CODEN [USA]: IAJPBB ISSN : 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

SJIF Impact Factor: 7.187

https://doi.org/10.5281/zenodo.16794937

https://www.iajps.com/volumes/volume12-august-2025/13-issue-08-august-25/

Available online at: http://www.iajps.com *Review Article*

EXPLORING THE NUTRITIONAL AND BIOACTIVE COMPOUNDS OF MYRCIARIA DUBIA IMPLICATIONS FOR HUMAN HEALTH

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Abstract:

Myrciaria dubia (kunth) Mc Vaugh, commonly known as camu camu, is an Amazonian fruit celebrated as a super fruit due to its exceptionally high content of bioactive and antioxidant compounds, including ascorbic acid, carotenoids, phenolic compounds, polyphenols, flavonoids, anthocyanins and ellagic acid. The pulp, peel and seeds of camu camu have demonstrated significant bio-functional properties, supported by extensive in vitro and in vivo studies. These include antioxidant, antihyperglycemic, antihypertensive, anti-obesity, antimicrobial anti-inflammatory, antiproliferative, antihepatotoxic, antimutagenic and cell rejuvenation activities, all contributing to improved quality of life. Nutritional analysis of camu camu pulp reveals valuable components such as total soluble solids, energy, proteins, carbohydrates, dietary fiber, ash, calcium, phosphorus, iron, thiamine, riboflavin, niacin and high levels of vitamin c. These combined nutritional and therapeutic properties underscore the potential of camu camu as a functional food and a key contributor of the amazon bioeconomy, promoting the development of bio-functional food ingredients with proven health benefits.

***Keywords**: Myrciaria dubia, camu camu, vitamin C, antioxidants, flavonoids, anthocyanins, bioactive compounds, functional foods, nutraceuticals.*

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Please cite this article in press M. Indhira et al., ***Exploring The Nutritional And Bioactive Compounds Of Myrciaria Dubia Implications For Human Health****., Indo Am. J. P. Sci, 2025; 12(08).*

1.INTRODUCTION:

Pharmacognosy is the study of medicinal drugs from natural sources like plants, animals, minerals, and microbes. It focuses on identifying, extracting, and analyzing bioactive compounds for therapeutic use. Myrciaria dubia (camu camu) is an Amazonian fruit shrub rich in vitamin C, amino acids, B-complex vitamins, and bioactive compounds with antioxidant, anti-inflammatory, and other health benefits. Its fruits, leaves, and roots contain phytochemicals such as phenolics, carotenoids, and terpenoids, validated through in vitro and in vivo studies. These compounds are synthesized via pathways like glycolysis, shikimate, and phenylpropanoid. While pulp and skin are widely studied, camu camu seeds—often discarded—contain valuable compounds with potential against malaria, schistosomiasis, and leishmaniasis. Their by-products are economically beneficial and supported by reliable cultivation systems. In Peru, camu camu is cultivated by smallholders in flood-prone areas. The government promotes it as a flood-resistant crop. However, using seeds from wild plants leads to high variability. Clonal propagation offers stability but is expensive. Low-cost methods like outdoor propagation and non-mist systems have shown success, especially in non-flooded seasons.

Figure 1. Visual representation of Myrciaria dubia

2.AIM AND OBJECTIVES:

AIM:

To explore the nutritional composition and bioactive compounds of Myrciaria dubia (camu-camu) and evaluate their implications for human health, with a focus on disease prevention, health promotion, and potential therapeutic applications

OBJECTIVES:

The objectives of this study are to determine the macro- and micronutrient profile of Myrciaria dubia, with particular emphasis on its vitamin C and antioxidant content, and to identify and quantify key bioactive constituents such as phenolics, flavonoids, anthocyanins, and tannins. The study will examine changes in nutritional and phytochemical content across different fruit ripening stages and processing methods, and investigate the antioxidant, anti-inflammatory, antimicrobial, antidiabetic, and neuroprotective properties of *M.* dubia through in vitro studies. Furthermore, it will review existing clinical and epidemiological evidence on the role of *M.* dubia in supporting immune function, metabolic health, and the prevention of chronic diseases. Finally, the research will explore the potential applications of M. dubia in the development of functional foods, nutraceuticals, and dietary supplements for use in public health nutrition initiatives.

BOTANICAL CLASSIFICATION

- Domain : Eukaryota
- Kingdom : Plantae
- Phylum : Angiosperms
- Class : Magnoliopsida
- Order : Myrtales
- Family : Myrtaceae
- Genus : Myrciaria
- Species : Myrciaria dubia
- Synonym : Myrciaria paraensis
- Common name : Camu Camu

VERNACULAR NAME

- English : Rum berry
- Spanish : Cacari
- Portuguese : Camu Camu
- Japanese : Kamu Kamu
- French : Camu Camu
- Hindi : Kaimu Kaimu
- Malayalam : Kamu Kamu
- Tamil : Kamu Kamu

3.DESCRIPTION

Myrciaria dubia (Kunth) McVaugh, or camu camu, is a 2–5 m Amazonian shrub/tree native to Peru, Brazil, and Colombia, thriving in riverbanks and floodplains. It is cultivated for its high vitamin C content and has opposite, lanceolate to oblong leaves with acuminate apex, cuneate base, and entire margins.

4.ETHANOCLAIM USES

1. **LEAVES:**Rastogi and Mehrotra (1993) found that Myrciaria dubia leaf extracts show inotropic, positive chronotropic, and spasmolytic effects, suggesting benefits for cardiovascular function and smooth muscle relaxation[1].
2. **FRUITS:**Oliver-Brewer (1986) noted that the fruits, which are sweet and astringent, are traditionally valued for treating blood disorders and used as anti-dysenteric and anti-helminthic remedies[2].
3. **SEEDS:**Alawa K. S. et al. (2015)

reported that Myrciaria dubia seeds are traditionally used as a natural anthelmintic to treat parasitic worm infections in rural and indigenous communities[3].

4. **BARK:**Kirtikar K. R. et al. (1987) reported that Myrciaria dubia bark, rich in tannins, is traditionally used as an astringent and tonic to promote healing, aid digestion, and support overall health[4].
5. **WHOLE PLANT:**Oliver-Brewer (1986) noted that Myrciaria dubia is traditionally used in Amazonian medicine for anti-inflammatory, wound-healing, anti-anxiety, anti-stress, anti-mutagenic, and spasmolytic purposes, with different plant parts used alone or in combination[5].

5.PHYTOCHEMICAL REVIEW

1. **LEAVES:** Susanta Kumar Mondal et al. (2007) found that Myrciaria dubia leaf aqueous extract contains phytosterols, phenols, proteins, steroids, and saponins, while the ethanolic extract contains alkaloids, phenols, phytosterols, carbohydrates, glycosides, and proteins[6].
2. **FRUIT:** Baskar et al. (2007) found volatile compounds in Myrciaria dubia fruit, including α- pinene, β-pinene, myrcene, limonene, terpinen-4-ol, and germacrene D, which enhance its aroma and offer antioxidant and anti-inflammatory benefits[7].
3. **SEED:** Maeda et al. (1993) identified numerous bioactive compounds in Myrciaria dubia seeds, including acetogenins like annotemoyin-1/2, squamosin, squamocin variants, and samoquasine A, which contribute to insecticidal, anticancer, and antihelminthic activities[8].
4. **LEAVES AND ROOTS:** Chang et al. (1993) reported sesquiterpenes like spathulenol, muurolene, copaene, and eudesmol in Myrciaria dubia leaves and roots, which provide anti- inflammatory, antimicrobial, and antioxidant effects, as well as a medicinal aroma[9].
5. **WHOLE PLANT:** Silva et al. (2020) found that Myrciaria dubia contains phenolics, flavonoids, tannins, alkaloids, and terpenoids, with notable antioxidant and anti-inflammatory activities, indicating strong phytotherapeutic potential[10].

6.PHARMACOLOGICAL REVIEW:

1. **ANTI-OXIDANT ACTIVITY:** Myrciaria dubia is a potent antioxidant with up to 2,800 mg vitamin C per 100 g pulp, plus ellagic acid, flavonoids, and anthocyanins that combat oxidative stress, neutralize free radicals, and support anti-aging[11].
2. **ANTI-MICROBIAL ACTIVITY:** Methanol and dried camu leaf extracts show strong inhibition of pathogens like E. coli, S. aureus, and P. aeruginosa, mainly due to tannins and polyphenols[12].
3. **ANTI-DIABETIC ACTIVITY:** Myrciaria dubia fruit and seed extracts improve diabetic conditions in rats by lowering fasting blood glucose, enhancing insulin sensitivity, and supporting β-cell function, likely through glucose transporter modulation and α-glucosidase inhibition[13].
4. **HEPATOPROTECTIVE ACTIVITY:** Camu extract shows hepatoprotective effects in paracetamol-induced liver damage by reducing ALT, AST, and tissue injury, mainly due to its phenolics and vitamin C, which decrease lipid peroxidation[14].
5. **ANTI-OBESITY AND LIPID-MODULATING ACTIVITY:**Regular consumption of camu camu juice has been linked to reduced visceral fat, improved lipid profiles (lower LDL and triglycerides), and decreased weight gain in both human and animal studies[15].
6. **NEUROPROTECTIVE ACTIVITY:** Flavonoids and anthocyanins in camu camu support mitochondrial function and reduce oxidative damage in neurons. By lowering ROS levels in brain cells, camu camu may help protect against neurodegenerative diseases[16].
7. **ANTI-HYPERTENSIVE ACTIVITY:** Although limited, research suggests that Myrciaria dubia (camu camu) may help lower blood pressure by inhibiting the ACE-I enzyme, linked to hypertension. While its pulp shows no ACE-I inhibition, dried pericarp and seed extracts especially in fermented soymilk demonstrate moderate to strong ACE-I inhibition, likely due to compounds like quercetin and ellagic acid[17].
8. **ANTI-INFLAMMATORY ACTIVITY:** Myrciaria dubia exerts anti-inflammatory and antioxidant effects mainly through its high vitamin C content, which reduces oxidative stress and eliminates reactive oxygen species (ROS). Its polyphenols, particularly flavonoids, further reduce pain and swelling by regulating gene expression and inhibiting the COX-2 enzyme[18].
9. **CARDIO-PROTECTIVE ACTIVITY:**

Myrciaria dubia supports cardiovascular and metabolic health due to its high antioxidant and vitamin C content. It helps lower blood pressure, inflammation, oxidative stress, and LDL cholesterol, making it a promising natural option for preventing and managing diabetes, heart disease, and obesity[19].

10. **DNA DAMAGE AND CANCER PROTECTION EFFECTS:** Camu camu (Myrciaria dubia) exhibits strong protective effects against genetic damage, mutations, and cancer, thanks to its high vitamin C, flavonoid, and phenolic content. Studies show it is non-genotoxic and has antigenotoxic and anti-mutagenic properties, reducing DNA damage and mutation rates. It also demonstrated anticancer effects by inhibiting tumor growth in liver and colorectal cancer models without causing toxicity[20].
11. **NEUROPROTECTIVE AND IMMUNOLOGICAL EFFECTS:** Camu camu (Myrciaria dubia) has shown neuroprotective and immune-boosting effects in preclinical studies. Extracts reduced neurotoxicity and paralysis in C. elegans models of Alzheimer's and Parkinson's, enhanced immunity and growth in fish, and boosted immune cell activity in rats. These benefits are linked to its bioactive, low-molecular-weight antioxidants[21].

Figure2. the visual representation of Nutrition and Health

7.COMPOSITION OF CAMU CAMU PULP

Camu camu (Myrciaria dubia) is exceptionally high in vitamin C (845–2700 mg/100g), with peak levels typically in semi-ripe to ripe fruits. It has the highest vitamin C content among tropical fruits. Its aroma profile includes 21 volatile compounds, mainly α-pinene and D-limonene[22].

Table 1. Composition of camu camu pulp

COMPONENT	VALUE PER 100G OF PULP
Total soluble solids	7.7g
Energy	7.1kJ
Protein	0.5g
carbohydrate	4.7g
Fibre	0.6g
Ash	0.2g
Calcium	27.0mg
phosphorus	17.0mg
Iron	0.5mg
Thiamine	0.01mg
Riboflavin	0,04mg
Niacin	0.062mg
Ascorbic acid	2780mg
Vitamin C1	2994mg

8.BIOACTIVE PROFILE OF MYRCIARIA DUBIA

1. **ASCORBIC ACID:** Camu camu's ascorbic acid levels peak at 2900 mg/100g in mid-ripe fruits, with green and fully ripe fruits containing around 2100 mg/100g. After one week of storage at 20°C and 85% humidity, vitamin C content drops by about 50%. Differences in reported peak levels may result from environmental or geographical factors[23].
2. **CAROTENOIDS:** Camu camu contains notable carotenoid levels, especially in the pulp (619.98 mg β-carotene/100g) and to a lesser extent in the peel-seed mix. Sixteen carotenoids were identified, with trans-lutein being the most abundant. Carotenoid levels decrease as the fruit matures, though they remain present even without visible yellow coloration. These compounds may offer health benefits, such as protection against cardiovascular diseases and cancer, though more research is needed on their bioavailability and effects[24].
3. **VITAMIN C:** Camu camu is a rich natural source of vitamin C (ascorbic acid), especially in the peel, with none found in the seeds. Vitamin C content increases with fruit maturity and varies by genotype and fruit part. Extraction and processing methods significantly affect its levels sulfuric acid is most effective for extraction, and freeze-drying preserves the most vitamin C. High heat and spray-drying reduce its content, while maltodextrin is the best carrier agent for retention. Proper harvesting and processing are essential to preserve camu camu's vitamin C and health benefits[25].
4. **PHENOLIC COMPOUNDS:** Camu camu is rich in polyphenols—especially in its peel and seeds—which provide antioxidant, anti-inflammatory, antidiabetic, and anticancer benefits. Key compounds include anthocyanins, flavanols, ellagitannins, and proanthocyanidins. Their levels vary with ripening, genotype, region, and processing methods. Freeze-drying best preserves polyphenols, while high heat reduces them. Carrier agents like maltodextrin help retain these compounds during microencapsulation. Byproducts are used in value-added products like juices and cookies, enhancing both health benefits and product acceptability[26].
5. **POLYPHENOLS AND FLAVONOIDS:** Myrciaria dubia (camu camu) is rich in flavonoids and polyphenols like quercetin, anthocyanins, tannins, and ellagic acid, which offer strong antioxidant and anti-inflammatory benefits. These compounds reduce oxidative stress, suppress inflammatory mediators (e.g., COX-2, IL-6), and activate antioxidant pathways (e.g., Nrf2). Camu camu supports immune health, tissue repair, and may help manage inflammation- related conditions when included in the diet or functional foods[27].
6. **ANTHOCYANINS AND ELLAGIC ACID:** Myrciaria dubia (camu camu) is rich in anthocyanins and ellagic acid, potent antioxidants that protect against oxidative stress and chronic diseases like heart disease, diabetes, and cancer. Anthocyanins boost antioxidant enzymes and enhance vitamin C effects, while ellagic acid regulates disease-related genes[28].
   Together, they support heart and brain health, improve insulin sensitivity, and combat metabolic and inflammatory disorders.

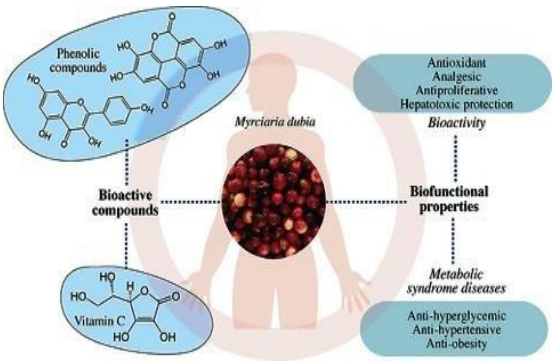

Figure 3. Additional Nutrients in Camu camu powder

9.CONCLUSION:

Camu camu (Myrciaria dubia) stands out as a nutritionally dense and pharmacologically valuable Amazonian superfruit, rich in vitamin C and a wide range of bioactive compounds. Its pulp, peel, and seeds exhibit diverse therapeutic effects, including antioxidant, anti-inflammatory, antihyperglycemic, antihypertensive, and antimicrobial activities, making it a promising functional food ingredient. The fruit's impressive nutritional profile, coupled with its scientifically validated health benefits, highlights its potential for use in the prevention and management of chronic diseases. Furthermore, the sustainable cultivation and commercialization of camu camu can play a significant role in enhancing the Amazon bioeconomy, providing both health and economic benefits at local and global levels. The anti-fungal

effect may be due to the presence of phytoconstituents. Further activity may be developed and furture investigation may lead to separate the phyto-principles from this plant.

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