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*Review Article*

# *Manilkara zapota* (L.) Royen Fruit Peel: A Phytochemical and Pharmacological Review

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## ABSTRACT

*Manilkara zapota* (L.) Royen fruit is a popular fruit crop commonly cultivated in most of the tropical reasons and used for its nutritional values over the world. Two varieties of the fruit are available, round and elongated. Present review revealed the scientific information on the phytochemicals and pharmacological evaluations of *Manilkara zapota* (L.) Royen fruit peel (MZFP), a juice byproduct often considered as a waste or garbage. MZFP constitutes about 20 % of the fruit. The literature survey postulate that main phenolic compounds are primarily concentrated in the peel portion of this fruit which includes, flavonoids, tannins, phenolic acids, hydroxybenzoic acids (p-hydroxybenzoic, gallic and ellagic), flavanols (catechin and epicatechin), flavonols (quercetin), hydroxycinnamic acids (ferulic, chlorogenic and trans-cinnamic), kaempferol, 5-caffeoyl quinic acid conjugates and lycopene a carotenoid. It is generally accepted that bioactive components can be more efficiently recovered from MZFP by optimizing the extraction condition or efficiency. A widespread assessment of phytochemicals is included while possible mechanisms and phytochemicals involved have been correlated. The curative relevance of these compounds has been mainly evaluated by *in vitro* experimentation. Therefore, convincing clinical trials of the bioactive principles present in MZFP are essential for correct validation of their health benefits.

**Key words:** Flavonoids, *Manilkara zapota* (L.) Royen fruit peel, Phenolics, Pharmacological activities.

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## INTRODUCTION

From last few decades more focus was emphasis on the identification of new chemical moieties (NCM's) which is derived from natural origin and possess biological activity. Among these NCM's 28% are discovered in between 1981 to 2002 which are derived from natural origin.[1] *Manilkara zapota* (L.) Royen is a popular fruit crop, species from the *Sapotaceae* family, which is widely cultivated in most tropical reasons across the world. Different plant parts such as latex, fruit and timber are being used for various purposes. The fruit is nearly oval, round, oblate, conical or ellipsoidal; unripe fruit is rigid, gummy and very astringent, smooth-skinned coated with a sandy brown scurf until fully ripen.[2]

At present, fruit peels are considered to be a new sources of bioactive components, focusing an increased interest in search for beneficial phytochemicals present in fruit peels and utilize them in pharmaceutical, cosmetic industries or as food supplement.

Health benefits of *Manilkara zapota* fruits are not limited towards the edible portion of the fruit but non-edible part of the fruit also contribute for the beneficial effect based on the biological principles involved in it.[3] Although the fruit peels of *Manilkara zapota* fruits are discarded but it contains a variety of medicinally important phytochemicals. The peel of *Manilkara zapota* is rich in antioxidant principles, containing many important bioactive phenolic compounds known to provide its health benefits. In particular, a rich variety of phenolic compounds (as sources of natural antioxidants) and flavonoids present in it have attracted the attention of many researchers and practitioners.[4] Among these, flavonoids are capable of effectively scavenging reactive oxygen species and becomes a strong antioxidant due to presence of phenolic hydroxyl groups.[5] Most of the flavonoids are already reported as antidiabetic, anti-inflammatory, anti-allergic and antiplatelet agents.[6-8] While the phenolic compounds are acknowledged to possess a wide range of health benefits such as antimutagenic, antioxidant, anticarcinogeneic and also to reduce cardio-vascular complications.[9]

## TAXONOMICAL CLASSIFICATION

*Manilkara zapota* (L.) Royen Fruit also known as *sapodilla,* belongs to the *Sapotaceae* family which is having an ecologically diverse family of 700 species and up to 40 ill-defined genera, pantropically distributed.[10,11]

The nomenclature of Sapodilla 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* Adans. (manilkara) |
| Species | *Manilkara zapota* (L.) van Royen |

### *Synonyms*

*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)

### *Vernacular names*

*Manilkara zapota* (L.) Royen Fruit is known by many vernacular or common names[12] as shown in Table 1.

*Botanical description*

***Fruit:*** May be nearly oval, oblate, ellipsoidal in shape as depicted in Plate 1. 6-9 cm in width, hard, gummy and astringent when immature, coated with a sandy brown scurf smooth-skin until ripe. The flesh is yellowish-brown.[13]

***Peel:*** The ripe fruit has a thin, rusty brown, scurfy peel.

## Traditional uses of fruit

Sapodilla fruit is used as a nutritional food, chicle and also used in many local medicines. A boiled decoction of young fruits is taken to stop diarrhea. Young fruits infusion helps in relieving pulmonary complaints. Melted butter soaked fruit helpful in prevention of biliousness and fevers. The tannin content of the unripe fruits helps in resolving stomach problems.[2]

# PHYTOCHEMICALS

Various phytochemical present in MZFP are identified and reported. The ripe fruit peel has exhibited presence of 5-caffeoyl quinic acid conjugates, a phenolic compound which is an essential bioactive component responsible for treating different diseases and disorders.[14,15] An another important bioactive compound lycopene found in MZFP which is a carotenoid having high capacity to eradicate the singlet oxygen.[16] Many studies have proved that lycopene shields low-density lipoproteins, lipid molecules, proteins and DNA from free radicals, playing an important role in the safeguard against diseases.[17,18] Furthermore, total phenolic content (TPC), total flavonoid content (TFC) and antioxidants activity revealed the presence of several bioactive compounds like hydroxybenzoic acids (p-hydroxybenzoic, gallic and ellagic), flavanols (catechin and epicatechin) flavonols (quercetin), hydroxycinnamic acids (ferulic, chlorogenic and trans-cinnamic) and kaempferol in MZFP, highlighting that all these phytochemicals could be used as valuable sources of minerals and polyphenols having high antioxidant property.[19,20] The contents of various phenolic compounds and the individual compounds identified in MZFP are presented in Table 2. The chemical structures of the phytochemicals identified in MZFP are shown in Figure 1.

**Table 1:** Vernacular or common names of *Manilkara zapota* (L.) Royen Fruit.

| Country | Vernacular or Common names |
|---|---|
| India | Chikoo, Chicku, Chiku |
| Bahamas | Dilly |
| Puerto Rico | Nispero |
| English | Sapodilla |
| El Salvador | Muyozapot |
| West Indies | Nasebery |
| French West Indies | Sapotille, Sapotillier |
| Malaysia | Chikoo |
| Sinhala | Sapodilla, Rata mee |
| Brazil | Sapoti, Sapotilha |
| Cuba | Sapota, Sapote |
| Thailand | Lamoot, Lamut, Lamut-farang |
| Indonesia | Sawu |
| Mexico | Chicopote, Chicozapote |
| Dutch West Indies | Sapatija, Sapodilla plum, Sapodille |
| Singapore | Ciku |
| Surinam | Mispu, Mispel, Mispelboon |
| Virgin Island | Mespel |

**Table 2:** Summary of the phytochemicals in MZFP extract.

| Type of Compound | Phytochemicals | Content | Reference |
|---|---|---|---|
| Phenolic | Total Phenolic Content | 1151.4 ± 32.3 gallic acid equivalents/100 g | Jatinder Pal Singh *et al.* 2016 |
| | 5-caffeoyl quinic acid conjugates | 94.6 ± 9.50 mg/kg | Jun Ma and Edward J. Kennelly *et al.* 2003. Pontes *et al.* 2002. |
| | Gallic acid | 27.5 ± 0.0 mg/100 g | Jatinder Pal Singh *et al.* 2016 |
| | Catechin | 43.3 ± 0.2 mg/100 g | Jatinder Pal Singh *et al.* 2016 |
| | Quercetin | 49.1 ± 0.3 mg/100 g | Jatinder Pal Singh *et al.* 2016 |
| | Kaempferol | 51.2 ± 0.2 mg/100 g | Jatinder Pal Singh *et al.* 2016 |
| | Chlorogenic acid | 8.49 ± 0.15 mg/100 g | Cesar A. *et al.* 2017 |
| | p-hydroxybenzoic | 6.42 ± 0.04 mg/100 g | Cesar A. *et al.* 2017 |
| | Ellagic acid | 9.94 ± 0.03 mg/100 g | Cesar A. *et al.* 2017 |
| | Ferulic acid | 3.32 ± 0.04 mg/100 g | Cesar A. *et al.* 2017 |
| | Trans-cinnamic acid | 2.22 ± 0.14 mg/100 g | Cesar A. *et al.* 2017 |
| Total Flavonoid Content | -------- | 564.5 ± 30.5 quercetin Equivalents /100g | Jatinder Pal Singh *et al.* 2016 |
| Carotenoid | lycopene | 36.48 ± 2.21 µg/100 g dry basis | Silva *et al.* 2014 |

**Plate 1:** *Manilkara zapota* (L.) Royen fruit variety with Round and Elongated shapes.

Literature survey reveals that the MZFP is known to possess extraordinary phytochemicals that have medicinal and nutritional significance. Present review tries to collect novel information about MZFP bioactive composition, which is essential for the understanding of their future application as a strong nutraceutical potential and nutraceutical supplements and/or pharmaceutical products. While, up till now the true pharmacological potential of MZFP has not yet been fully explored.

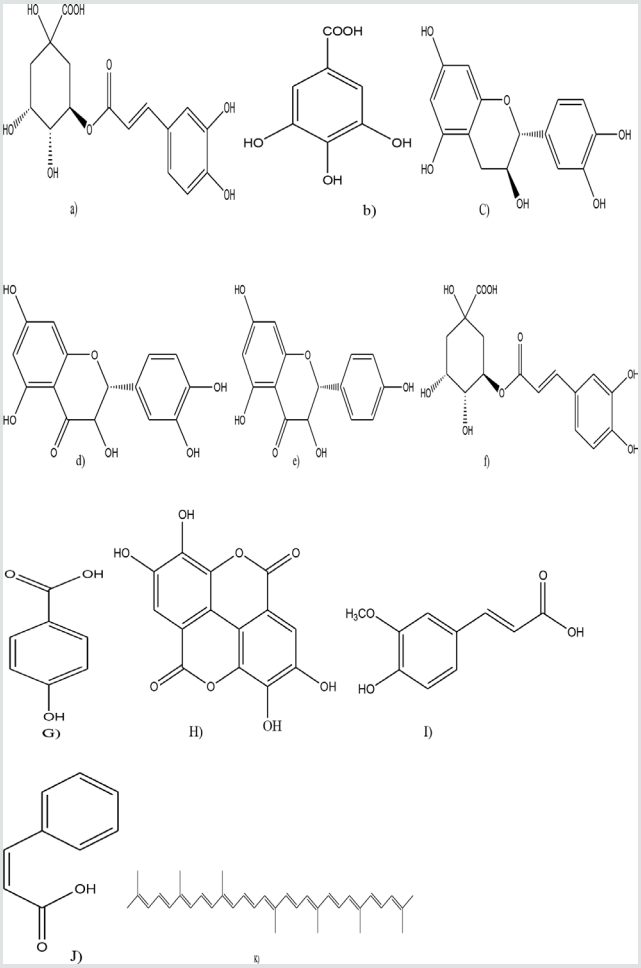

**Figure 1: Chemical structures of the phytochemicals identified in MZFP:** 5-caffeoyl quinic acid conjugates (a), gallic acid (b), catechin (c), quercetin (d), kaempferol (e), chlorogenic acid (f), p-hydroxybenzoic (g), ellagic acid (h), ferulic acid (i), trans-cinnamic acid (j), lycopene (k)

## Optimization of extraction conditions for *Manilkara zapota* (l.) Royen fruit peel

Yield of phenol and antioxidants principles in crude plant is strongly associated with solvent concentration, extraction time and temperature.[21] Extraction has to be carried out for 02 h at 40°C using 80% ethanol for obtaining higher yield of TPC and total antioxidant content (TAC) from peel. Due to high phenolic compounds in peel it requires higher percentage of ethanol for extraction as compared to the pulp. This optimized extraction conditions for peel had yielded TPC and TAC higher than that of pulp.[22] While another factor which could decrease the amount of TPC and TAC of peel content, which is storage time. TPC and TAC decreases considerably as the fruits gradually changes towards the overripe stage with time. The best time of extraction with high yields of antioxidants from peel is when the fruit is having a flavorful stage.[23]

## PHARMACOLOGICAL ACTIVITIES

### *Antioxidant study*

The MZFP extract showed its potential as natural antioxidant in *in-vitro* antioxidant assays like 1,1-diphenyl-picrylhydrazyl (DPPH) radical scavenging activity, ß-carotene bleaching activity assays (BCB) and oxygen radical absorbance capacity (ORAC) methods. Antioxidant activity by DPPH scavenging activity had showed a good correlation with phenolic and flavonoid content.[24] While when subjected to *in-vitro* free radical scavenging assays like ABTS+, nitric oxide and lipid peroxidation inhibition assays the results indicated that MZFP extract showed highest radical scavenging potential and high antioxidant activity compared to that of pulp extracts.[3]

### *Antimicrobial activity*

The MZFP when subjected to its antibacterial activity using gram negative bacteria *(Citrobacter freundii, Enterobacter aerogenes, Klebsiella pneumoniae, Proteus mirabilis, Salmonella typhimurium)* and gram positive bacteria *(Bacillus megaterium, Bacillus subtilis, Corynebacterium rubrum, Staphylococcus aureus, Staphylococcus epidermidis)* and fungi *(Candida albicans, Candida glabrata, Candida neoformans, Candida epicola),* depicted significant reduction in the zone of inhibition in gram negative bacteria than other microorganism species. Thus, disclosed a good antimicrobial activity indicating its potency as a promising source of natural antimicrobics.[25]

## CONCLUSION

Present review tries to highlight the bioactive constituents in MZFP and its reported pharmacological and nutritional values. MZFP is a good source of bioactive phenolic compounds and antioxidants having immense opportunities for future research related with their application as well as recovery. Some of the studies which need reinvestigation is, the optimization of the conditions for extraction of MZFP. Additional studies have to be carried out related to the isolation, identification, characterization of bioactive principles involved in the MZFP for its pharmacological effect.

Some preclinical studies using animal models and clinical trials are required to know the exact mechanism of individual active ingredients in health promotion. However, studies regarding isolation of carotenoid, in particular lycopene are needed. Also, more convincing studies are needed to validate that MZFP can be used as a potential natural antioxidant and nutraceutical source. Being a rich source of antioxidants and phenolics will attract the researchers across the globe to study and explore its health promoting benefits.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## ABBREVIATIONS

**MZFP:** *Manilkara zapota* (L.) Royen fruit peel; **NCM's:** New chemical moieties; **TPC:** Total phenolic content; **TFC:** Total flavonoid content; **TAC:** Total antioxidant content; **ABTS+:** 2,2′-azino-bis 3-ethylbenzothiazoline-6-sulfonic acid radical anion.

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