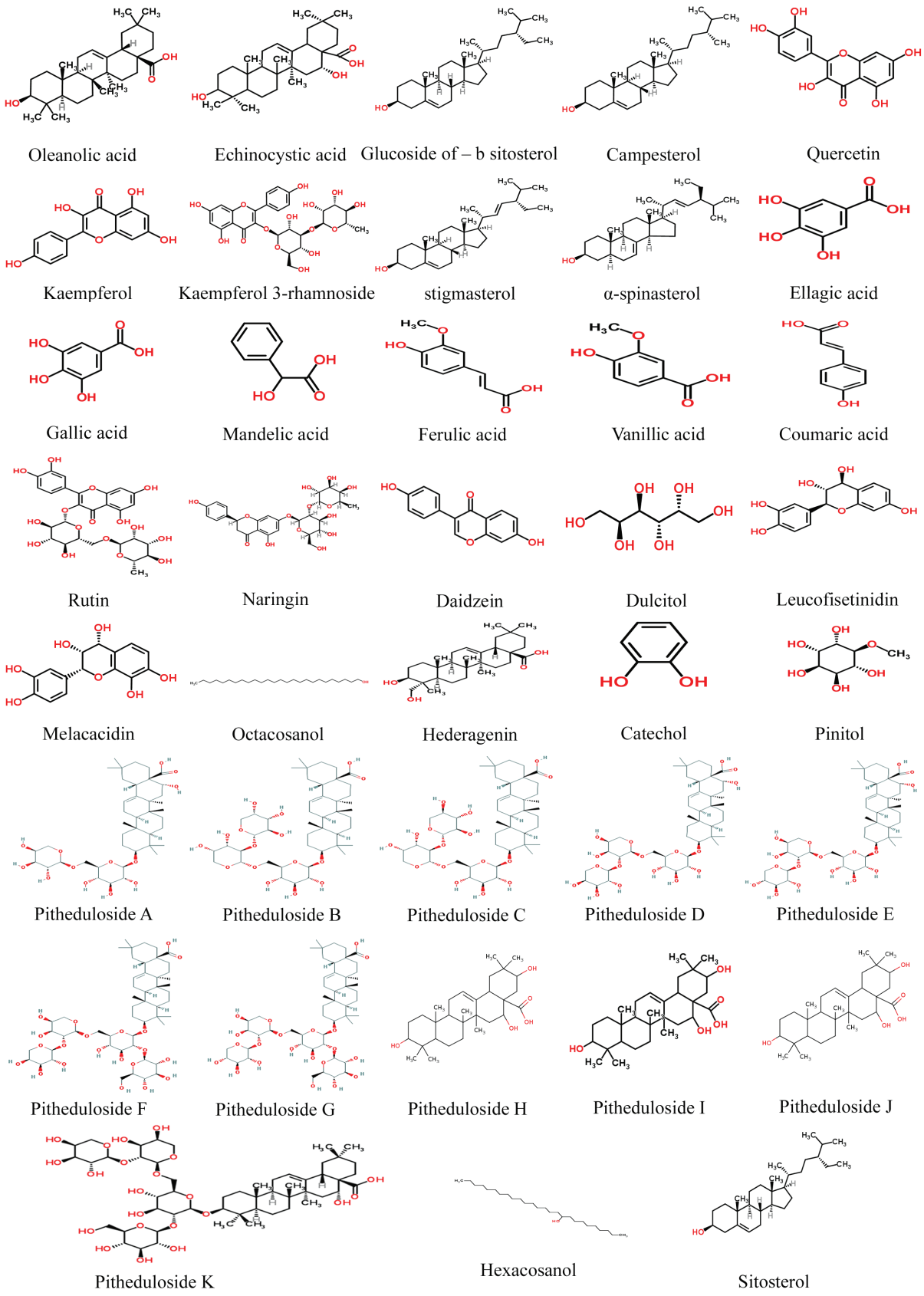


Figure 5. Important chemical structure reported in *Pithecellobium dulce*.

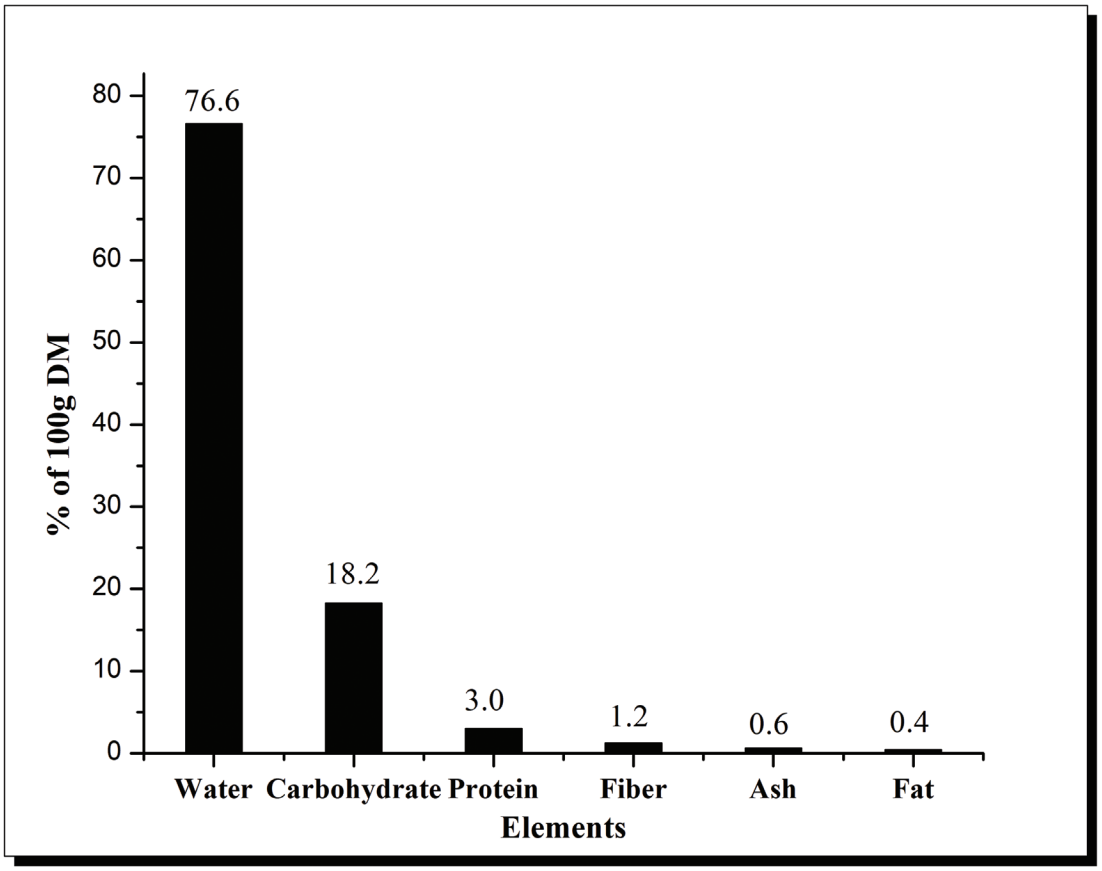


Figure 6. Composition of desiccated *Pithecellobium dulce* fruits.

Table 2. Pharmaceutical and biological effects of *Pithecellobium dulce.*

S. no	Biological activity	Part of the plant	Extraction	Reference
1.	Adultical	Leaf and seed	Hexane, Benzene, Chloroform, Ethyl acetate, and Methanol	Govindarajan *et al*., 2012; Rajeswary and Govindarajan, 2014; Raman *et al*., 2012
2.	Antidiabetic	Seed	Methanol	Nagmoti *et al*., 2015
3.	Hypolipidemic	Seed	Methanol	Nagmoti *et al*., 2015
4.	Anti-oxidant	Seed	Aqueous, Methanol	Katekhaye and Kale, 2012; Nagmoti *et al*., 2012; Sukantha *et al*., 2011
		Wood bark, leaf	Methanol, acetone	
		Fruits	Aqueous, hydro alcoholic	
5.	H^+, K^+-ATPase inhibition	Fruits	Aqueous, hydro alcoholic	Megala and Geetha, 2009
	Anti-ulcer	Fruits	Hydro alcoholic	Megala and Geetha, 2011
6.	Anti- venom	Bark	Hexane	Pithayanukul *et al*., 2005
7	Nephroprotective	Fruit	Aqueous	Pal *et al*., 2012
8	Anti-diarrheal	Leaves	Ethanol	Rashid *et al*., 2015
9	Anti-bacterial	Pod pulp, Fruit Peel	Ethanol	Pradeepa *et al*., 2014
		Leaves	Methanol	Sukantha *et al*., 2014
10	Anti-fungal	Leaves, seed	Aqueous, Ethanol	Bautista *et al*., 2003; Shanmugakumar *et al*., 2006

and diabetes mellitus (Asmat *et al*., 2016; Mateen *et al*., 2016; Saegusa *et al*., 2006;). In our human body, various mechanisms like enzymatic and non-enzymatic antioxidants protect the inner cellular molecules and tissues against reactive oxygen species (ROS) induced damage (Aruoma, 1998).

The phytochemicals are widely known to be the precious sources for antioxidant activity. It stabilizes the radicals generated through various factor and help in promoting the antioxidant enzymes in our body. The leaves, seeds, fruits, and wood barks extract of *P. dulce* have potential activity against free radicals has proved. The whole plant has active free radical scavenging potential against synthetic radicals of DPPH, NO, superoxide, and hydroxyl ions (Katekhaye and Kale, 2012; Nagmoti *et al*., 2012; Sukantha *et al*., 2011). Further, the HPLC profiling confirms the

abundant active phenolic and flavonoid contents in the fruits (Megala and Geetha, 2009).

Anti-ulcer activity

Peptic ulcer is one of the major and common global health issues. Because many of the anti-inflammatory drugs [called non-steroidal anti-inflammatory drugs (NSAIDS)], dietary factors, stress, or painkiller drugs were found to be affect the stomach and causes an ulcer (Lanas and Chan, 2017). Continuous alcoholic adductors are also affected by peptic ulcer. The development of ulcer is correlated with oxidative stress by hypersecretion of HCL and reactive oxygen species (ROS) generation (Osefo *et al*., 2009; Suzuki *et al*., 2012). The hypersecretion of HCL is caused by H^+, K^+-ATPase action. Omeprazole, Lansoprazole, Ranitidine, and Famotidine are the major H^+ and K^+-ATPase inhibitors used to treat the ulcer and to control the acid secretion. But these anti-secretary drugs produce adverse side effects on the human body.

The aqueous crude extract of *P. dulce* was orally treated in acetylsalicylic acid (ASA)-induced rat model (Male albino Wistar rats). The phytocompounds reacted and inhibited the gastric mucosal H^+, K^+-ATPase (Megala and Geetha, 2009). The H^+, K^+-ATPase level was analyzed and compared with the standard drug of Omeprazole. Gastric mucin is an important factor in protecting the gastric mucosa. Gastric mucin, myeloperoxidase activity, and prostaglandin E2 (PGE2) level were analyzed and reported in Megala and Geetha (2012). The important role of PGE2 is to maintain the gastric mucosa by increasing the gastric mucus secretion and decreasing the gastric acid secretion. In the *P. dulce* treated rats, the PGE2 level was found to be increased and that indicates the stimulation of cytoprotective factors that contribute to accelerate the ulcer healing effect. From the results, *P. dulce* have an ability to cure the gastrointestinal disorders (Peptic ulcer). So, the *P. dulce* extract can be used as an antiulcer agent and it also act as an anti-acid secreting agent and cytoprotective factor (Megala and Geetha, 2012).

Nephroprotective

Carbon tetrachloride (CCl_4) is an environmental toxin and is also used as medicine for hookworm disease and it affects and damages the kidney and liver (Rahmat *et al*., 2014). It causes fibrosis, cirrhosis, and hepatic carcinoma. Cytochrome P450 isozymes produce trichloromethyl free radical (TCCM free radicals) with higher toxicity of CCl_4. TCCM Free radicals react with oxygen to form the reactive trichloromethyl peroxy radical (high level toxic), a reactive oxygen species (ROS). Free radical also induces the lipid peroxidation and it is a major factor for cell membrane damage in many pathological situations. CCl_4 generates free radicals and cause renal disorders by generating free radicals in hepatic disorder (Al-Yahya *et al*., 2013). *Pithecellobium dulce* crude extract was orally administrated in the CCl_4 induced rats (orally before CCl_4 induced rat) and crude extract was also administrated to the rat before inducing CCl_4 toxin (orally after CCl_4 induced rat). The crude extract of *P. dulce* decreased the lipid peroxidation and protein carboxylation after inducing CCl_4 in rats, as the *P. dulce* compounds have antioxidant activity. In the CCl_4 administrated rats, the ROS level was found increased, while *P. dulce* fruit extract treated rats have decreased ROS level when compared with CCl_4 administrated untreated rats. Anti-oxidants enzymes are mainly involved in cellular defense and to prevent and protect from oxidative stress or oxidative damage. Glutathione reductase (GR), Superoxide dismutase (SOD), Glutathione-S-transferase (GST), and catalase (CAT) are major antioxidant enzymes and CAT & SOD are important enzymes to eliminate the ROX. In the *P. dulce* extract pretreated rats, higher amount of anti-oxidant enzyme level was observed as compared with CCl_4 induced rats and the rats treated with *P. dulce* extract. The aqueous extract of *P. dulce* also prevents and protects the renal DNA damage and cell death, by means of stabilizing the oxidative radicals, which disturbs the mitochondrial membrane and causes loss of ATP production that directly leads to cell death. Pal *et al*. (2012) evaluated and proved the anti-necrotic properties and nephroprotective properties of *P. dulce*.

Anti-venom effect

The tannin was extracted from *P. dulce* barks using aqueous extraction. The venom lethality was inhibited and the necrotizing activity of the venom was minimized by this crude extract. The extract also inhibited 90% of acetylcholine esterase activity as it contains higher tannin concentration or combined hydrolyzable tannin concentration. α-cobra toxin protein was docked with four different tannin compounds using Autodock 3 and tannic acid, Digallic acid has −14.7 kcal/mol, −10.38 kcal/mol binding energies were studied. The plant extract selectively blocks nicotinic acetylcholine receptor and non-selectively precipitate the venom protein (Pithayanukul *et al*., 2005).

Anti-diarrheal effect

The ethanolic extract of *P. dulce* showed an anti-diarrheal effect in the castor oil-induced mice. Loperamide is the standard anti-diarrheal drug used to compare the results. The phytochemicals of *P. dulce* has the ability to increase the latent period, delay, and decrease the frequency of defecation (Rashid *et al*., 2014).

Anti-bacterial effect

The ethanolic extract of *P. dulce* pod pulp has potent to inhibit the Gram-positive bacteria (*Bacillus subtilis*) and Gram-negative bacteria (*Klebsiella pneumonia*). The secondary metabolites (flavonoid, saponin, etc.) are responsible for the inhibition of bacterial growth (Pradeepa *et al*., 2014). The aqueous, methanolic and ethyl acetate extract of *P. dulce* fruit peel inhibit the eight different microorganisms (*Staphylococcus epidermis*, *Escherichia coli*, *Klebsiella pneumonia*, *Staphylococcus aureus*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Pseudomonas putida*, and *Proteus vulgaris*) isolated from wound infection. The higher zone inhibition was found in the crude methanolic extract. From the result, *P. dulce* fruit peel metabolites could be used as an antimicrobial agent and wound healing agent was proved. The ethanolic extract of P. dulce leaf has also been investigated and their effective anti-bacterial property was reported by Sukantha *et al*., 2014.

Anti-fungal effect

The plant pathogens like fungus cause contamination in strawberry fruits during storage. Many of the preventive agents are used to prevent fungal contamination on fruits but they are usually

holding some toxic effects. *Pithecellobium dulce* is a natural resource that could be used against fungal contamination. The aqueous and hydroalcoholic extracts of *P. dulce* have potentiality against Rhizopus *stolonifer, Botrytis cinerea*, and *Penicillium digitatum* contamination. In the aqueous extract, the secondary metabolite of kaempferol and some other mixture of compounds are mainly involved against the fungal contamination. While comparing the aqueous and hydro alcoholic extracts, the aqueous extract has better activity against fungal contamination (Bautista-Banos *et al*., 2003; Shanmugakumar *et al*., 2006).

CONCLUSION

The present review concludes that this *P. dulce* has several beneficiary health effects and pharmaceutical activities such as anti-ulcer, anti-fungal, anti-diabetic, and anti-venom activities. From this review, presents a comprehensive view of the plant *P. dulce* physiological, pharmaceutical properties, and traditional applications of *P. dulce*. The origin, distribution, nutritional, metabolites, and pharmaceutical properties information given above will be beneficiary to the society over various health issues. Further, this study encourages consuming traditionally practiced herbs and fruits to face modern life-threatening illness.

CONFLICT OF INTEREST

All authors declare that there is no conflict of interests regarding publication of this paper.

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None.

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