Rekha Bora, 2026, 14:3
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

International Journal of Science, Engineering and Technology
An Open Access Journal

Blood Fruit, Haematocarpus validus Bakh. f. ex Forman: A Underutilized Edible Plant from India

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Abstract- Blood fruit (Haematocarpus validus Bakh. f. ex Forman) is a lesser-known, underutilized woody climber or liana belonging to the family Menispermaceae, mainly found in Northeast India, the Andaman and Nicobar Islands, and few other parts of Southeast Asia. It has long been used by indigenous communities as a fruit and traditional medicine for treating blood-related disorders, jaundice, and skin ailments. The fruit is rich in iron, vitamin C, carotenoids, phenolic compounds, flavonoids, and anthocyanins, making it a valuable source of natural antioxidants with potential applications in the food, pharmaceutical, nutraceutical, and natural dye industries. This review summarizes the current knowledge on the taxonomy, distribution, botanical characteristics, traditional uses, nutritional and phytochemical composition, pharmacological properties, ecological importance, and commercial potential of H. validus. It also focusses on current work on its anthocyanin content, physicochemical properties, and value-added applications. Although recent studies have been conducted on this plant, research on this species remains limited. Therefore, this review identifies the major research gaps and emphasizes the need for further studies on conservation, cultivation, product development, and sustainable utilization to promote the wider use of this valuable native fruit while supporting biodiversity conservation and rural livelihoods.

Keywords: Haematocarpus Validus, Blood fruit, Menispermaceae, Phytochemicals, Anthocyanins, Nutritional composition, Physical and Morphological Characteristics.

I. INTRODUCTION

Haematocarpus validus (Miers.) Bakh. f. ex Forman, has been reported under several synonyms, including *Baterium validum, Fibraurea haematocarpus, Haematocarpus comptus* Miers, and *Haematocarpus thomsonii* Miers [1, 2].

It has common names, blood fruit (English) , Khoon phal (Hindi), Roktogula or Lalgula (Bengali), Rosco (Chakma), Thoyphal (Tripura), Te.pattang (Garo), Theichhung-sen (Mizo), Ranguichi (Marma), Raktaphal (Tamil, Telugu, and Malayalam), and Sohsnam (Khasi and Pnar) [2]. The species is native to the tropical forests of South and Southeast Asia and is distributed in India, Bangladesh, Myanmar, Thailand, Malaysia, Indonesia, and other neighboring countries. In India, it is predominantly reported in the Northeastern states and the Andaman and Nicobar Islands. The plant grows in evergreen and semi-evergreen forests of such regions [3,4]. *H. validus* is a strong liana with broad cordate leaves, small greenish-yellow flowers, and deep red globose berries which contain a juicy edible pulp [5].

Blood fruit has been an important non-timber forest product for the indigenous and rural communities for its nutritional and medicinal properties. The fruits are either consumed fresh as beverages, jams, and natural dyes, or as a folk medicine to cure blood-related disorders, jaundice, skin irritation, and other ailments. The plant act as a part of the forest ecology by providing food to the frugivorous animals and supporting natural forest regeneration. However, large number of fruits are being unsustainably harvested from the wild which leads to habitat destruction, deforestation, and climate change [4].

In recent years, blood fruit gets significant scientific attention because of its special nutritional and phytochemical availabilities. Study revealed that the fruits are rich in iron, vitamin C, carotenoids, phenolic compounds, flavonoids, anthocyanins, and other antioxidants significant health-promoting properties [4]. Among these, anthocyanins are responsible for the deep-red colour to the fruit which have effective antioxidant activity. Studies have identified pelargonidin as the major anthocyanin, minors are the cyanidin, peonidin, and petunidin. Therefore, these fruits can be used as natural source of food colourants and also can be used as ingredients for

the food, pharmaceutical, and nutraceutical industries [6].

Research has been conducted in recent years which improve the information regarding this less-known plant. Studies like morphological evaluation, distribution, traditional used, nutritional composition, phytochemical profiling, antioxidant potential, physicochemical properties, anthocyanin composition, acidity, and pigment concentration of *Haematocarpus validus* have been carried out so far [5]. Recent studies have also focused on its domestication through forest-to-farm, agroforestry incorporation, community-based conservation, and product development through value addition, to improve the rural livelihoods and nutritional security [3, 4].

Despite these findings on *H. validus* remains limited compared with other commercially important tropical fruits. Moreover, standardized cultivation practices, propagation techniques, breeding strategies, molecular characterization, product development, industrial applications, and market potential have yet to be explored.

Therefore, the present review aims to summarize the available information on *H. validus*, like its taxonomy, botanical description, geographical distribution, traditional uses, and nutritional and phytochemical composition. The review also identifies the research gaps and discusses future perspectives for the sustainable harvesting, utilization and conservation of this valuable underutilized fruit species.

II. DISTRIBUTION OF HAEMATOCARPUS SPECIES

The genus Haematocarpus comprises two recognized species, *H. subpeltatus* Merr. and *H. validus* (Miers) Bakh.f. ex Forman. *H. subpeltatus* is distributed across Southeast Asian countries like China, the Philippines, Borneo, and Sulawesi [7-9]. Whereas, *H. validus* distributed across Bangladesh, India, Laos, Indonesia, Malaysia, and Thailand [1, 10]. Additionally, some reports have documented its occurrence in Pakistan and other parts of Southeast Asia [6, 11].

As above mentioned, *H. validus*, are mainly distributed Assam, Arunachal Pradesh, Meghalaya, Mizoram, and Tripura, where the humid tropical climate, high rainfall, and dense forest ecosystems provide favorable conditions for its growth [1, 5, 10, 12]. Beyond Northeast India, the species has also been reported from West Bengal and the Andaman and Nicobar Islands, indicating a broader but fragmented distribution within the Indian subcontinent [4, 6]. This distribution pattern indicates that the plant species, *H. validus* is inhabited in the Indo-Myanmar biodiversity hotspot region.

III. ETHNO-MEDICINAL USES

Haematocarpus validus is widely used in traditional medicine by local tribal communities. The Chakma and Marma tribes of Bangladesh use the extract of tender shoots in jaundice. They also use the fruits and seeds to treat anaemia and the paste from the roots use to cure itching [13]. The Garo tribe of Meghalaya treating anaemia by consuming this fruit. The fruits are also consumed by preparing traditional wine [14]. In Tripura, the fruits are used as a natural dye for colouring handicrafts and are processed into squash, pickles, and chutneys. Ripe fruits are also dried and stored for future use [15].

Fig 1: Fruits of collected from East Garo Hills, Meghalaya, India

IV. PHYSICAL AND MORPHOLOGICAL CHARACTERISTICS

H. validus is a perennial, woody, dioecious liana of the family Menispermaceae. Therefore, the plant grows by taking support from large trees for climbing in tropical evergreen and deciduous forests. The stem is glabrous to sparsely puberulous, seedlings remain leafless during the early stages of development, producing small leaves. The leaves are simple, alternate, elliptic to ovate-elliptic, three-nerved, and obtuse at the base. Young leaves are soft and light green, becoming dark green and leathery upon maturity. In the Andaman Islands, leaves have petioles 1.6–2.5 cm with laminae average 12.5 × 5.6 cm [16].

The species is dioecious, dioecious means male and female flowers bear on separate plants, after about 6–7 years to the plant get its fruiting stage. Flowering and fruiting periods vary with geographical location and altitude, In the Andaman Islands and Tripura, flowering occurs from January-February, followed by fruiting from April-June. In the Garo Hills of Meghalaya, flowering takes place from October-December, with fruiting occurring from March-June. In Bangladesh, the species flowers from November-January and bears fruits from May-August [12, 16]. The inflorescence is a cauliflorous panicle, 30–45 cm long, borne on the main stem and mature branches, carrying numerous small greenish-yellow flowers. Staminoides are rod-shaped, carpels are ovoid to ellipsoid, and male plants generally produce more abundant flowers than female plants [5,16].

The fruit is a single-seeded, oblong to ovoid drupe borne in sub-clusters of 1-7 fruits, with each brunch producing approximately 32–71 fruits (Fig 1). Immature fruits are light green and gradually change through yellowish, orange, crimson red, dark red, and finally deep purple at full ripeness. Mature fruits measure approximately 3.5–4.3 cm in length and 2.7–3.1 cm in width, with an average weight ranging from 12.7 to 21.2 g (Bohra et al., 2022). Seed dispersal occurs primarily through gravity (barochory), animals and birds (zoochory), and humans (anthropochory) [5,16].

The physical and morphological characteristics of blood fruit were evaluated at a moisture content of 79.59 ± 0.51% (wet basis), providing important baseline information for postharvest handling and processing. The average fruit mass is 21.76 ± 0.02 g, with an edible pulp content of 6–7 g, and an average fruit volume of 9.32 cm^3. The true density of the fruit is 1.01 g cm^{-3} and a bulk density is 0.98 g cm^{-3}, properties that are valuable for designing storage, transportation, and processing systems. The average fruit dimensions were 3.56 cm in length, 2.49 cm in breadth, and 2.51 cm in thickness, while the surface area measured 10.15 cm^2, making these parameters useful for the design of grading, sorting, and image-processing systems and for predicting heat and mass transfer during drying operations. The fruit has a porosity of 32.97%, indicating its packing behaviour and tendency to become partially submerged in water. Collectively, these physical characteristics serve as fundamental engineering parameters for the effective harvesting, handling, packaging, storage, transportation, and commercialization of blood fruit [17].

V. BIOCHEMICAL COMPOSITION AND NUTRITIONAL PROPERTIES OF BLOOD FRUIT

The biochemical composition of blood fruit indicates its high nutritional and functional value. The fruit contains 79.0 ± 0.71% moisture, which contributes to its texture, freshness, and shelf life, while its total soluble solids (17.11 °Brix) reflect good sweetness and eating quality [16]. Blood fruit is also a good source of ascorbic acid (vitamin C), which plays an essential role in collagen synthesis, tissue repair, and iron absorption, and its relatively high acidity is associated with the presence of organic acids [16].The fruit contains both reducing (5.83%) and non-reducing sugars (8.88%), indicating the presence of sucrose, along with appreciable amounts of carbohydrates (11.20 ± 0.04%), protein, crude fat, dietary fiber, and ash, making it nutritionally superior to many other berry fruits [16].

Blood fruit also contains antinutritional compounds, including phytate (197.25 ± 1.26 mg/100 g), saponin (39.14 ± 0.33 mg/100 g), and oxalate (11.66 ± 0.50

mg/100 g), which may reduce mineral bioavailability when present in high concentrations [16]. In addition, the fruit is exceptionally rich in bioactive phytochemicals, with total polyphenols (678.21 ± 10.71 mg GAE/100 g), flavonoids (489.80 ± 6.72 mg RE/100 g), and anthocyanins (581.21 ± 5.31 mg C3GE/100 g), levels that are higher than those reported for several commercially important berries such as blueberry and lingonberry. These compounds contribute significantly to the fruit's antioxidant capacity and may help reduce the risk of chronic diseases by protecting against oxidative stress and enhancing immune function [16].

VI. CONCLUSION

Haematocarpus validus (blood fruit) is a promising yet underutilized indigenous fruit species with considerable nutritional, medicinal, ecological, and economic importance. The available literature demonstrates that the species is widely distributed across Northeast India, the Andaman and Nicobar Islands, and several Southeast Asian countries, where it has traditionally been used as a nutritious food and ethnomedicine. Morphological and physicochemical studies have revealed substantial variability among natural populations, highlighting the existence of valuable genetic resources that can be exploited for crop improvement and domestication. The fruit possesses desirable engineering characteristics that facilitate the development of postharvest handling, grading, storage, and processing technologies.

Blood fruit is particularly noteworthy for its rich biochemical composition, including high levels of vitamin C, phenolic compounds, flavonoids, and anthocyanins, which confer strong antioxidant properties and significant potential as a functional food and natural colorant. Recent studies have further demonstrated its suitability for value-added products and identified superior germplasm with enhanced fruit quality traits, suggesting considerable opportunities for commercial cultivation. Nevertheless, the species remains largely wild and underexploited, with limited information available on its propagation, agronomic practices, genetic improvement, molecular characterization, postharvest management, and industrial utilization.

Future research should therefore focus on germplasm conservation, molecular diversity assessment, breeding and selection of elite genotypes, development of efficient propagation techniques, standardized cultivation practices, and comprehensive evaluation of its pharmacological and nutraceutical properties. In addition, efforts toward product development, value-chain creation, market promotion, and community-based cultivation are essential for the sustainable utilization of this species. With appropriate research, conservation, and commercialization strategies, *H. validus* has the potential to emerge as an important functional fruit crop that contributes to nutritional security, biodiversity conservation, rural livelihoods, and the development of sustainable bio-based industries.

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