IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Pharmacognosy Of *Sechium Edule*: A Review

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Abstract: *Sechium edule* (Jacq.) Sw. is a valuable plant with significant nutritional and pharmacological properties. It is widely cultivated in tropical and subtropical regions for its edible fruits, tuberous roots, and young shoots. Rich in bioactive compounds such as flavonoids, alkaloids, polyphenols, terpenoids, and saponins, S. edule exhibits diverse therapeutic potential. Pharmacological studies highlight its antioxidant, antibacterial, anti-inflammatory, cardioprotective, hepatoprotective, anti-ulcer, anti-diabetic, anti-obesity, and anticancer properties. Various parts of this species have demonstrated efficacy in managing hypertension, hyperlipidemia, and metabolic disorders, while also showing neuroprotective effects. The plant's antimicrobial and cytotoxic activities further suggest its potential in combating infections and cancer. Despite its extensive medicinal applications, S. edule remains underutilized. Future research should focus on isolating bioactive compounds, understanding their mechanisms of action, and exploring their clinical applications. Integrating Sechium edule into modern medicine could enhance therapeutic strategies by combining traditional knowledge with contemporary scientific advancements.

Keyword: *Sechium edule*, Phytochemical composition, Therapeutic potential, Botany

I. INTRODUCTION

For centuries, people in South-East Asia have relied on various parts of plants to address specific health issues. Traditional Indian medicine systems like Ayurveda and Siddha have long been valued and practiced, rooted in a deep tradition of natural healing wisdom passed down through generations. (Kumar et al., 2010). Herbal remedies are more than just a collection of plant-based treatments—they represent the wisdom and experience of countless generations who have relied on nature to heal and maintain health. These remedies weave together time-honoured traditions and practical knowledge, passed down within families and communities, and are still valued today for their ability to support well-being alongside modern medical practices (Ahmad Khan & Ahmad, 2018). Over 80% of global populations in over 170 of the 194 Member States of WHO consume some type of traditional medicine, e.g., herbal medicine, and traditional therapies (*Integrating Traditional Medicine in Health Care*, 2023).

Sechium edule, commonly known as chayote, chow-chow, or squash, is a vegetable that belongs to the Cucurbitaceae family. This unique crop produces a pear-shaped, fleshy fruit containing a single soft seed and is typically cultivated in tropical and subtropical climates (Saade, 1996). Sechium edule is primarily grown for its edible tuberous roots, tender shoots and leaves, as well as its immature fruits. The fruits are naturally viviparous, meaning they can sprout while still attached to the parent plant. Due to rising economic demand, this crop is now widely cultivated in countries including Mexico, Brazil, Puerto Rico, Algeria, India, New Zealand, and Australia ("Production, Genetics, Postharvest Management and Pharmacological Characteristics of Sechium Edule (Jacq.) Sw").

United States is the main exporter of *fresh S. edule*, representing 61.74% of the value exported in 2024, followed by 33.46% from New Zealand(*2024 Fresh Chayote Global Market Overview Today*). Originally from central America, S. edule (Jacq.) Sw. (Cucurbitaceae) is now grown in tropical and subtropical climates worldwide (Vieira et al., 2019). The Aztec term "chayotl," which means "with thorns," is the source of the common name "chayote" (Cook 1901). Because of its versatility in a variety of environmental situations, the crop can be cultivated with moderate ease. Despite its many uses, chayote often remains underutilized, largely because people may not fully appreciate its nutritional value or understand how the plant develops. Beyond the well-known edible fruit, several other parts of the plant can be put to good use: the tender young shoots make nutritious vegetable greens, while the mature climbing vines and their flowers can serve as animal feed or even be used decoratively as natural fencing. Additionally, the tuberous roots found underground can also be used as feed for livestock. This versatility highlights the potential of chayote as a valuable crop that could be more widely embraced if its benefits were better understood. (Newstrom, 1991). S. edule is a hardy and low-maintenance plant that naturally resists most pests and diseases, though it can occasionally be affected by nematodes, insects, and fungi. When stored properly—ideally at around 7ºC with 85–90% humidity—the fruit can stay fresh for four to six weeks. However, if kept at warmer temperatures, it tends to lose weight and freshness more quickly, sometimes even day by day (“Production, Genetics, Postharvest Management and Pharmacological Characteristics of Sechium Edule (Jacq.)

2. SPECIES

Recognized Species: Sechium edule (Jacq.) Sw. – Chayote, Sechium tacaco (Pittier) C. Jeffrey, Unplaced or Tentative Species Names: Sechium chinantlense Lira & F. Chiang, Sechium mexicanum Lira & M. Nee, Sechium panamense (Wunderlin) Lira & F. Chiang, Sechium pittieri (Cogn.) C.Jeffrey, Sechium talamancensis (Wunderlin) C. Jeffrey, Sechium venosum (L.D.Gómez) Lira & F. Chiang, Sechium villosum (Wunderlin) C. Jeffrey,(Newstrom, 2019) Formerly Classified Under Sechium:, Cayaponia amazonica (formerly Sechium amazonicum),Cayaponia peruviana (formerly Sechium peruvianum), Microsechium compositum (formerly Sechium compositum), Microsechium hintonii (formerly Sechium hintonii), Microsechium palmatum (formerly Sechium palmatum)(*World Checklist of Vascular Plants: Royal Botanic Gardens, Kew*)

2.1 Taxonomy

Kingdom: *Plantae*, Phylum*: Tracheophyta*, Class*: Magnoliopsida*, Order: *Cucurbitales*, Family: *Cucurbitaceae*, Genus: *Sechium*, Species*: Sechium edule* (Jacq.) Sw.

2.2 Vernacular name of S. edule

French: Christophine, chou- chou; Spanish: Chayote; Portuguese: Chuchu, Japanese: Hayato Uri; Malay: Labu siam (Wiersema & León, 1999) Hindi: Chow Chow, Manipuri: Daskush; Tamil: Seema-Katharikkai; Kannada: seeme badanekaye; Bengali; Quash, Telugu: Seema vankaya(Veigas et al., 2020)

2.3 Ethnomedicinal significance of S. edule

Sechium edule (chayote) is rich in several bioactive and nutritional components, making it a valuable plant for health and medicinal purposes.(Cam-Pos-Vargas et al., 2022).The hydroalcoholic extracts from the roots and aerial parts are utilized to reduce high blood pressure, dissolve kidney stones, and support kidney function. With cardiotonic properties, they aid in managing arteriosclerosis and regulating blood sugar levels, thereby helping diabetic patients by improving insulin sensitivity and glucose metabolism. The plant also possesses antibacterial qualities that are useful against a variety of infections and prebiotic potential, which promotes gut health and lowers cholesterol levels. (Aguiñiga-Sánchez et al.,2020).

2.4 Botany of S. edule

Sechium edule is an herbaceous climbing vine that is perennial and monoecious. Axillary tendrils support the long, glabrous stems with angular grooves that can reach considerable lengths. Alternate, lobed, widely heart-shaped to ovate leaves that range in length from 10 to 20 cm and are slightly rough to the touch. The leaf bases are cordate with tapering apexes to the lobes, and the petioles can reach a length of 6 inches. Axillary inflorescences have pistillate flowers alone and staminate flowers in lengthy racemes. The pale green corolla of the flower is 12–17 mm wide. The 5-grooved ovary produces pear-shaped fruits that are 7–20 cm long, smooth or slightly wrinkled, and green to white in color(Aung et al.,1990). One big seed adheres to the flesh of the fruit.(*Sechium Edule: Info from PIER (PIER Species Info)*). In order to promote the plant's rapid growth, the rootstock is tuberous and stores nutrients. Sechium edule is a plant with great agricultural and

nutritional value that grows well in tropical settings with lots of water and sunshine.(*Promoting the Conservation and Use of Underutilized and Neglected Crops. 8. C h a y o t e C h a y o t e*).

2.5 Geographical distribution of S. edule

Originating in Mexico, Sechium edule is native to Central America. Introduced and grown all over the world, it can be found in places like South America, the Caribbean Islands, Southern Asia (Bangladesh, India, and Thailand), Africa, Macaronesia, Australia, New Zealand, and on a number of Pacific and Indian Ocean islands(Rojas-Sandoval, 2018). Tropical and subtropical climates are optimal for its growth, and tropical America is where it is most significant for food and agriculture (*Sicyos Edulis Jacq. | Plants of the World Online | Kew Science*)

2.6 Cultivation of S. edule

For optimal growth, *Sechium edule* (chayote) requires fertile, well-drained soils with a pH range of 6.0 to 7.0. It thrives in warm climates with temperatures between 18°C and 30°C. Propagation typically involves using the fruits or tubers, with the sprouting end of tubers facing upwards during planting. Adequate watering is essential, especially during dry periods, but excessive moisture should be avoided to prevent root rot. Common pests include aphids and beetles, for which integrated pest management strategies are recommended (*Sechium Edule Chayote, Mirliton, Cho Ko, Cho-Cho, Vegetable Pear PFAF Plant Database*).

2.7 Macroscopic characteristics of S. edule

Chayote (Sechium edule) is a perennial herbaceous climber that can reach a height of 30 meters. It has tuberous roots. The climber's leaves are palmate-lobed or heart-shaped, and it employs tendrils. The leaf blade is widely ovate-circular, with a diameter of 7.25 cm and a petiole of 3.25 cm. These leaves have an angular or lobed shape, typically showing three to five lobes, three to five split tendrils, and sharply denticulate (toothed) borders(Aung et al., 1990). Male blooms on the monoecious shrub are grouped together, whereas female flowers are solitary. When ripe, the fleshy fruits can be either green or white, and they contain a single big seed.

2.8 Microscopic characters

The fruit's anatomy includes an exterior epidermis and subepidermal annular collenchyma, while its main body is made up of vascularization, reserve parenchyma with amyloplasts, mucilage cells, and chlorenchyma (Mejía Doria et al., 2023). The petiole anatomy includes angular cross-section with bicollateral vascular bundles arranged in a circle; epidermis has glandular and non-glandular multicellular trichomes; underlying layers of angular collenchyma (Hernandez-Uribe et al., 2011)**.** The Leaf anatomy includes adaxial epidermis cells have slightly sinuous walls; abaxial epidermis cells have strongly sinuous walls; presence of stomata on the abaxial surface; mesophyll differentiated into palisade and spongy parenchyma; glandular and non-glandular trichomes present(Karina de Andrade Silva et al.,2020).

3.PHYTOCHEMISTRY

The phytochemical analysis of Sechium edule plant, results were presented in table1.(Nagarajaiah & Prakash, 2015; Ragasa et al.,2014; Vieira et al., 2022) .

Table :1- Phytochemistry of *Sechium edule*

Phytochemical Components	Alcoholic Fruit Pulp extract	Aqueous and alcoholic Seeds extract	Aqueous and alcoholic leaves extract	Hydroalcoholic Root extract
Alkaloids	Present	Present	Present	Present
Flavonoids	Present	Present	Present	Present
Carotenoids	Present	Present	Present	Not reported
Triterpenoids	Present	Present	Not reported.	Present
Saponins	Present	Present	Not reported.	Not reported
Phenolic Acids	Present	Present	Present	Present
Peroxidases	Present	Not Reported	Not reported	Not reported
Potassium	High	High	High	Moderate

Calcium	High	High	High	Moderate
Phosphorus	Moderate	Moderate	Moderate	Moderate
Magnesium	Moderate	Moderate	Moderate	Moderate
Essential Amino Acids	Not Reported	Present	Not reported	Not reported
Total Carotenes	Moderate	Not Reported	Present	Not reported
Tannins	Low	Low	Low levels detected	Low levels detected
Proteins	Moderate	High	Moderate	Moderate to high levels
Glycolipids	Not Reported	Moderate	Not reported	Not reported
Phospholipids	Not Reported	Moderate	Not reported	Not reported

4.PHARMACOLOGICAL ACTIVITIES OF SECHIUM EDULE

4.1 *Antimicrobial Activity*

S. edule extracts have shown remarkable antimicrobial activity, especially against gram-positive bacteria like Staphylococcus aureus and Enterococcus faecalis. The highest antibacterial activity was shown by the ethanolic extracts of leaves and seeds with minimal inhibitory concentration (MIC) values showing efficacy against multi-resistant strains. The maximum activity was achieved with the 96% ethanolic seed extract (MIC values of 8.32-16.64 &119 g/ml and >8.32 &119 g/ml against staphylococci and enterococci, respectively) and the 80% aqueous-ethanolic leaf extract (MIC values of 4.16-8.32 &119 g/ml against staphylococci and enterococci). Chloroform and methanolic extracts also exhibited antibacterial activity against gram-negative bacteria like Escherichia coli and Salmonella typhimurium (Ordoñez et al.,2003).

4.2 *Anti-ulcer Activity*

The ethanolic extract of *Sechium edule* fruit was studied for its protective effects against aspirin-induced gastric ulcers in rat models. Administered orally at a dose of 500 mg/kg body weight, the extract significantly reduced ulcer formation by 79.53% compared to the control group ($p < 0.001$). It also decreased total and free gastric acidity, lowered gastric output, and increased the pH of gastric secretion, demonstrating strong anti-ulcer and cytoprotective properties. These effects are attributed to the presence of bioactive compounds such as flavonoids and tannins in the fruit extract (Sateesh et al.,2012)

4.3 ANTIHYPERTENSIVE EFFECTS

The water extracts of *Sechium edule* fruit, including pulp and peel, have demonstrated significant hypotensive activity in anaesthetized rat models. When administered intravenously, these aqueous extracts caused a notable reduction in mean arterial pressure by approximately 23 mmHg, with minimal effects on heart rate and no direct action on cardiac tissue. Additionally, hydroalcoholic extracts of *Sechium edule* roots showed intense antihypertensive effects in vagotomised rats with angiotensin II-induced hypertension. Oral doses of 50, 100, and 200 mg/kg produced a dose-dependent decrease in both systolic and diastolic blood pressure, with the acetone fraction exhibiting the highest activity. These findings suggest that the antihypertensive effects may be mediated through mechanisms such as calcium antagonism and modulation of angiotensin II activity, highlighting the therapeutic potential of *Sechium edule* in managing hypertension (Lombardo-Earl et al., 2014).

4.4 ANTI-DIABETIC PROPERTIES

The ethanolic extract of *Sechium edule* (chayote) fruit peel has demonstrated notable anti-diabetic activity in streptozotocin-induced diabetic rat models. Administered orally at doses of 200 and 400 mg/kg body weight, the extract significantly reduced blood glucose levels and improved insulin sensitivity. This beneficial effect is attributed to the extract's ability to inhibit glycogenolysis and enhance glucose transport to peripheral tissues, thereby effectively managing hyperglycaemia and supporting glucose metabolism. These findings highlight the potential of chayote peel extract as a natural therapeutic agent for diabetes management (Loizzo et al., 2016a).

4.5 HEPATOPROTECTIVE EFFECTS

Research has demonstrated that extracts of *Sechium edule* provide significant protection against liver damage caused by toxins. Ethanolic extracts and ethyl acetate fractions of *Sechium edule* fruits have been shown to protect rats from carbon tetrachloride (CCl_4)-induced hepatic injury by improving liver function markers such as AST, ALT, ALP, and albumin, enhancing antioxidant levels, and reducing histopathological liver damage. These effects are largely attributed to the extract's antioxidant and anti-inflammatory properties. Additionally, hydroalcoholic extracts of *Sechium edule* roots, standardized for cinnamic acid content, have demonstrated protective effects against chronic angiotensin II-induced liver damage in mice. Oral administration at 11 mg/kg/day significantly prevented increases in serum triglycerides, ALT levels, hepatic triglyceride accumulation, hepatomegaly, inflammatory cytokines (TNFα, IL-1β, IL-6, TGFβ), fibrosis, and histopathological alterations. The hepatoprotective effects are linked to the presence of antioxidant and anti-inflammatory polyphenols such as cinnamic and coumaric acids. Together, these findings highlight the therapeutic potential of *Sechium edule* as a natural hepatoprotective agent (Firdous, Sravanthi, et al.,2012).

4.6 ANTI-INFLAMMATORY AND CNS EFFECTS

The research demonstrates that polysaccharides from *Sechium edule* both raw and cooked, have been shown to modulate macrophage activity in vitro, specifically in RAW 264.7 murine macrophage cells. These polysaccharides enhance macrophage functions such as nitric oxide production, reactive oxygen species generation, and cytokine secretion, which are key markers of immune activation. The composition and immunomodulatory efficacy of these polysaccharides are altered by cooking, but both forms demonstrate significant potential for improving immune responses. (Castro-Alves et al., 2016).The plant has shown potential in reducing inflammation and providing central nervous system (CNS) depressant effects. In animal studies, it reduced the duration of convulsions in seizure models, suggesting its utility in managing epilepsy The doses used in these studies varied, with macrophage modulation observed at polysaccharide concentrations ranging from 10 to 100 µg/mL, while specific doses for anticonvulsant activity were not always detailed. Overall, these findings support the use of *Sechium edule* polysaccharides and extracts as promising agents for immune enhancement and neurological disorder treatment. (Firdous, Ahmed, et al., 2012).

4.7 ANTI-OBESITY AND ANTI-HYPERLIPIDEMIC EFFECT

The polyphenol extract from *Sechium edule* shoots, obtained using aqueous or ethanolic solvents, was evaluated for its lipid-lowering effects in oleic acid-treated HepG2 liver cells. Although the exact doses were not specified, the extract demonstrated strong activity by effectively inhibiting lipogenesis and stimulating lipolysis through activation of the AMPK signalling pathway. This activation resulted in decreased expression of lipogenic enzymes such as fatty acid synthase (FAS), HMG-CoA reductase (HMGCoR), and sterol regulatory element-binding proteins (SREBPs), while simultaneously increasing the levels of lipid oxidation regulators including carnitine palmitoyl transferase I (CPT-I) and peroxisome proliferator-activated receptor alpha (PPARα). These molecular changes led to a significant reduction in intracellular lipid accumulation, indicating the extract's potential as a natural agent for preventing and treating fatty liver and other metabolic disorders.(Wu et al., 2014). The polyphenol-rich extract from *Sechium edule* shoots was evaluated in high-fat diet-fed rats at a dose of 100 mg/kg body weight per day administered orally. The extract significantly reduced body weight gain, adipose tissue fat accumulation, and hepatic levels of triglycerides and cholesterol. These beneficial effects were associated with the activation of the AMPK signalling pathway and a decrease in the expression of key lipogenic enzymes such as SREBP-1, SREBP-2, and HMG-CoA reductase. Overall, the extract effectively prevented fatty liver development and attenuated both adipogenesis and lipogenesis, demonstrating its potential as a natural therapeutic agent against obesity and related metabolic disorders (Yang et al., 2015).

4.8 ANTIOXIDANT EFFECT

Ethanolic extracts of *Sechium edule* leaves and aqueous extracts of its seeds have demonstrated considerable antioxidant activity in vitro, as evidenced by significant reducing power in the linoleate model and strong inhibition in the β-carotene bleaching assay. Flavanols were identified as the primary flavonoids responsible for this antioxidant effect(Flick et al., 1978). Additionally, extracts from the peel, leaves, and pulp of *Sechium edule*, prepared using a 37% ethanol-water mixture, showed strong antioxidant capacity assessed by DPPH radical scavenging and ferric reducing antioxidant power (FRAP) assays. Among these, the peel exhibited the most potent antioxidant activity. These findings highlight the robust antioxidant potential of different parts of *Sechium edule*, largely attributed to their flavonoid content (Loizzo et al., 2016b).

4.9 ANTI- CANCER EFFECT

Aqueous extracts of *Sechium edule* have demonstrated notable antimutagenic properties, particularly in fractions with molecular weights greater than 30 kDa, which also exhibit significant peroxidase activity. These effects are believed to be due to heat-stable phenolic compounds present in the extracts. (Yen et al.,2001). human cervical cancer HeLa cell lines using the methanolic extract of Sechium edule fruit, particularly the Perla Negra cultivar. It was found that the inhibitory concentration (IC50) was 1.85 µg/mL, which is 632 times less potent than the IC50 of S. edule var. amarus silvestrys (1170 µg/mL) (Salazar-Aguilar et al.,2021). Furthermore, when the Perla Negra methanolic extract was encapsulated in chitosan-based microspheres, it retained its antineoplastic activity and exhibited significant antiproliferative effects on tumor cells, with an IC50 of 8 µg/mL. These findings suggest that *Sechium edule* extracts, especially from the Perla Negra cultivar, have promising applications in cancer therapy and chemoprevention. (Wiktor et al., 2021).

CONCLUSION

Sechium edule is a nutritionally and pharmacologically valuable plant, known for its diverse phytochemical composition. It contains various bioactive compounds, including flavonoids, polyphenols, alkaloids, terpenoids, and saponins, which contribute to its antioxidant, antibacterial, cardioprotective, anticancer, Anti-hyperlipidaemic, Anti-epileptic and anti-inflammatory properties. Considering the vast medicinal potential of *Sechium edule*, continued research on this plant could offer valuable knowledge for future studies investigating its therapeutic uses. Increased scientific interest could facilitate its integration into modern medicine, promoting health benefits grounded in both traditional wisdom and contemporary research methodologies.

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