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A systematic review of phytochemical and pharmacological studies of *Manilkara Zapota*

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Abstract
Plants play a crucial role in human health, providing essential nutrients, bioactive compounds, and therapeutic benefits. *Manilkara zapota* (sapodilla), a member of the Sapotaceae family, is a tropical fruit-bearing tree renowned for its nutritional and medicinal significance. Distributed across Central America, the Caribbean, and tropical Asia, it thrives in well-drained soils under moderate climatic conditions. Various parts of *M. zapota*—including leaves, seeds, fruits, and bark—contain diverse phytochemicals such as phenolic compounds, flavonoids, tannins, triterpenoids, and glycosides, which underlie its broad spectrum of pharmacological activities. Ethnopharmacological studies have documented its traditional use in treating gastrointestinal disorders, fever, pain, and inflammatory conditions. Modern pharmacological research supports these uses, demonstrating anti-inflammatory, hypoglycemic, anti-lipidemic, analgesic, anticancer, antimicrobial, antioxidant, antiulcer, neuroprotective, immunomodulatory, hepatoprotective, anthelmintic, CNS depressant, and anti-pyretic activities. These effects are attributed to its rich array of bioactive constituents, including quercetin, myricetin, catechin, lupeol acetate, oleanolic acid, and zapotin. Collectively, the evidence positions *M. zapota* as a promising natural source for functional foods, nutraceuticals, and pharmaceutical development. This review article provides more scientific information about the plant to the researcher who carries the phytochemical and pharmacological screening of the scientific plant.

Keywords: Manilkara zapota, phytochemical constituents, ethnopharmacology, bioactive compounds, pharmacological activities

Introduction

Plants are a fundamental part of the environment and greatly enhance life on Earth by supplying food, oxygen, medicines, and numerous economic benefits. They contain a wide range of active compounds that are essential in the treatment of many diseases. The botanical significance of plants lies in their ability to contribute a broad spectrum of biological activities [1].

Sapodilla (*Manilkara zapota*) is a highly nutritious fruit belonging to the Sapotaceae family and is commonly grown in regions ranging from tropical wet climates to subtropical cool and dry areas. It is known by several names, including chiko, sapota, naseberry, and sapodilla, across American, Asian, and European countries [2].

The family comprises approximately 70 genera and around 800 species of trees. Within the genus *Manilkara*, about 85 species have been identified [3].

Regarding the medicinal significance of *M. zapota*, it is considered one of the most important plant species used in the treatment of various ailments due to its rich content of diverse phytochemicals [4].

A wide range of phytochemicals have been isolated from different parts of the plant, and various components of the tree have traditionally been used to treat ailments such as dysentery, fever, and diarrhoea [5].

Phytochemical investigations have shown that the plant primarily contains phenolic compounds such as protocatechuic acid, quercitrin, myricitrin, catechin, gallic acid, vanillic acid, caffeic acid, syringic acid, coumaric acid, and ferulic acid [6].

The leaves of sapodilla contain major constituents such as lupeol acetate, oleanolic acid, apigenin-7-O-α-L-rhamnoside, myricetin-3-O-α-L-rhamnoside, and caffeic acid. Studies by Ganguly and Rahman have shown that sapodilla leaves exhibit cytotoxic, antioxidant, antimicrobial, and mild central nervous system depressant activities, indicating their potential therapeutic use against cancer, tumors, infectious diseases, and oxidative stress [4].

Bioactive compounds identified in *M. zapota* include tannins, flavonoids, and triterpenoids. In addition, the leaves and seeds are rich in triterpenes, tannins, and polyphenols, which have been studied for their potential medicinal benefits [7].

Synonyms

Sapodilla has been referred to in the literature by numerous synonyms, including *Achras sapota* L., *Achras zapota* L. var. *zapotilla* Jacq. *Achras zapotilla* Nutt. *Achras mammosa* L., *Manilkara achras* (Miller) Fosberg, *Manilkara zapotilla* (Jacq.) Gilly, *Sapotazapotilla* (Jacq.) Coville, *Sapota achras* Miller, and *Sapota zapotilla* (Coville), among others [4].

Distribution

Most *Manilkara zapota* plants thrive in tropical climates around the world. They are widely cultivated across the Caribbean islands and Central America, where they grow into large forest trees. The species is native to northeastern Guatemala, northern Belize, and southern Mexico. It is a well-known fruit tree, produced in large quantities in Mexico and tropical Asian countries such as Bangladesh, India, Pakistan, Thailand, Malaysia, Cambodia, Vietnam, and Indonesia (Kirtikar and Basu, 1956; Bhowal *et al*., 2014).

Habitat

Manilkara zapota grows best in environments with medium to full shade and generally does not require irrigation. The species thrives at temperatures ranging from 12°C to 36°C, avoiding extremes of heat or cold. It prefers dark, well-drained alluvial sandy loam soil with a pH of 6–8. The optimal periods for sowing sapota seeds are February to March and August to October to maximize yield.

Commonly used fertilizers include farmyard manure (FYM), phosphorus, potassium, and nitrogen (Karle *et al*., 2019) [8].

Botanical description

Manilkara zapota trees are evergreen with a spreading habit and can live up to 100 years. The tree canopy can be categorized into four types: erect-growing, with drooping branches, spreading branches bearing sweet fruits, and spreading branches with inferior fruits. Trees can reach a height of up to 8 meters and develop a strong trunk with regularly spaced scaffolds. The bark contains abundant white, gummy latex known as chicle. Leaves are medium green, glossy, alternate, and range from elliptic to ovate, measuring 7–15 cm in length with an entire margin.

Manilkara zapota flowers grow singly or in clusters in the leaf axils near the branch tips. They are small, bisexual, off-white, bell-shaped, and approximately 3/8 inch (9.5 mm) in diameter. Each flower has six sepals and six petaloid stamens. The flowers are protogynous, meaning the stigma becomes receptive before the stamens release pollen, making sapota a cross-pollinated (allogamous) crop.

The fruit is a large, ellipsoid berry with flesh that ranges from pale yellow to earthy brown and has a grainy texture. The pulp is sweet to very sweet with a pleasant flavor. Each fruit typically contains 3–5 or more shiny black seeds, resembling beans with a hook at one end that can pose a choking hazard if swallowed. Seedless fruits are also occasionally observed (Singh, 1995) [10].

Taxonomical Nomenclature [10]

The classification of Genus *Manilkara* is as follows:

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.* (Manilkara)
Species	*M. zapota* (L.)

Manilkara Zapota Plant

Vernacular names of *Manilkara zapota* [4]

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

Country	Common/Vernacular names
Brazil	Sapota, 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

Phytochemistry of *Manilkara zapota*

Numerous studies have been conducted to analyze the phytochemical composition of various parts and extracts of *M. zapota*.

- **Leaves:** Contain hydrocarbons, sterols, lupeol-3-acetate, oleanolic acid, apigenin-7-O-α-L-rhamnoside, caffeic acid, myricetin-3-O-α-L-rhamnoside (5, 7, 3′, 4′, 5′-pentahydroxyflavon-3-O-α-L-rhamnoside), tannins, phlobatannins, saponins, cardiac glycosides, flavonoids, terpenoids, steroids, alkaloids, and other phenolic compounds.

- **Fruits:** Contain cyanogenic glycosides, phenolic compounds, terpenoids, sapotin, saponins, achrassaponin, fixed oils, 3-O-acyl-L-rhamnose, L-arabinose, 3-O-acetyl-D-methyl galacturonate, methyl 4-O-galloylchlorogenate, 4-O-galloylchlorogenic acid, methyl chlorogenate, dihydromyricetin, quercitrin, myricitrin, (+)-catechin, (–)-epicatechin, (+)-gallocatechin, and gallic acid.

- **Bark:** Contains saponins, gums, reducing sugars, tannins, flavonoids, phenolic compounds, alkaloids, steroids, amino acids, proteins, anthraquinone glycosides, deoxy sugars, and terpenoids.

- **Seeds:** Preliminary screening of various solvent extracts revealed the presence of alkaloids, flavonoids, saponins, tannins, phenolic compounds, carbohydrates, proteins, fats, and oils.

This diverse phytochemical profile highlights the therapeutic potential of *M. zapota* across its different plant parts [11].

The fruits of *M. zapota* are a good source of edible sugars and contain significant amounts of protein, fiber, fats, and minerals such as iron, calcium, and phosphorus. The leaves and seeds of *M. zapota* (MZ) contain compounds like D-quercitol, myricetin-3-O-α-L-rhamnoside, zapotin, zapotinine, and sucrose. Major phytoconstituents identified across various parts of the plant—including leaves, flowers, fruits, stems, and roots—include methyl chlorogenate, quercetin, (+)-catechin, (–)-gallocatechin, myricitrin, (–)-epicatechin, polyphenol oxidase, and β-carotene. Additionally, the roots of MZ were found to contain the amino acids arginine and lysine [12].

Traditional Uses of *Manilkara zapota*

Manilkara zapota (Sapotaceae) is a significant medicinal plant with a variety of ethnopharmacological applications.

In the Ayurvedic system of medicine, a decoction of its leaves is traditionally used to treat cough, cold, and diarrhoea. The leaves have been reported to exhibit antioxidant, antimicrobial, analgesic, antihyperglycemic, and hypocholesterolemic activities. The bark serves as a tonic, and its decoction is used to manage diarrhoea, dysentery, and peludism. Additionally, the bark has been traditionally employed for treating gastrointestinal disorders, fever, pain, and inflammatory conditions [13].

Pharmacological Activities of Manilkara Zapota

1. Anti Inflammatory activity

The crude methanolic extract of the bark of *Manilkara zapota* (Molina) Standley (Family: Sapotaceae), collected in Bangladesh, was evaluated for its anti-inflammatory activity and total flavonoid content. The anti-inflammatory effects were assessed using carrageenan- and histamine-induced rat paw edema tests at doses of 200 and 400 mg/kg body weight. At 400 mg/kg, the extract demonstrated significant anti-inflammatory activity in both models, reducing paw volume by 59.72% and 60.0%, respectively, which was comparable ($P<0.01$) to the standard drug indomethacin (62.50% and 65.16%) at 4 hours. The extract's inhibition of paw edema at 400 mg/kg was also statistically significant ($P<0.05$; $P<0.01$) at 1, 2, and 3 hours, closely matching the effects of indomethacin.

The total flavonoid content of the methanolic bark extract was high, measured at 169.37 mg/g quercetin equivalent. Acute toxicity testing indicated that the plant is likely safe for pharmacological use. These findings support both the acute anti-inflammatory activity and the rich flavonoid content of the methanolic bark extract, providing scientific validation for its traditional use as a remedy for pain and inflammation [14].

2. Hypoglycemic Activity

The hypoglycemic activity of *Manilkara zapota* was evaluated using petroleum ether extracts of leaves and methanol extracts of seeds. In the oral glucose tolerance test, mice were administered 2 mg/kg glucose solution, and blood glucose levels were measured at 15, 30, 60, 90, and 120 minutes post-administration. Diabetes was induced in mice via intravenous injection of alloxan (70 mg/kg). The hypoglycemic study was conducted over a period of 7 days.

In the glucose tolerance test, all extracts produced highly significant reductions in blood glucose levels ($p<0.0001$) at 60, 90, and 120 minutes compared to the glucose control. During the 7-day hypoglycemic study, the extracts began lowering blood glucose levels rapidly, with significant effects observed from the 2nd day of treatment ($p<0.0001$). These results demonstrate the strong hypoglycemic potential of the leaf and seed extracts of *M. zapota* [15].

3. Anti lipidemic Activity

The aim of this study was to evaluate the effect of *Manilkara zapota* (sapodilla) leaf extract on the lipid profiles of alloxan-induced diabetic mice. A total of 30 male mice were randomly divided into five groups, each containing six mice: non-diabetic control, diabetic control, diabetic mice treated with pioglitazone (2 mg/kg BW), diabetic mice treated with sapodilla leaf extract at 100 mg/kg BW, and diabetic mice treated with sapodilla leaf extract at 300 mg/kg BW.

On the 14th day of treatment, mice were lightly anesthetized, and serum lipid profiles—including total cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL), and low-density lipoprotein (LDL)—were measured using Pars Azmoon diagnostic kits and an automatic analyzer (Abbot, Alcyon 300).

- **Total Cholesterol (TC):** Significant reductions were observed in the pioglitazone and 100 mg leaf extract groups compared to all other treatments.
- **Triglycerides (TG):** Significant reductions were seen in the pioglitazone and 300 mg leaf extract groups.
- **LDL:** Significant differences were observed in the 100 mg and 300 mg leaf extract groups, as well as the pioglitazone group, compared to the negative and diabetic controls.
- **HDL:** Significant differences were noted between the negative control and the 300 mg leaf extract group compared to the 100 mg leaf extract, pioglitazone, and diabetic control groups.

The study concluded that ethanol extracts of *M. zapota* leaves contain several phytochemicals, including alkaloids, flavonoids, saponins, polyphenols, tannins, quinones, and steroids. Administration of the leaf extract at 100 mg/kg and 300 mg/kg significantly improved the lipid profile in diabetic mice [16].

4. Anti Analgesic Activity

The ethanolic extract of *Manilkara zapota* seeds demonstrated a significant analgesic effect compared to the control in a standard analgesic screening method. The effect peaked at 60 and 90 minutes. Administration of 200 mg/kg of the seed extract significantly increased reaction time in the Eddy's hot plate test, indicating potent analgesic activity. The study concluded that *M. zapota* seed extract has notable pain-relieving properties, suggesting its potential use in multi-drug therapy for analgesia. However, further research is needed to isolate and characterize the specific active compound(s) responsible for this effect [17].

5. Anticancer Activity

This study investigated the *in vivo* antitumor activity of the ethyl acetate extract of *Manilkara zapota* leaves (EALM) against Ehrlich ascites carcinoma (EAC). The extract was evaluated at doses of 50, 100, and 200 mg/kg/day. Intraperitoneal administration of EALM at 100 and 200 mg/kg/day resulted in a significant increase in survival time, along with a decrease in viable EAC cell count and body weight gain in tumor-bearing mice.

Treatment with EALM also improved altered hematological parameters, including hemoglobin content and red and white blood cell counts, in EAC-bearing mice. These results indicate the antitumor potential of EALM. Additionally, erythrodiol, isolated for the first time from EALM, demonstrated a 70.8% reduction in viable tumor cell count compared to untreated controls [18].

6. Anti Bacterial Activity

Ethanol extracts of the leaves and stem bark of *Manilkara zapota* (L.) were evaluated for their antimicrobial activity and phytochemical composition. The agar gel diffusion

method was used to assess their inhibitory effects against five Gram-positive and eight Gram-negative bacteria. The bark extract at 400 µg/disc exhibited significant antibacterial activity against all tested bacteria, with zones of inhibition ranging from 7 to 13.5 mm. The leaf extract showed comparatively lower activity at the same concentration and was ineffective against *Staphylococcus aureus* among the thirteen bacteria tested. Kanamycin (30 µg/disc) served as the standard antimicrobial agent, producing zones of inhibition from 16.5 to 25 mm. Preliminary phytochemical screening of both extracts revealed the presence of alkaloids, flavonoids, saponins, and tannins [19].

7. Anti Oxidant Activity

The antioxidant potential of *Manilkara zapota* L. leaf extracts, obtained through sequential extraction using solvents of varying polarity, was evaluated using four *in vitro* assays: DPPH radical scavenging, superoxide radical scavenging, hydroxyl radical scavenging, and reducing capacity assessment. The acetone extract demonstrated the strongest DPPH radical scavenging activity with an IC_{50} of 20 µg/ml, comparable to the standard ascorbic acid (IC_{50} = 11.4 µg/ml). Its superoxide anion scavenging activity (IC_{50} = 140 µg/ml) was superior to that of gallic acid (IC_{50} = 185 µg/ml), and it also exhibited good reducing capacity.

The high antioxidant activity of the acetone extract is likely attributed to its elevated phenolic content. These findings suggest that *M. zapota* leaf extract could serve as a natural additive in the food industry to protect against oxidative damage. However, confirmation of its antioxidant activity in *in vivo* models is necessary. The study also emphasizes that there is no single universal criterion for antioxidant activity in plants, highlighting the importance of using multiple assays and solvents when evaluating a plant's antioxidant potential ([Nature and Science 2010; 8(10):260–266], ISSN: 1545-0740) [20].

8. Anti Nociceptive and Anti Diarrhoeal Activity

Ethanol extract (400 mg/kg), petroleum ether fraction (400 mg/kg), and ethyl acetate fraction (400 mg/kg) of *Manilkara zapota* demonstrated significant peripheral antinociceptive activity, with writhing inhibition of 59.89%, 58.24%, and 46.7% ($p < 0.001$), respectively, comparable to standard diclofenac (59.34% inhibition). The ethanol extract (400 mg/kg) and petroleum ether fraction (400 mg/kg) also exhibited notable central analgesic activity, showing 74.15% and 82.15% elongation of reaction time at 90 minutes post-administration ($p < 0.001$), similar to morphine (85.84% elongation).

In antidiarrheal screening, the ethanol extract at doses of 200 and 400 mg/kg significantly inhibited defecation by 53.57% and 60.71% ($p < 0.001$), respectively, compared with loperamide (71.42%). These results indicate that *M. zapota* extracts possess potent peripheral and central analgesic as well as antidiarrheal activities [13].

9. Anti-Ulcer Activity

Phytochemical analysis of the ethanolic stem bark extract of *Manilkara zapota* revealed the presence of flavonoids and phenolic compounds. The free radical scavenging properties of these compounds play a key role in ulcer healing. *In vivo* antioxidant studies showed a significant increase in glutathione (GSH) levels and a reduction in malondialdehyde (MDA) levels in extract-treated groups. Therefore, the potential mechanism for the healing of ulcerative colitis by the ethanolic stem bark extract of *M. zapota* is likely due to its antioxidant and free radical scavenging activities, which are primarily attributed to the flavonoid and phenolic content [21].

10. Anti Parkinsonism Activity

Parkinson's disease (PD) is a prevalent neurodegenerative disorder characterized by motor symptoms such as bradykinesia, tremors, and muscle rigidity. Oxidative stress plays a central role in PD pathogenesis, contributing to neuronal damage and loss. Phenolic and flavonoid compounds, known for their antioxidant properties, can mitigate oxidative stress and may offer therapeutic benefits in neurodegenerative diseases like PD.

The ethanolic extract of *Manilkara zapota* (EEMZ) contains significant levels of these bioactive compounds, suggesting its potential as a neuroprotective agent. In a study using haloperidol-induced Parkinsonism in Swiss albino mice, EEMZ improved motor function, muscle strength, and coordination while enhancing antioxidant enzyme levels in the brain. Histopathological analysis further revealed structural improvements in brain regions affected by PD-like pathology.

These results highlight the promise of *M. zapota* as a natural neuroprotective agent for Parkinson's disease. Future research should focus on elucidating the molecular mechanisms, identifying the active constituents responsible for its neuroprotective effects, and conducting long-term efficacy and safety studies across diverse PD models to explore its potential clinical applications [22].

11. Immunomodulatory activity

Background: Diabetes mellitus (DM) is one of the most prevalent metabolic disorders worldwide, characterized by chronic inflammation of pancreatic β-cells. Modulating the immune response to enhance anti-inflammatory molecules may help alleviate this disease. This study aimed to evaluate the immunomodulatory effects of unripe sapodilla fruit (USF) extract by examining TNF-α and IFN-γ expression from CD4 T cells, CD4 CD25 IL-10 levels, and malondialdehyde (MDA) in a type 1 diabetes mellitus (T1DM) model.

Methods: USF was extracted with water using maceration followed by freeze-drying. Phytochemical profiling was performed using Liquid Chromatography-High Resolution Mass Spectrometry (LC-HRMS). Twenty-five male BALB/c mice were randomly divided into five groups (n=5). T1DM was induced with a single high dose of streptozotocin (STZ, 145 mg/kg BW, intraperitoneally). USF extract was administered orally once daily for 14 days. Blood glucose and body weight were monitored every three days. Splenic cells were immunostained for flow cytometric analysis, and data were analyzed using ANOVA with $p \leq 0.05$ considered significant.

Results: LC-HRMS analysis identified 12 major bioactive compounds in the aqueous USF extract, exhibiting anti-diabetic, anti-inflammatory, free radical scavenging, and NF-κB inhibitory activities. Administration of USF reduced blood glucose levels in diabetic mice, though not significantly. Expression of CD4 TNF-α, CD4 IFN-γ, and MDA decreased, while CD4 CD25 IL-10 expression increased following USF treatment.

Conclusion: USF extract demonstrates immunomodulatory activity by regulating inflammatory cytokines in a non-dose-dependent manner. It enhances IL-10, an anti-inflammatory cytokine, to suppress TNF-α and IFN-γ, and reduces MDA levels through its antioxidant properties, contributing to the suppression of inflammatory cytokines in diabetic mice [23].

12. Anti Microbial Activity

The present study aimed to evaluate the antimicrobial activity of *Manilkara zapota* (L.). Ethyl acetate extracts of the stem bark and leaves were tested against several pathogenic bacteria and fungi. Thin-layer chromatography (TLC) profiling of the extracts revealed the presence of terpenoids, glycosides, and flavonoid-type compounds.

The ethyl acetate extract of the stem bark exhibited antimicrobial activity against all tested pathogenic bacteria and also showed activity against fungi, including *Aspergillus flavus*, *Vasianfactum* sp., and *Fusarium* sp., with inhibition zones ranging from 8 to 16 mm. In contrast, the leaf extract displayed mild activity against *Bacillus subtilis*, *Bacillus megaterium*, *Sarcina lutea*, *Escherichia coli*, and *Salmonella typhi*. The minimum inhibitory concentrations (MICs) of the extracts ranged from 256 to 512 µg/ml.

Cytotoxicity was evaluated using brine shrimp (*Artemia salina*) nauplii, showing LC_{50} values of 16.17 µg/ml for the leaf extract, 50.26 µg/ml for the stem bark extract, and 12.38 µg/ml for the standard drug ampicillin trihydrate. These results indicate that *M. zapota* possesses notable antimicrobial and cytotoxic activities, with stem bark extract being more potent than the leaf extract [24].

13. Anti Fungal Activity

The study aimed to evaluate the antifungal activity of extracts from two plant species against *Aspergillus Niger* and *Candida albicans*, selected based on their ethnobotanical uses. Hydroalcoholic extracts of the seeds of *Annona squamosa* (L.) and *Manilkara zapota* (L.) were tested for antifungal activity. Both extracts demonstrated broad-spectrum and significant antifungal effects, producing clear zones of inhibition against the two microorganisms. The findings suggest that the seed extracts of *Annona squamosa* and *Manilkara zapota* may serve as potential sources of antifungal compounds for treating fungal infections, showing notable activity even at low concentrations [25].

14. Anthelmintic Activity

Manilkara zapota is an evergreen tree recognized for its medicinal properties against various ailments. This study aimed to evaluate the phytoconstituents, antioxidant, and anthelmintic activities of hydro-ethanolic and petroleum ether extracts prepared from a combination of seeds and leaves of *M. zapota*.

Phytochemical screening revealed the presence of alkaloids, flavonoids, and phenolic compounds in both extracts. The hydro-ethanolic extract exhibited higher levels of total flavonoids and phenolics, with total flavonoid content measured at 433.6 ± 6.62 mg quercetin equivalent/g extract and total phenolic content at 170.3 ± 5.55 mg gallic acid equivalent/g extract. In DPPH radical scavenging assays, the hydro-ethanolic extract showed significant antioxidant activity, whereas the petroleum ether extract displayed negligible antioxidant effects.

The hydro-ethanolic extract also demonstrated strong anthelmintic activity against adult *Pheretima posthuma* earthworms, showing mortality rates comparable to the standard drug albendazole. Complementing the experimental study, molecular docking analyses were conducted to investigate interactions of optimized compounds with amino acid residues in the active site of human GABA receptor (4MS3). Compounds with favorable docking scores corresponded well with the observed *in vitro* anthelmintic activity. Additionally, ProTox was used to predict the toxicity of the most promising compound, supporting its safety profile.

Overall, this study highlights the hydro-ethanolic extract of *M. zapota* leaves and seeds as a potent source of antioxidants and anthelmintic agents, with computational studies corroborating the experimental findings [26].

15. Hepatoprotective and lipid lowering Activity

The tropical fruit sapodilla (*Manilkara zapota* syn. *Achras zapota*) is a nutrient-rich source of minerals and diverse bioactive phytochemicals, including flavonoids and catechins. Pharmacological studies have demonstrated its anti-bacterial, anti-parasitic, anti-fungal, antiglycative, hypocholesterolemic, and anti-cancer properties. However, its effects on hepatic tissue and serum lipids remain less explored.

To investigate this, an *in vivo* study was conducted using a carbon tetrachloride (CCl_4)-induced liver damage model in rats to assess the effects of lyophilized sapodilla extract (LSE). CCl_4 exposure elevated serum biomarkers of liver injury—such as aspartate transaminase, alanine aminotransferase, γ-glutamyl transferase, and alkaline phosphatase—as well as bilirubin, while disrupting serum lipid profiles (cholesterol and triglycerides). Treatment with LSE at doses of 250 and 500 mg/kg significantly and dose-dependently reversed these changes.

Histological examination revealed that LSE reduced structural liver damage caused by CCl_4. Furthermore, assessment of oxidative stress markers demonstrated that LSE mitigated CCl_4-induced increases in malondialdehyde and preserved non-protein sulfhydryl levels. *In vitro* assays, including DPPH and β-carotene-linoleic acid tests, confirmed the strong antioxidant activity of LSE.

In conclusion, lyophilized sapodilla extract exhibits hepatoprotective and lipid-lowering effects against CCl_4-induced liver injury, effects that are at least partially mediated by its potent antioxidant properties [27].

16. Anti Pyretic Activity

In an anti-pyretic study using yeast-induced pyrexia in albino Wistar rats, the ethanol extract of *Manilkara zapota* leaves (300 mg/kg) significantly reduced body temperature from 37.90°C to 37.41°C ($P < 0.01$) at the 3rd hour and to 37.07°C ($P < 0.001$) at the 4th hour. Similarly, both petroleum ether and ethyl acetate fractions demonstrated significant anti-pyretic effects ($P < 0.001$), with the petroleum ether fraction showing the maximum temperature reduction to 36.86°C. These results indicate that *M. zapota* leaves possess notable anti-pyretic activity, suggesting their potential therapeutic use in managing fever [28].

17. CNS Depressant Activity

This study also demonstrated that *Manilkara zapota* leaves exhibit mild CNS depressant activity, as evidenced by the

phenobarbitone-induced sleep test. The extract increased the duration of sleep in experimental animals, an effect that may be attributed to compounds capable of inducing sedation or hypnosis. This action is likely mediated through potentiation of GABAergic neurotransmission, enhancing postsynaptic inhibition via allosteric modulation of GABA receptors [29].

Conclusion

Manilkara zapota (sapodilla) is a highly valuable plant species with substantial nutritional, medicinal, and pharmacological significance. Its diverse phytochemical profile—including phenolic compounds, flavonoids, tannins, triterpenoids, and bioactive secondary metabolites—underpins its wide-ranging therapeutic potential. Various parts of the plant, such as leaves, seeds, fruits, and bark, exhibit multiple biological activities, including anti-inflammatory, hypoglycemic, anti-lipidemic, analgesic, anticancer, antimicrobial, antioxidant, antiulcer, neuroprotective, immunomodulatory, hepatoprotective, anthelmintic, and CNS depressant effects. Traditional uses of M. zapota for gastrointestinal disorders, fever, pain, and other ailments are strongly supported by modern pharmacological studies, validating its role in ethnomedicine.

This review article provides more scientific information about the plant to the researcher who carries the phytochemical and pharmacological screening of the scientific plant.

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References

1. Priyanka S, Aakash D, Harish K, Nitin B, Sanjiv K, Davinder K. *et al*. Pharmacological potential of Manilkara zapota (L.) P. Royen (Sapodilla): a narrative review. Journal of Traditional Chinese Medicine,2024:44(2):403.
2. Bangar SP, Sharma N, Kaur H, Kaur M, Sandhu KS, Maqsood S, *et al*. A review of Sapodilla (Manilkara zapota) in human nutrition, health, and industrial applications. Trends in Food Science Technology,2022:127:319-34.
3. Yong KY, Shukkoor MS. Manilkara zapota: A phytochemical and pharmacological review. Materials Today: Proceedings,2020:29:30-3.
4. Bano M, Ahmed B. Manilkara zapota (L.) P. Royen (Sapodilla): a review. International Journal of Advance Research, Ideas and Innovations in Technology,2017:3(6):1364-71.
5. Gam S, Ahmed R, Kashyap B, Sarma H, Sahariah BJ, Bora NS, *et al*. A systematic review on traditional use, phytochemistry and pharmacological activities of Manilkara zapota. Pharmacological Research-Natural Products,2024:4:100062.
6. Bashir S. Pharmacological importance of Manilkara zapota and its bioactive constituents. Boletín Latinoamericano y del Caribe de Plantas Medicinales y Aromáticas, 2019, 8(4).
7. Febriza A, Usman F, Rasyid AU, Idrus HH, Mokhtar MH. Potential role of Manilkara Zapota L in treating bacterial infection. PeerJ,2024:12:17890.
8. Alamgir SB, khatun a, nijhu rs. a review on the traditional uses, phytochemistry and pharmacology of manilkara zapota linn.
9. Srivastava AK, Kashyap P, Meena VS, Verma N, Singh SP. Sapota [Manilkara achras (Mill.) Fosberg (Syn: Achras zapota L.)]. Ghosh SN, Singh A, Thakur A., editors. Underutilized fruit crops: importance and cultivation. New Delhi: Jaya Publishing House, 2017, 1159-94.
10. Anjali VG, Dhiman A, Dutt R, Ranga S. The genus manilkara: an update. The Pharma Innovation Journal,2018:7(1):316-8.
11. Yong KY, Shukkoor MS, Chin JH. Analgesic activity of chloroform and methanolic leaf extracts of Manilkara zapota. Materials Today: Proceedings,2020:29:20-5.
12. Rani A, Gupta T, Kangra K, Garg V, Dutt R. Evaluation of antioxidant, antibacterial and anticancer activity of fruit and leaf extracts of manilkara zapota against a431 skin cancer cell lines. South African Journal of Botany,2023:153:219-26.
13. Ganguly A, Al Mahmud Z, Kumar Saha S, Abdur Rahman SM. Evaluation of antinociceptive and antidiarrhoeal properties of Manilkara zapota leaves in Swiss albino mice. Pharmaceutical biology,2016:54(8):1413-9.
14. Hossain MH, Jahan F, Howlader MS, Dey SK, Hira A, Ahmed A, *et al*. Evaluation of antiinflammatory activity and total flavonoids content of Manilkara zapota (linn.) bark. International Journal of Pharmaceutical and Phytopharmacological Research,2012:2(1):35-9.
15. Paul SR, Hakim ML. *In vivo* hypoglycemic study of Manilkara zapota leave and seed extracts. Bangladesh Journal of Pharmacology,2015:10(1):246-50.
16. Solikhah TI, Wijaya TA, Pavita DA, Miftakhurrozaq RK, Raharjo HM, Yunita MN, *et al*. The effect of sapodilla leaf extract (Manilkara zapota L.) on lipid profiles of alloxan-induced diabetic mice. Pharmacognosy Journal, 2023, 15(2).
17. Ramanna M, Priyadarsini KS, Janti SS, Annamalai M, Eerike M, Sri MN. *et al*. Evaluation of the analgesic activity of ethanolic extract of Manilkara zapota seeds in experimental animal model. Biomedical and Pharmacology Journal,2023:16(3):1797-803.
18. Rashid MM, Hossain MI, Osman MA, Aziz MA, Habib MR, Karim MR. *et al*. Evaluation of antitumor activity of Manilkara zapota leaves against Ehrlich ascites carcinoma in mice. Environ Exp Biol,2014:12:131-5.
19. Islam MR, Parvin MS, Banu MR, Jahan N, Das N, Islam ME. *et al*. Antibacterial and phytochemical screening of ethanol extracts of Manilkara zapota leaves and bark. International Journal of Pharma Sciences,2013:3(6):394-7.
20. Chanda SV, Nagani KV. Antioxidant capacity of Manilkara zapota L. leaves extracts evaluated by four *in vitro* methods. Nature and science,2010:8(10):260-6.
21. Kumar A, Sahoo HB. Preliminary pharmacological evaluation of stems bark extract for Manilkara zapota ulcerative colitis in rats. Adv Pharm J,2020:5(4):144-8.

22. Banu Z, Samreen S, Mujeeb SA. Evaluation of Antiparkinsonism Activity of Manilkara zapota (L.) P. Royen Leaf Extract in Haloperidol-Induced Parkinsonism in Swiss Albino Mice. Indian Journal of Pharmaceutical Education and Research,2025:59(1s):s179-89.
23. Sari FN, Samoedra RS, Pratama SK, Rahayu S, Soewondo A, Jatmiko YD, *et al*. Immunomodulatory Effects of Unripe Sapodilla (Manilkara zapota) Fruit Extract Through Inflammatory Cytokine Regulation in Type 1 Diabetic Mice. Jordan Journal of Biological Sciences, 2023, 16(2).
24. Osman MA, Aziz MA, Habib MR, Karim MR, Rezaul M. Antimicrobial investigation on Manilkara zapota (L.) P. Royen. Int J Drug Dev Res,2011:3(1):185-90.
25. Koushik OS, Babu PS, Karthikeyan R. Phyto chemical screening and evalution of anti-fungal activity on the seed extracts of annona squamosa (l) and manilkara zapota (L.). CIB Tech Journal of Biotechnology,2017:6(1):8-11.
26. Tiwari A. Phytochemical Profiling and Anthelmintic Activity of Manilkara zapota L.(Chiku) Extracts: An Integrated *In-vitro* and In-silico Approaches.
27. Alrashood ST, Al-Asmari AK, Alotaibi AK, Manthiri RA, Rafatullah S, Hasanato RM, *et al*. Protective effect of lyophilized sapodilla (Manilkara zapota) fruit extract against CCl4-induced liver damage in rats. Saudi Journal of Biological Sciences,2020:27(9):2373-9.
28. Ganguly A. In-*vivo* anti-inflammatory and anti-pyretic activities of Manilkara zapota leaves in albino Wistar rats Asian Pacific Journal of Tropical Disease.
29. Ganguly A, Rahman SA. Evaluation of the cytotoxic, antimicrobial, antioxidant, anthelmintic and cns depressant activities of Manilkara zapota leaf (Sapotaceae). World Journal of Pharmaceutical Research,2014:4(1):272-83.