INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 3, Issue 6)
Available online at www.ijariit.com

Manilkara zapota (L.) P.Royen (Sapodilla): A Review

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Abstract: Manilkara zapota, also known as Sapodilla, is very commonly distributed in Indian subcontinent. It is an important member of Sapotaceae family as it is well known all over the world for its traditional medicinal uses. Numerous phytoconstituents have been reported from the plant by different authors that are responsible for many biological effects such as anti-inflammatory, anti-arthritis, anti-bacterial, anti-fungal, anti-oxidant, anti-tumor and anti-diabetic activities. The present article describes a detailed review of literature for this plant species including taxonomy, pharmacology and photochemistry in an organized way. This review paper will surely serve as an important source for the future scientific investigations on this plant.

Keywords: Sapodilla, Phytoconstituents, Anti-tumor, Anti-diabetic, Pharmacology.

INTRODUCTION

We have been endowed by nature with a marvellous flora and fauna which had beautified our life. *Manilkara zapota* (L.) P. Royen, commonly known as Sapodilla, chickoo or sapota, one of the wonders of nature belongs to family Sapotaceae including about 65 genera and 800 species [1]. The name Sapodilla is taken from the Spanish word zapotilla which means sapote (a soft edible fruit) [2]. Being a very popular fruit crop, grows well in tropical conditions and cultivated world over in tropical countries for various benefits like edible fruits, timber, latex, etc [2]. Sapodilla has its origin in Mexico and is native to Central America, although it is also cultivated in Asian countries including India [3]. The land under cultivation of sapota in India is about 162 thousand hectares with the overall annual production of about 1358 thousand tonnes [4]. Sapodilla fruit holds great nutritional value because of good source of sugar (fructose and sucrose) varying from 12 to 14%. Bose & Mitra [5] reported that a 100 g of edible fruit contains moisture (73.7 g), carbohydrates (21.49 g), protein (0.7 g), fat (1.1 g), calcium (28 mg), phosphorus (27 mg), Iron (2 mg) and ascorbic acid (6 mg) [6].

So far as the medicinal importance of *M. zapota* is concerned, it is one of the most important plants species being used for the treatment of various ailments because of the presence of various phytochemicals in it. The main components present in the leaves of sapodilla are lupeol acetate, oleanolic acid, apigenin-7-O-α-L-rhamnoside, myricetin-3-O-α-L-rhamnoside and caffeic acid [7]. The findings of Ganguly and Rahman [8] demonstrated the potential of sapodilla leaves for cytotoxic, antioxidant, antimicrobial and mild CNS depressant activities which could be used for therapeutic actions against cancer, tumor, infectious diseases and oxidative stress.

This communication briefly reviews the botany, photochemistry, pharmacology, traditional knowledge and therapeutic application of *M. zapota*. It was an attempt to compile and document information on these aspects and highlight the need for research and development.

TAXONOMY

Sapotaceae family is a diverse and ecologically important family of 800 species and nearly 65 genera. These include shrubs and trees which are widely distributed in tropical regions like America, Asia and Africa [9]. The members of this family can be easily recognized by the characteristic milky latex and alternate leathery leaves with parallel secondary and tertiary veins [10]. The genus *Manilkara* includes 30-32 species, most of which are economically important and commercially used as source of fruit, timber and latex [10]. Some of the related varieties to Sapodilla are the sapote (*Calocarpum mamosum*) which has a large central seed similar to the avocado, the green sapote (*Calocarpum viride*) and the star apple (*Chrysophyllum cainito)* [2].

Table I: Taxonomic Details of Sapodilla

Kingdom:	Plantae (plants)
Sub kingdom:	Tracheobionta (vascular plants)
Super division:	Spermatophyta (seed plants)
Division:	Magnoliophyta (flowering plants)
Class:	Magnoliopsida (dicotyledanae)
Sub class:	Dilleniidae
Order:	Ebenales
Family:	Sapotaceae
Genus:	*Manilkara* Adans. (manilkara)
Species	*M. zapota* (L.) P.Royen

SYNONYMS

Sapodilla has been mentioned in literature by a large number of synonyms such as *Achras sapota* L., *Achras zapota* L. var. zapotilla Jacq. *Achras zapotilla* Nutt., *Achras mammosa* L., *Manilkara achras* (Miller) Fosberg, *Manilkara zapotilla* (Jacq.) Gilly, *Sapota zapotilla* (Jacq.) Coville, *Sapota achras* Miller, *Sapota zapotilla* (Coville), etc. [2]. The generic names, *Manilkara* and *Achras* are the commonly used ones but still the name *Achras* is controversial and the botanists have no agreement for the proper name. *Sapota* (*zapota*) or *sapote* (*zapote*) is used for the species name; however this name too is not free of disagreements among authors. The generic name *Achras*, given by Linnaeus, was based upon a plate and description by the botanist Plumier but unfortunately, the plant that Plumier described is not Sapodilla and thus leading to the misnaming of this genus [2]. Gilly [11] suggested that *Manilkara zapotilla* (Jacq.) Gillys‘s is the only proper name, based on the fact that *Manilkara* is the earliest recorded name of the Sapodilla group and *zapotilla* was used specifically to Sapodilla at the time of its publication.

Vernacular Names

Sapodilla is known by a number of vernacular/common names in different countries.

Table II. Vernacular names of *Manilkara zapotilla*

Country	Common / Vernacular Name
Brazil	Sapoti, Sapotilha
Thailand	Lamoot, Lamut, Lamut-farang
English	Sapodilla
Indonesia	Sawu
Cuba	Sapota, Sapote
India	Chikoo, Chicku, Chiku
Mexico	Chicopote, Chicozapote
West Indies	Nasebery
Singapore	Ciku
Malaysia	Chikoo

Source: Morton (1987) [12]

BOTANICAL DESCRIPTION

Sapodilla is a medium to large sized tree with dense and almost round canopy formed by profuse branching system (sympodial type). Initially the growth of these trees is slow but after many years, may reach upto 20-30 metres in height. All tree parts exude out milky latex known as "chicle" [2].

Roots: Sapodilla roots show shallow-root system with a major portion of roots present within the top 75 cm of soil and about 66% of the moisture extracted from the soil is in the first 75 cm [13]'

Leaves: The leaves are evergreen and spirally arranged (7-12×2-4cm in size), pinkish brown when young and turns light-dark green at maturity. Secondary veins make a wide angle with the midrib.

Flowers: Flowers are small, bisexual, bell-shaped (10 mm in diameter), borne singly or in clusters in the axils of leaves near the branch tips.

Fruit: The fruit of sapodilla is a brown coloured berry, nearly round and varies from 5-10 cm in width. The unripe fruit is hard and coarse whereas it becomes soft and juicy on maturity [14].

Seeds: Some Sapodilla fruits are seedless but normally they produce 3-12 seeds per fruit. They are hard and brown or black in colour with one white margin. The seeds contain some phytochemicals like sapotin, saponin, achras saponin and the bitter sapotinine. Hydrocyanic acid is also present in seeds, so should be removed before eating the fruit.

Reproductive biology: Sapodilla is an out-breeding species and shows self-incompatibility [15-16]. Flowers are bisexual and the stigma grows beyond the corolla so that cross pollination can occur easily. The flowers of self-incompatible variety undergo cross-pollination by other sapodilla varieties so as to produce fruits. Flowering and fruiting occurs throughout the year; it takes about 4 months for fruits to mature. The seedlings start bearing fruits after 5-8 years, while the grafted varieties flower earlier (2-3 years from planting). Sapodilla is pollinated by insects. Pollinators of sapodilla are *Hermitia* spp. *Oecophylla smaragdina*, *Thrips hawaiiensis* and *Haplothrips tenuipennis* [15-16]. Honey bees also visit Sapodilla flowers for nector collection and in turn are involved in pollination [2].

Phytoconstituents

Various workers from time-to-time reported the presence of phytochemicals in leaf and seed extracts of Sapodilla. Mohanapriya *et al*. [17] demonstrated the extraction of various phytochemicals from *M. zapota* using three different solvents (acetone, chloroform and methanol extracts). These workers observed the presence of steroids, glycosides and saponins in low polar chloroform extract; steroids, phenols, glycosides and saponins in the high polar methanol extract and maximum number of phytoconstituents such as tannins, flavonoids, alkaloids, phenols, steroids, glycosides and saponins were present in the medium polar acetone extract. Presence of secondary metabolite in acetone extracts of *M. zapota* seeds had been earlier observed in various reports [18]. These phytoconstituents produced in the seeds and other plant parts of sapodilla are responsible for their antioxidant activities and pharmacological applications.

PHARMACOLOGICAL STUDIES

Antioxidant Activities

Antioxidants are the chemical compounds that act on oxidation chain reactions by inhibiting or delaying the oxidation of other molecules. Antioxidants protect the human body from harmful effects of free radicals and ROS (Reactive Oxygen Species) [19]. Almost all the medicinal plants contain several antioxidants such as carotenoids, flavonoids (flavones, isoflavones, flavonones, anthocyanins), polyphenols (ellagic acid, gallic acid, tannins), saponins, enzymes, vitamins (A, C, E, K) and minerals (copper, manganese, zinc, chromium, iodine, etc) [20]. Natural antioxidants are safer than synthesized antioxidants and they show anti-viral, anti-inflammatory, anti-cancer, anti-mutagenic, anti-tumour and hepatoprotective properties [21].These natural antioxidants are produced in all or any part of plants but mostly leaves are considered as the main source for their synthesis [21-22].

Chanda & Nagani [23] observed the antioxidant activities in the leaf extracts of *M. zapota* by sequential extraction using different solvents. The antioxidant potential of plant extracts evaluated by standard methods like DPPH (2, 2-diphenyl-1picrylhydrazyl), superoxide and hydroxyl radical scavenging activity, showed that the acetone extracts are better in DPPH radical and superoxide anion scavenging activity than the standard ascorbic acid and gallic acid. The high antioxidant capacity detected for acetone extracts of sapodilla indicates that this plant can be used as supplement in the foods conferring protection against oxidative damage [23]. Ganguly and Rahman [8] examined antioxidant potential of sapodilla and noticed increase in scavenging activity of DPPH radical with increasing concentration of the extracts.

Anti-diabetic Activities

Seeds, leaves and roots extracts of *M. zapota* have been reported to have hypoglycaemic activity due to the presence of various phytochemicals [24-26]. Saradha *et al*. [26] studied hypoglycemic activity using aqueous and ethanol extracts of sapodilla seeds, however it was found that the ethanolic extract produce better hypoglycaemic effect than the aqueous extract. Among the various phytochemicals produced by sapodilla plants, saponins are known to have anti-diabetic activity and have been studied in streptozotocin-induced diabetic rats for hypoglycemic effects where they show significant results [27]. Many other commonly used plants also contain saponins and proved to have hypoglycaemic activity such as *Allium sativum*, *Eugenia jambolana*, *Momordica charantia*, *Ocimum sanctum*, *Pterocarpus marsupium*, *Trigonella foenum graecum* and *Tinospora cordifolia* [28-34].

Anti-microbial Activity

Osman *et al*. [35] tested antimicrobial activities of *M. zapota* using ethyl acetate extracts of both stem-bark and leaves against some pathogenic bacteria and fungi and found that ethyl acetate extract of stem bark showed antimicrobial activity against all the pathogenic bacteria used (*Bacillus subtilis*, *Bacillus megaterium*, *Sarcina lutea*, *Escherichia coli* and *Salmonella typhi*) with zone of inhibition in the range of 08-16 mm whereas extracts of leaves had mild activity against these bacterial strains with inhibition zones in the range of 06-09 mm.

While examining the antifungal activity in *M. zapota*, Osman *et al*. [35] observed that ethyl acetate extract of stem bark showed positive effects against some fungal strains like *Aspergillus flavus*, *Fusarium* sp and *Vasianfactum* sp with zone of inhibition between 08 to 13 mm. Ethyl acetate extract of leaves had no antifungal activity. These studies indicate that the antibacterial constituents in bark and leaves of *M. Zapota* are present in very low concentrations and therefore they show antibacterial activities at high doses. Similar studies for evaluation of antimicrobial activity in *Woodferdia fruticosa* showed same results [36].

Anti-cancerous Activity

From the past few decades many natural products isolated from herbs have been screened for anti-cancerous activities in cancer cell lines and in some animal models [37]. The cytotoxic effects of Sapodilla fruit for anti-cancerous action are being studied now-a-days. Ma *et al*. [38] described Sapodilla fruits for their anticancerous potential where methyl 4-O-galloylchlorogenic acid and 4-O-galloylchlorogenic acid produced by Sapodilla fruits were examined for their cytotoxic effects on colon cancer cell lines. Later, Srivastava *et al*. [39] studied the cytotoxicity of methanolic extracts of Sapota fruit (MESF) and determined viability of cells in human and mouse breast cancer cell lines (EAC, MCF7 and T47D). All the three cell lines showed decrease in the cell viability at high doses of MESF. However, when cervical cancer cell line (HeLa) was tested for cytotoxic effects, it showed less sensitivity than breast cancer cell lines. Further studies by Srivastava *et al*. [39] on effect of Paclitaxel (an anti-cancerous plant derived compound) on NALM6, K562 and MCF7 cells showed a decrease in cell viability and found that NALM6 was most sensitive among all the cell lines tested. Sumithra *et al*. [40], however, reported that the flower extracts of *M. zapota* showed strong cytotoxic effects against MCF-7 breast cancer cell line while the non-cancerous Vero cell line revealed a very low activity.

Anti-cancer agents lead to activation of apoptosis during which reactive oxygen species (ROS) are produced and these ROS are then readily or gradually oxidised by antioxidants [41]. No ROS level was detected by fluorescence of DCFDA and flow cytometry upon MESF (fruit extract) treatment and this is clear by the fact that fruits contain high levels of antioxidants [39]. Since, fruits are good sources of antioxidants and polyphenolics, so dietary intake of fruits can serve as beneficial approach for the treatment of various cancers [42-43]. These studies suggest that sapodilla flowers and fruits possess anti-cancer property and their extracts can promote cytotoxicity in different cancer cell lines of varying origin.

Anti-arthritic Activity

Singh *et al*. [44] studied anti-arthritic effect of ethanolic extract of *Manilkara zapota* using *in-vitro* inhibition of protein denaturation model and found significant protection against denaturation of proteins suggesting the potential use of *Manilkara* as anti-arthritic agent.

Anti-inflammatory Activity

Konuku *et al*. [45] carried out *in vitro* and *in vivo* anti-inflammatory studies using ethyl acetate extract of *M. zapota* and the results showed significant anti-inflammatory activity over methanolic extracts which can be on account of presence of compounds such as flavonoids, terpenoids, steroids (glycosides, cardiac glycosides).

ETHNOMEDICINAL USES

Traditionally, the leaves of *M. zapota* have been used against cold, cough and diarrhoea [46] and have good potential for analgesic, antihyperglycemic and hypocholesterolemic activities [7, 47]. The decoction of bark is given in diarrhoea, dysentery and peludism and is also used as a tonic [3, 46]. Singh *et al*. [44] reported the use of gummy latex of sapodilla (chicle) to make chewing gums; however, its fruit are being used to treat diarrhoea and pulmonary diseases.

While, crushed seeds are used to treat stones of bladder and kidney as well as rheumatism, leaf decoction is used to cure fever, haemorrhage, wounds and ulcers. The bark of this plant is also traditionally used for the treatment of gastrointestinal disorder, fever and pain and inflammation [48-49]

Ripe fruits are known to contain tannins providing astringent, antioxidant, antiviral, antibacterial and anti-inflammatory properties to the plant, useful for treating indigestion, diarrhoea, dysentery and haemorrhage. Fruit and flower decoction is expectorant, taken for diarrhoea, treats pulmonary problems, boosts nervous system functions treats depression, stress, anxiety and insomnia. Fruit also have got antispasmodic value that helps in treatment of muscle spasms and pains and also inhibit growth of breast and colon cancers. Seeds contain saponins and quercitin, used as tonic, antibacterial, antipyretic, febrifuge and laxative. While, seed paste is effective against stings and venomous bites, seed juice is known to have diuretic and antihistamine qualities, effective against anxiety and depression, removes bladder and kidneys stone [50].

CONCLUSION

From above review, it is clear that Sapodilla is an important minor fruit crop and can be considered as one of the healthy fruits because of the presence of various nutritious components in it. Apart from this, large numbers of phytochemicals have been reported from the plant by various researchers from time to time that are responsible for many biological effects such as anti-inflammatory, anti-arthritis, anti-bacterial, anti-fungal, anti-oxidant, anti-tumor and anti-diabetic activities. Despite being economically and medicinally important, it has not gained popularity because of high degree of perish ability. Present communication was therefore aimed to gather the available literature, of course scarce, describing the correlation between the physiology, biochemistry, and nutritional attributes of the plant. By doing so, we can provide a gathered information for further research purposes because this plant has huge potential to improve postharvest quality and marketing possibilities of sapota fruit life as well as nutritional quality.

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