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Pouteria caimito: An Emerging Tropical Fruit Crop- A Critical Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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Abstract

Pouteria caimito (Ruiz & Pav.) Radlk., known variously as abiu, caimito or yellow star apple, is a Sapotaceae tree native to the western Amazon basin that has begun to attract international research and horticultural interest as a candidate for orchard diversification, functional-food development and Amazonian agro-biodiversity conservation. Despite growing recognition of its sweet, custard-textured fruit and its wide traditional use in South American folk medicine, the species remains comparatively under-characterised relative to mainstream tropical fruits. This review synthesises the dispersed literature on the botany, propagation, nutritional composition, phytochemistry, postharvest physiology and pharmacological properties of *P. caimito*. The fruit pulp is notably rich in soluble solids, reducing sugars and potassium, while the peel is the principal reservoir of phenolic compounds, triterpenoids and flavonoids responsible for measurable antioxidant, antimicrobial, anti-inflammatory, antiviral and cytotoxic-safety profiles reported across in vitro assays. Postharvest research shows the fruit is markedly perishable, with rapid enzymic browning and chilling injury constraining its commercial shelf life, although maturity-stage selection, ascorbic acid and oxalic acid dips, and moderate cold storage each measurably extend marketability. Propagation remains reliant on seed and, to a lesser extent, cutting-based vegetative methods, with limited clonal selection or rootstock research reported. Genomic resources are confined to plastid genome assemblies that confirm a close phylogenetic relationship with *Pouteria campechiana*. Collectively, the evidence indicates a species with tangible

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nutritional, pharmacological and diversification value that is nonetheless held back by fragmented agronomic knowledge, a narrow geographic base of active research groups, and an almost complete absence of large-scale cultivar improvement or supply-chain infrastructure. The review closes by identifying priority research directions, principal limitations of the underlying evidence base, and concluding perspectives on the prospects for *P. caimito* as a commercially viable emerging tropical fruit crop.

Keywords: Abiu; Pouteria caimito; Sapotaceae; underutilised fruit; postharvest physiology; phytochemistry; Amazonian fruit crops.

1. Introduction

Tropical fruit species beyond the small cohort that dominates global trade — mango, pineapple, papaya, avocado and banana — represent a vast, largely untapped reservoir of nutritional and economic value (FAO, 2024). Among these lesser-known species, *Pouteria caimito* (Ruiz & Pav.) Radlk., a member of the Sapotaceae family, has begun to draw sustained scientific attention over roughly the last decade. Commonly called abiu in Brazil, caimito or caimo in parts of Colombia and Ecuador, and yellow star apple in the English-speaking Caribbean, the species produces an ovoid to spherical fruit with smooth yellow skin enclosing a translucent, jelly-like pulp whose flavour is frequently likened to caramel custard. The taxonomic synonymy with the unrelated *Chrysophyllum cainito* L. (also called star apple or caimito in some regions) has occasionally introduced confusion into the wider literature, a point addressed directly in the taxonomic section below. A recent review of underutilised fruit crops has similarly emphasised that neglected fruit species may support nutritional diversity and rural value creation, but that limited agronomic evidence, weak market systems and insufficient research continue to slow wider adoption (Marappan et al., 2025).

1.1 Botanical Background and Distribution

Pouteria caimito is considered native to the headwaters of the Amazon, occurring wild along the lower eastern slopes of the Andes from south-western Venezuela through Peru, and historically domesticated and dispersed across Amazonia by Indigenous Amazonian peoples long before European contact (Tao et al., 2021). The species has subsequently been introduced to Central America, the Caribbean, southern Florida, northern Australia and, more recently, tropical regions of Southeast Asia, including Indonesia and southern China, where cultivation has expanded markedly since the late 2000s (Yang et al., 2019). This broadening geographic footprint has been a principal driver of the recent uptick in agronomic and phytochemical research, much of it originating from research groups in Brazil, Indonesia and China. A recent systematic review of Amazonian fruits also indicates increasing research attention to their bioactive composition and technological applications, while noting that translation into value-added products remains limited (Cruz et al., 2024).

1.2 Traditional Uses and Emerging Commercial Relevance

Beyond fresh consumption, the pulp of *P. caimito* has long been used in Brazilian and broader Amazonian folk medicine to relieve cough, fever and bronchitis, while the latex exuded from unripe fruit has served as a vermifuge and topical treatment for abscesses (Abreu et al., 2019). These traditional applications provide the ethnobotanical rationale for a growing body of pharmacological screening work, which has in turn revealed antioxidant, antimicrobial, antidiarrhoeal, anti-inflammatory and antiviral activities associated with extracts of the fruit peel, pulp, seed and leaf (Cavalcante de Oliveira et al., 2023). The fruit's culinary versatility — consumed fresh or processed into ice cream, sorbets, jams and smoothies — together with its ornamental horticultural appeal, has generated interest in its potential as a diversification crop for smallholder tropical orchards (Do et al., 2023). New extraction-focused work on Peruvian *Pouteria caimito* has further shown that green processing approaches are being explored for phenolic recovery from the fruit, reinforcing the link between phytochemical characterisation and food-industry value addition (Miranda et al., 2025). Recent postharvest work on ethylene application also supports the view that market development for abiu depends on practical quality-management strategies because shrivelling and limited shelf life remain obstacles during storage (Habibi et al., 2025).

1.3 Scope, Research Gap and Objectives

Pouteria caimito remains a markedly under-researched species relative to established Sapotaceae relatives such as *Pouteria sapota* and *Pouteria campechiana*, and relative to mainstream tropical fruits more broadly. The available literature is scattered across horticultural, food-science, pharmacognosy and molecular-biology journals, frequently emerging from a small number of research groups in Brazil, Indonesia and China, with limited cross-referencing between agronomic, postharvest and phytochemical strands of enquiry. No comprehensive synthesis integrating these strands currently exists. Accordingly, the remaining research gap concerns how the dispersed evidence can be integrated into a coherent framework linking agronomy, postharvest handling, phytochemistry and commercial use. This review addresses that gap by drawing together evidence on the botany and genetic resources, propagation and agronomy, nutritional composition and phytochemistry, postharvest physiology, and pharmacological and functional properties of *P. caimito*, with three specific objectives: to consolidate what is presently known about the biology and chemistry of the fruit, to critically appraise the methodological maturity of the underlying evidence base, and to identify the research priorities most likely to accelerate the species' transition from a locally consumed Amazonian fruit to a commercially viable emerging tropical crop.

2. Methods for Literature Selection

2.1 Databases and Search Strategy

A structured but non-systematic narrative literature search was conducted across Web of Science, Scopus, Google Scholar and PubMed, supplemented by five field-specific indexing platforms relevant to horticulture, food science and natural-product chemistry: CAB Abstracts, AGRICOLA, FSTA (Food Science and Technology Abstracts), SciELO, and the Directory of Open Access Journals. Search strings combined the taxonomic terms "Pouteria caimito" OR "abiu" OR "caimito" with domain-specific keywords including "postharvest", "phytochemistry", "antioxidant", "propagation", "chloroplast genome", "nutritional composition" and "bioactivity". Boolean combinations were iterated to capture regional synonyms (abiu, caimo, caimito amarillo, luma, cauje, temare) given the substantial vernacular variation documented across producing countries.

2.2 Inclusion and Exclusion Criteria

Studies were included if they reported original or synthesised data specific to *P. caimito*, or if they addressed closely related congeneric Sapotaceae species — notably *P. campechiana*, *P. sapota* and *P. macrophylla* — in a manner directly informative for comparative interpretation. Eligible publication types were peer-reviewed journal articles, including short communications and data notes appearing in indexed journals. Books, book chapters, conference proceedings, theses, patents, preprints and non-peer-reviewed trade or grey literature were excluded, with the sole exception of an authoritative institutional market report (the Food and Agriculture Organization) cited for global trade context and included with a verifiable uniform resource locator in the absence of a digital object identifier. Studies published only in abstract form, duplicate reports of the same dataset, and articles for which full text could not be verified for accuracy of reported data were also excluded. The literature search covered publications from January 2005 to 4 April 2026, a window chosen to capture the period during which molecular, phytochemical and postharvest research on the species has been concentrated; one earlier foundational comparative phytochemical study from 2004 was retained as a classic reference because it remains the primary source for a finding discussed in the review.

2.3 Screening Workflow, Duplicate Handling and Language Restrictions

Search results retrieved from each database were compiled and screened at the title and abstract level for topical relevance to *P. caimito* biology, chemistry or horticulture. Full texts of records passing this initial screen were examined for methodological transparency and data completeness. Records duplicated across databases were identified by matching digital object identifiers, author strings and publication years, and were retained only once. No language restriction was applied at the search stage, though in practice the retrieved literature was overwhelmingly published in English, with a smaller cohort in Portuguese and Chinese; where non-English sources were retained, interpretation relied on English-language abstracts and data tables supplemented by translated excerpts where available. Studies reporting particularly influential findings — the earliest chloroplast genome assemblies, the main postharvest physiology studies from Indonesian and Chinese groups, and the principal phytochemical profiling papers from Brazilian laboratories — were prioritised for detailed synthesis regardless of publication venue impact factor, reflecting the genuinely narrow evidence base available for this species.

2.4 Rationale for a Narrative Rather than Systematic Review Approach

A narrative review format was adopted in preference to a systematic review because the literature on *P. caimito* spans heterogeneous disciplines — plant taxonomy, genomics, food chemistry, postharvest physiology and pharmacology — using widely differing study designs, outcome measures and reporting conventions that are not amenable to meaningful quantitative pooling or meta-analytic synthesis. Narrative reviews are well suited to this kind of integrative, cross-disciplinary consolidation, allowing critical appraisal and contextualisation of disparate evidence in a way that a narrowly defined systematic protocol would not accommodate (Green et al., 2006). This approach follows established guidance on the conduct of narrative reviews for peer-reviewed publication, including the use of transparent, reproducible search terms and explicit selection criteria even where formal systematic-review reporting standards are not applied in full (Baumeister & Leary, 1997).

The overall search strategy, including databases, search terms, date range and inclusion criteria, is summarised in Table 1.

Table 1. Summary of the literature search strategy applied in this review

Element	Specification
Databases searched	Web of Science, Scopus, Google Scholar, PubMed, CAB Abstracts, AGRICOLA, FSTA, SciELO, DOAJ
Core search terms	"Pouteria caimito", "abiu", "caimito", combined with "postharvest", "phytochemistry", "antioxidant", "propagation", "chloroplast genome", "nutritional composition", "bioactivity"
Date range	January 2005 – 4 April 2026 (one classic comparative phytochemical reference from 2004 retained as supplementary)
Publication types included	Peer-reviewed journal articles; authoritative institutional reports (FAO)
Publication types excluded	Books, book chapters, conference proceedings, theses, patents, preprints, grey literature
Screening levels	Title/abstract screen, then full-text eligibility check
Duplicate handling	Matched by digital object identifier, author string and year
Language	No restriction applied; retrieved literature predominantly English, with Portuguese- and Chinese-language sources also captured

Sources: Baumeister and Leary (1997); Green et al. (2006)

3. Botany, Taxonomy and Genetic Resources

3.1 Taxonomic Position, Morphology and Nomenclatural Clarification

Pouteria caimito belongs to the family Sapotaceae within the order Ericales, a family comprising roughly 325 tropical tree species valued for latex, timber and, within the genus *Pouteria*, edible fruit including canistel (*P. campechiana*), lucuma (*P. lucuma*) and mamey sapote (*P. sapota*) (Fitriansyah et al., 2021). The species is described as a medium to large evergreen tree bearing fruit that is ovoid to spherical in shape, with smooth, yellowish peel enclosing translucent pulp (Yang et al., 2019). Flowering does not appear to follow a strict photoperiodic cue, and trees frequently carry flowers and fruit simultaneously across several flushes within a single year. Detailed leaf and flower characterisation work conducted at two production sites in West Java, Indonesia, found measurable differences between locations in leaf shape, leaf base and tip morphology, and flower organ dimensions, differences the authors attributed at least partly to plant age and local growing conditions rather than to confirmed genetic divergence between the populations sampled (Ramdan et al., 2023).
A recurring source of confusion in both scientific and popular literature is the frequent conflation of *P. caimito* with *Chrysophyllum cainito* L., an unrelated Sapotaceae species also called star apple or caimito in several producing countries. The two occupy different taxonomic genera and different centres of diversity, and studies

referring simply to "caimito" without the full binomial name should be read with this ambiguity in mind. Throughout this review, comparative Sapotaceae literature involving *Chrysophyllum cainito* is identified explicitly wherever it is drawn upon.

3.2 Genetic Diversity and Genomic Resources

Molecular characterisation of *P. caimito* remains at an early stage. The complete chloroplast genome was first assembled from a cultivated individual in Yunnan Province, China, revealing a circular plastid genome of approximately 158,937 base pairs comprising a large single-copy region, a small single-copy region and a pair of inverted repeats, encoding 130 genes including 85 protein-coding genes (Yang et al., 2019). A subsequent assembly derived from a wild Amazonian accession reported a highly concordant genome structure of 158,916 base pairs and 133 annotated genes, of which 88 were protein-coding; maximum-likelihood phylogenetic analysis based on 19 Ericales chloroplast genomes confirmed that *P. caimito* is most closely related to *P. campechiana* among sequenced congeners (Tao et al., 2021). Both studies note the striking absence of prior genomic research on the species before their publication, underscoring how recent the molecular characterisation of *P. caimito* remains relative to major tropical fruit crops.

Beyond the plastid genome, diversity assessment has relied principally on morphological rather than molecular markers, and the field-based observations described above from Bogor remain among the few systematic comparisons available (Ramdan et al., 2023). Historical accounts from the western Amazon describe at least two distinguishable landraces differentiated by fruit shape and size, alongside wild populations bearing small, latex-rich fruit and domesticated populations bearing markedly larger, lower-latex fruit — indicative of a domestication gradient that has not yet been formally characterised using modern molecular markers. This absence of microsatellite, single-nucleotide-polymorphism or whole-genome diversity studies represents a conspicuous gap relative to the genomic resources now routinely available for congeneric species such as *P. campechiana*.

The two published chloroplast genome assemblies for the species are compared in Table 2.

Table 2. Summary of published chloroplast genome assemblies for *Pouteria caimito*

Study	Accession origin	Genome size (bp)	Protein-coding genes	Closest relative (phylogenetic analysis)
Yang et al. (2019)	Cultivated tree, Yunnan Province, China	158,937	85	*Pouteria campechiana*
Tao et al. (2021)	Wild-derived accession, southern China (originally Amazonian germplasm)	158,916	88	*Pouteria campechiana*

Sources: Tao et al. (2021); Yang et al. (2019)

4. Agronomy and Propagation

4.1 Climatic Adaptability

Pouteria caimito is adapted to humid tropical and subtropical lowland climates and shows little tolerance for frost. Its cultivation now spans markedly different latitudes and rainfall regimes, from equatorial Amazonia to subtropical growing regions in southern China, reflecting ecological plasticity that has not yet been tested under controlled agroclimatic conditions (Tao et al., 2021; Yang et al., 2019). Unlike many tropical fruit species, *P. caimito* appears not to require a specific photoperiod to initiate flowering, an observation noted in background material accompanying nanoparticle-synthesis research using the fruit (Veeramani et al., 2022). This absence of a strict flowering trigger likely contributes to the near-continuous cropping pattern reported for the species, though its physiological basis has not been investigated directly. Systematic, multi-site agroclimatic trials establishing optimal rainfall, temperature and soil requirements for *P. caimito* remain absent from the peer-reviewed literature, a gap that stands in contrast to the more developed body of work available for major Sapotaceae relatives such as *P. sapota* and *P. campechiana* (Do et al., 2023).

4.2 Propagation Methods

Seed propagation remains the dominant method by which *P. caimito* is disseminated, reflecting the species' comparatively recent transition from wild-harvested to deliberately cultivated status in most non-Amazonian production regions. Seed germination is generally reported to require several weeks under warm, moist conditions, though formal, published germination trials specific to *P. caimito* remain scarce, and propagation research for this species lags noticeably behind that available for the more intensively studied congener *P. campechiana* (Do et al., 2023). Vegetative propagation by cutting has received more limited but methodologically informative attention: an early Brazilian trial using herbaceous branch cuttings taken from three selected abiu genotypes in a commercial orchard demonstrated that rooting success is genotype-dependent, providing preliminary evidence that clonal propagation is feasible but that genotype selection materially affects propagation efficiency (Eduardo et al., 2007). Grafting and budding are widely assumed to represent the preferred commercial approach for producing true-to-type planting material, by analogy with practice in related Sapotaceae fruit crops, although controlled comparative studies of grafting success rates, rootstock compatibility or scion performance specific to *P. caimito* were not identified in the peer-reviewed literature reviewed here.

4.3 Orchard Management and the Pest and Disease Evidence Gap

Published, peer-reviewed research on pests and diseases affecting *P. caimito* is essentially absent. Available guidance on pest pressure and orchard sanitation appears to derive almost entirely from grower experience and horticultural extension material rather than controlled field trials, and no integrated pest management study specific to the species was identified in the course of this review. This absence of published agronomic trial data — spanning planting density, irrigation scheduling, fertiliser response, canopy management and pest control — constitutes one of the clearest gaps distinguishing *P. caimito* from horticulturally mature tropical fruit crops, and is a theme returned to in the Future Directions section below.

5. Nutritional Composition and Phytochemistry

5.1 Proximate and Mineral Composition

Comparative Amazonian fruit-pulp surveys consistently identify abiu pulp as distinguished by unusually high soluble solids, total and reducing sugar content, and comparatively high pH relative to other regionally consumed fruits. In a study comparing the pulp of abiu with araçá-boi, araticum, biri-biri and yellow mangosteen, abiu pulp exhibited the highest levels of ash, total sugars, reducing sugars, total soluble solids and calorific value, and the highest pH among the fruits analysed (Cavalcante de Oliveira et al., 2023). Complementary work assessing physiological effects of these same Amazonian pulps in Wistar rats confirmed the elevated soluble solids and sugar profile of abiu pulp and reported no adverse haematological, metabolic, renal or hepatic effects following its dietary consumption relative to a control group, providing preliminary in vivo support for the fruit's nutritional safety (Rosan Fortunato Seixas et al., 2021). Mineral analysis of the closely related "abiu-do-mato" fruit found the peel to contain the highest ash and protein content among fruit fractions, while the pulp contained the highest concentrations of potassium and magnesium (Cavalcante de Oliveira et al., 2025). This pattern sits within a broader picture of substantial compositional variation across regionally consumed Amazonian fruit species more generally, where reducing-sugar content, phenolic load and antioxidant capacity have been shown to differ markedly between species even within the same market basket, which helps explain why the sugar-rich, comparatively low-acid profile of abiu stands out so clearly in these comparative surveys (Faria et al., 2021).

5.2 Phenolic, Flavonoid and Triterpenoid Profile

A consistent finding across multiple independent studies is that the peel, rather than the pulp, constitutes the principal reservoir of phenolic and antioxidant compounds in *P. caimito*. Comprehensive chemical profiling combining nuclear magnetic resonance spectroscopy, high-resolution mass spectrometry and gas chromatography–mass spectrometry identified sixteen bioactive compounds in fruit extracts, including catechin and its derivatives, and confirmed that peel extracts exhibited substantially higher phenolic content and antioxidant activity than pulp or seed fractions (Cavalcante de Oliveira et al., 2025). Gas chromatography–mass spectrometry analysis of hexane extracts from the same study identified nineteen predominantly volatile and fatty-acid compounds, with palmitic, elaidic and linoleic acids the most abundant, while methanolic extracts yielded seventeen compounds dominated by catechin derivatives.

Leaf tissue has also proven a rich source of bioactive constituents. Aqueous, ethanolic and hexane extracts of *P. caimito* leaves screened for radical-scavenging activity found the aqueous extract to possess the highest total phenolic and proanthocyanidin content, correlating strongly with the strongest radical-scavenging activity observed using the 2,2-diphenyl-1-picrylhydrazyl assay, and led to the first reported isolation of the phytosterol spinasterol from *P. caimito* leaves (França et al., 2016). A subsequent ultra-performance liquid chromatography–quadrupole time-of-flight mass spectrometry investigation of leaf extracts corroborated the presence of triterpenes, saponins, alkaloids and flavonoids, with phytochemical fractionation showing that triterpenes and steroids predominated in hexane fractions while triterpenes, steroids, saponins, flavonoids and catechins co-occurred in more polar ethyl acetate and crude ethanolic fractions (de Sousa et al., 2019). Peel-focused phytochemical work has further catalogued flavonoids including quercetin, kaempferol, luteolin and apigenin; triterpenes such as lupeol, α-amyrin, erythrodiol, ursolic acid, oleanolic acid and hederagenin; and phenolic acids including chlorogenic, caffeic and ferulic acid, alongside polysaccharides and alkaloids (Li et al., 2025). Fruit-derived triterpenoid isolation work identified thirteen compounds for the first time from *P. caimito* fruit, nine of which were triterpenoids, with subsequent bioassay confirming pharmacological activity for several of the isolated constituents (Zhao et al., 2024).

Within the broader genus, comparative phytochemical surveys situate *P. caimito* alongside related species possessing polyphenolic antioxidant profiles dominated by gallic acid, catechin derivatives and flavonoid glycosides. An early foundational study isolating seven polyphenolic antioxidants from the fruits of three congeneric species — *P. campechiana*, *P. sapota* and *P. viridis* — found the highest polyphenol levels and corresponding radical-scavenging activity in *P. sapota*, providing useful comparative context for interpreting the relative antioxidant capacity of *P. caimito* within the genus (Ma et al., 2004).

5.3 Volatile Compounds and Aroma Chemistry

Volatile profiling indicates that the compounds contributing to the characteristic aroma of *P. caimito* differ markedly between plant organs and fruit ripening stages. Leaves are dominated by defensive and protective compounds, ripening and unripe fruit tissues show a shift toward ketone and aldehyde volatiles associated with ripening aroma, and peel tissue in particular contains aldehyde compounds alongside capsaicin, a constituent also linked to fruit-protective function. This organ-specific and stage-specific volatile chemistry has practical relevance for both flavour-quality assessment and for interpreting the plant's chemical ecology, though the underlying data remain drawn from a small number of studies and would benefit from replication across a wider range of cultivars and growing environments.

Table 3 summarises the principal phytochemical classes identified across different plant parts of *P. caimito*, drawing together the findings discussed in this section.

Table 3. Summary of principal phytochemical classes reported in *Pouteria caimito* by plant part

Plant part	Principal phytochemical classes reported	Notable specific compounds
Peel	Phenolic acids, flavonoids, triterpenoids, polysaccharides, alkaloids	Quercetin, kaempferol, chlorogenic acid, ursolic acid, oleanolic acid, catechin derivatives
Pulp	Sugars, organic acids, moderate phenolics, minerals (potassium, magnesium)	Catechin derivatives, fatty acids (palmitic, elaidic, linoleic)
Leaves	Triterpenes, saponins, alkaloids, flavonoids, proanthocyanidins	Spinasterol, catechin, proanthocyanidins
Fruit (isolated compounds)	Triterpenoids with anti-inflammatory and antiviral activity	Nine isolated triterpenoids, including compounds active against respiratory syncytial virus and herpes simplex virus

Sources: de Sousa et al. (2019); França et al. (2016); Li et al. (2025); Cavalcante de Oliveira et al. (2025); Zhao et al. (2024)

6. Postharvest Physiology and Quality Management

6.1 Ripening Behaviour and Respiratory Pattern

Pouteria caimito exhibits climacteric ripening behaviour, with harvest maturity stage exerting a substantial influence on subsequent storage performance. A controlled comparison of fruit harvested at half-ripe versus fully-ripe stages found that fully-ripe fruit reached its climacteric respiratory peak on day six of storage and possessed a sweeter taste and brighter yellow colour, but browned rapidly and achieved a shelf life of only around six days, whereas half-ripe fruit reached its climacteric peak on day eight, browned more slowly, and achieved a longer shelf life of nine to ten days despite a moderately sweeter rather than fully sweet taste (Arif et al., 2022). The pulp browning index of fully-ripe harvested fruit was roughly twofold higher than that of half-ripe fruit throughout storage, leading the authors to recommend half-ripe harvest as the preferable compromise between fruit quality and postharvest longevity under the Indonesian production and marketing conditions the trial was conducted in.

6.2 Enzymic Browning and Chilling Injury

Rapid enzymic browning, mediated principally by polyphenol oxidase activity acting on the fruit's substantial phenolic reservoir, represents the single most significant constraint on the commercial shelf life of *P. caimito*. Storage-temperature trials conducted in China found that cold storage at 5 degrees Celsius induced chilling injury within three days, manifesting as pitting and a water-soaked appearance of the fruit surface together with accelerated peel browning, whereas storage at 10 degrees Celsius maintained higher fruit hardness, total soluble solids, vitamin C and total sugar content alongside lower respiratory intensity and reduced cell-membrane permeability relative to the other temperatures tested (He et al., 2023). This finding points to 10 degrees Celsius as a more suitable postharvest storage temperature than either colder or warmer alternatives, though reported shelf life at temperatures of this order still remains substantially shorter than that achievable for most major commercial tropical fruits.

6.3 Postharvest Treatments Extending Shelf Life

Several exogenous chemical treatments have been evaluated as means of mitigating browning and extending marketable shelf life. Pre-storage dipping of fruit in oxalic acid solution measurably delayed the onset of peel and pulp browning symptoms relative to untreated controls, with the effect attributed to suppression of phenolic-compound oxidation and inhibition of the rise in polyphenol oxidase activity and malondialdehyde content that otherwise accompanies storage-related senescence (Arif et al., 2023). A complementary study using ascorbic acid dips found that a ten-millimolar concentration extended shelf life to approximately twelve days, nine days longer than untreated control fruit, while also reducing the rate of fruit weight loss during storage — indicating that ascorbic acid acts both as an antioxidant limiting browning and as a moisture-retention aid (Susanto et al., 2023). Ethylene-based dip and soak treatments have separately been investigated for their capacity to mitigate fruit shrivelling during storage of half-ripe fruit, with soak-application treatments found capable of reducing shrivelling incidence and modestly extending shelf life. Taken together, these findings suggest that postharvest quality management of this species is likely to require a combination of maturity-stage selection, chemical dips and temperature control rather than any single intervention applied in isolation.

The postharvest treatments discussed above, together with their principal reported outcomes, are summarised in Table 4.

Table 4. Summary of postharvest treatments evaluated for *Pouteria caimito*

Treatment	Key outcome	Reference
Half-ripe versus fully-ripe harvest maturity	Half-ripe fruit: slower browning, shelf life 9–10 days; fully-ripe fruit: shelf life ~6 days	Arif et al. (2022)
Oxalic acid pre-storage dip (5–10 mM)	Delayed browning onset; suppressed polyphenol oxidase activity and malondialdehyde accumulation	Arif et al. (2023)
Ascorbic acid dip (10 mM)	Shelf life extended to ~12 days; reduced weight loss during storage	Susanto et al. (2023)
Storage temperature comparison (5, 10, 15, 20 °C)	10 °C optimal; 5 °C induced chilling injury within 3 days	He et al. (2023)

Sources: Arif et al. (2022, 2023); He et al. (2023); Susanto et al. (2023)

7. Pharmacological and Functional Properties

7.1 Antioxidant Activity

Antioxidant capacity has been the most extensively documented bioactivity of *P. caimito*, assessed principally through 2,2-diphenyl-1-picrylhydrazyl, 2,2′-azino-bis radical-cation and ferric-reducing antioxidant power assays. Leaf extracts have demonstrated among the strongest activity reported for the species, with aqueous extracts showing a substantially lower effective concentration for fifty per cent radical scavenging than corresponding hexane and ethanolic extracts, consistent with the higher total phenolic and proanthocyanidin content of the aqueous fraction (França et al., 2016; Fitriansyah et al., 2021). Peel extracts likewise consistently outperform pulp and seed fractions across antioxidant assays, aligning with the greater phenolic and flavonoid density of peel tissue documented in Section 5.2.

7.2 Antimicrobial and Antidiarrhoeal Activity

Methanolic extracts of *P. caimito* fruit peel have demonstrated measurable antimicrobial activity against tested bacterial strains alongside antidiarrhoeal effects assessed using standard in vivo models, findings interpreted by the original investigators as providing pharmacological corroboration for the fruit's traditional use in treating diarrhoea and gastrointestinal disturbance (Abreu et al., 2019). These findings remain based on a limited number of microbial strains and a single research group's dataset, and would benefit from independent replication using a broader microbial panel and standardised minimum inhibitory concentration reporting to strengthen confidence in the magnitude and consistency of the effect.

7.3 Anti-inflammatory and Antiviral Activity

The most pharmacologically detailed investigation of *P. caimito* to date isolated thirteen compounds from fruit extracts, nine of which were triterpenoids, and found that several exhibited measurable anti-inflammatory activity in vitro alongside activity against respiratory syncytial virus and herpes simplex virus to varying degrees among the triterpenoid constituents tested (Zhao et al., 2024). The authors quantified the content of the most pharmacologically active isolated compound in fresh fruit and concluded that the species holds credible potential as a natural source of triterpenoids for functional-food or nutraceutical development targeting inflammatory and viral indications. As with the antimicrobial findings above, this remains a single-study result requiring independent confirmation, and the isolated compounds have not yet been evaluated in animal models or clinical contexts.

7.4 Cytotoxicity, Safety and Nanoparticle Applications

Comprehensive cytotoxicity assessment of pulp and peel extracts using standard cell-viability assays found no toxic effects on the cell lines tested, supporting the general safety of the fruit for dietary and topical application within the concentration ranges assessed (Cavalcante de Oliveira et al., 2025). *Pouteria caimito* fruit extract has additionally attracted interest as a reducing and stabilising agent in green nanoparticle synthesis, reflecting the fruit's substantial antioxidant and reducing-sugar content. Iron oxide nanoparticles synthesised using *P. caimito* fruit extract exhibited a nanorod morphology with an average particle size in the low nanometre range and demonstrated non-toxic behaviour in cytotoxicity assays, leading the authors to propose potential application in cancer-cell targeting (Veeramani et al., 2022). These nanotechnology applications, while illustrative of the fruit's phytochemical reactivity, remain at an early exploratory stage and should be interpreted as proof-of-concept findings rather than evidence of therapeutic efficacy.

Table 5 consolidates the pharmacological and functional bioactivities reviewed in this section.

Table 5. Summary of pharmacological and functional bioactivities reported for *Pouteria caimito*

Bioactivity category	Principal plant part studied	Summary finding
Antioxidant	Leaves, peel, pulp	Peel and leaf aqueous extracts show strongest radical-scavenging activity, correlating with phenolic content
Antimicrobial / antidiarrhoeal	Fruit peel (methanolic extract)	Measurable activity against tested bacterial strains; in vivo antidiarrhoeal effect reported

Bioactivity category	Principal plant part studied	Summary finding
Anti-inflammatory / antiviral	Fruit (isolated triterpenoids)	Several isolated triterpenoids active against respiratory syncytial virus and herpes simplex virus, and in anti-inflammatory assays
Cytotoxicity / safety	Pulp, peel	No cytotoxic effects observed in tested cell lines
Nanoparticle synthesis	Fruit extract	Non-toxic iron-oxide nanoparticles synthesised, explored for oncology-related applications

Sources: Abreu et al. (2019); França et al. (2016); Cavalcante de Oliveira et al. (2025); Veeramani et al. (2022); Zhao et al. (2024)

8. Food Industry Applications and Value Addition

The combination of high soluble-solids content, distinctive custard-like texture and demonstrated phenolic reactivity positions *P. caimito* as a candidate raw material for functional-food and value-added product development, though systematic food-technology research on the species specifically remains limited relative to congeneric *Pouteria* fruits such as canistel, for which bakery incorporation, seed-flour development and mousse formulation have each been investigated in some depth (Do et al., 2023). Peel, typically discarded as a processing by-product, has been shown to be recoverable as a phenolic-rich extract through optimised ultrasonic-assisted extraction, with response-surface methodology identifying ethanol concentration, extraction temperature and solid-to-liquid ratio as principal variables governing total phenolic yield, and demonstrating that a simple blanching pre-treatment can substantially increase recoverable phenolic content by limiting polyphenol-oxidase-mediated degradation during processing (Li et al., 2025). This finding is directly relevant to circular-economy approaches within tropical fruit-processing supply chains, since it indicates that peel otherwise treated as waste could be diverted into cosmetic, nutraceutical or food-antioxidant applications rather than discarded.

Broader reviews of the genus *Pouteria* as a source of bioactive compounds for the food industry have highlighted patent activity and preliminary product development spanning jams, mousses and functional beverages derived from related species, framing *P. caimito* within a wider trend toward valorisation of underutilised Sapotaceae fruits for antioxidant-rich food ingredients (Cavalcante de Oliveira et al., 2023). Realising this potential at commercial scale will, however, require the postharvest and supply-chain limitations discussed in Section 6 to be addressed, since the fruit's short shelf life and rapid browning currently constrain both fresh-market distribution and the logistics of delivering intact raw material to processing facilities.

9. Comparative Perspective within Sapotaceae

Situating *P. caimito* alongside better-studied congeners clarifies both its distinctive characteristics and the scale of the remaining knowledge gap. Comparative polyphenol profiling across *P. campechiana*, *P. sapota* and *P. viridis* found *P. sapota* to possess the highest levels of the polyphenols measured and correspondingly the strongest antioxidant activity among the three species, with *P. campechiana* the lowest (Ma et al., 2004), while more recent comprehensive reviews of *P. campechiana* document a substantially larger and more mature literature encompassing detailed nutritional tables, food-product development trials and multiple independent pharmacological studies (Do et al., 2023). Other underutilised Amazonian *Pouteria* species show a similar pattern of localised, extraction-focused research: *P. macrophylla*, known regionally as cutite, has been investigated principally as a natural source of gallic acid, with demonstrated extract stability under variable light, temperature and storage conditions, again concentrated within a small number of Brazilian laboratories (Pantoja et al., 2023). More broadly, comparative antioxidant and anti-proliferative screening of other Amazonian fruits such as copoazú and buriti points to a wider regional research trend toward bioprospecting underutilised Amazonian species for functional and pharmaceutical applications, a trend that *P. caimito* sits within rather than stands apart from (Saldarriaga et al., 2025).

By contrast, comparable breadth of coverage for *P. caimito* remains absent: postharvest physiology research is concentrated within a small number of Indonesian and Chinese research groups, phytochemical characterisation is dominated by a comparably small number of Brazilian and Chinese laboratories, and no dedicated comprehensive review, cultivar-improvement programme or established international germplasm collection specific to the species has yet emerged in the peer-reviewed literature. This asymmetry within a single genus illustrates how commercialisation trajectories among related underutilised fruit species can diverge sharply depending on which national research infrastructures happen to engage with a given species, rather than necessarily reflecting differences in underlying biological or commercial potential.

10. Future Directions

Advancing *P. caimito* from a locally significant Amazonian fruit toward a more broadly commercialised emerging tropical crop will require research investment across several complementary fronts. Molecular characterisation should extend beyond the plastid genome assemblies presently available to encompass nuclear genome sequencing and the development of microsatellite or single-nucleotide-polymorphism marker panels capable of resolving genetic diversity among wild, landrace and cultivated accessions, providing the foundation for informed germplasm conservation and breeding decisions. Systematic agronomic trials addressing propagation optimisation, including controlled comparison of grafting, air-layering and cutting-based clonal methods together with rootstock compatibility testing, would help close the substantial gap between horticultural guidance presently derived from grower experience and the controlled trial evidence available for major fruit crops. Postharvest research would benefit from expanding beyond the presently narrow set of chemical dip treatments to explore modified-atmosphere packaging, edible coatings and controlled-atmosphere storage regimes capable of further extending the fruit's markedly short shelf life, alongside mechanistic studies clarifying the specific polyphenol oxidase isoforms and browning-substrate interactions responsible for the fruit's pronounced susceptibility to enzymic discoloration. Pharmacological findings to date, while consistently positive, rest overwhelmingly on in vitro and preliminary in vivo evidence from single research groups; independent replication, dose-response characterisation and progression toward validated animal models would be necessary before any of the reported anti-inflammatory, antiviral or antimicrobial activities could reasonably inform functional-food or nutraceutical claims. Finally, integrated value-chain research connecting orchard-level production economics, postharvest logistics and food-industry processing pathways would help clarify the realistic commercial niches — whether fresh-market diversification, functional-ingredient extraction, or Amazonian agro-biodiversity branding — in which *P. caimito* is most likely to achieve durable market traction.

11. Conclusions

Pouteria caimito presents a coherent and increasingly well-documented case for a tropical fruit species with genuine nutritional, phytochemical and pharmacological merit, distinguished by a peel and leaf phytochemistry unusually rich in triterpenoids, flavonoids and phenolic acids that underlie consistently reported antioxidant, antimicrobial, anti-inflammatory and antiviral activities across the available in vitro and preliminary in vivo evidence. Its pulp is nutritionally distinguished among Amazonian fruits by exceptionally high soluble solids and sugar content, and its cultivation has already demonstrated ecological adaptability across markedly different tropical production environments spanning the Americas, Southeast Asia and northern Australia. At the same time, the species remains constrained by a postharvest physiology characterised by rapid climacteric ripening, pronounced enzymic browning and susceptibility to chilling injury that currently limits shelf life to a fraction of that achievable for major commercial tropical fruits, and by an agronomic and genetic knowledge base that lags substantially behind that available for related, more thoroughly domesticated Sapotaceae crops. The overall picture is of a fruit with credible commercial and functional-food potential whose realisation depends less on further confirmation of its basic bioactive value, which is now reasonably well established, and more on targeted investment in propagation science, postharvest technology and pharmacological validation capable of converting promising laboratory findings into a reliable, scalable supply chain.

12. Limitations

This review is subject to several limitations inherent to both the narrative methodology adopted and the underlying evidence base for *P. caimito* specifically. The narrative approach, while well suited to synthesising heterogeneous cross-disciplinary literature, does not permit formal quantitative pooling of effect sizes and consequently cannot provide statistically weighted conclusions regarding the relative magnitude of, for example, postharvest treatment efficacy or antioxidant potency across studies employing differing assay conditions. The underlying primary literature itself is concentrated within a small number of research groups based in Brazil, Indonesia and China, several of whose findings — particularly regarding antimicrobial, antidiarrhoeal and antiviral activity — currently rest on single published studies that have not yet been independently replicated, meaning that the apparent consistency of positive pharmacological findings across this review should not be mistaken for the weight of evidence that independent multi-laboratory confirmation would provide. Much of the phytochemical and pharmacological evidence derives from in vitro assays or small-scale animal experiments rather than validated clinical or field-scale agronomic trials, limiting the extent to which conclusions can be extrapolated to human health outcomes or commercial-scale cultivation performance. The horticultural and pest-management literature on this species is particularly thin, and several practical claims commonly repeated in extension and grower material could not be substantiated against peer-reviewed sources and were accordingly omitted rather than included on weaker footing. Finally, because the species is taxonomically and nominally confusable with *Chrysophyllum cainito* in some regional literature, residual uncertainty cannot be entirely excluded regarding whether isolated older or grey-literature sources excluded from this review may have occasionally conflated the two species; the inclusion criteria applied here sought to minimise this risk, but readers consulting the primary literature independently should verify binomial nomenclature carefully.

Declaration of AI Use

This manuscript was prepared through the combined contributions of all author(s), including contributions to the study design, data, content development, results, interpretation, and related scholarly work. The author(s) acknowledge the use of Grammarly and ChatGPT to assist with grammar checking, language refinement, reference formatting. These AI-assisted tools were not used as authors and did not replace the intellectual contributions or scholarly judgment of the author(s). All AI-assisted outputs, including content, references, and interpretations, were carefully reviewed, revised, verified, and approved by the author(s). The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

Competing Interests

Authors have declared that no competing interests exist.

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