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Rice bean (*Vigna Umbellata*) the forgotten gold: unraveling the commercial, nutritional and medicinal value

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Abstract
Rice bean (*Vigna Umbellata*), a traditional crop cultivated across South, Southeast, and East Asia, is characterized by its wild variety spanning the tropical monsoon forest climatic zone. Despite its vast nutritional and production potential, falling within the leguminous family Fabaceae, the rice bean represents one of many underutilized crops. Indigenous to South and Southeast Asian regions, particularly hilly areas, rice bean is cultivated alongside crops like maize, forming an integral part of impoverished farming communities' livelihoods. Despite its extensive utilization in traditional practices, its commercial significance remains largely unrecognized. However, recent attention has been significantly drawn to the rice bean's nutritional richness, bioactive compounds, and various medicinal properties, including anti-inflammatory, antioxidant, and antidiabetic effects. This significant attention underscores its potential for commercialization and contribution to improving the livelihoods of underprivileged populations. Furthermore, its cultivation and processing give rise to diverse products, reflecting its cultural significance and adaptability across different regions.

Keywords: Rice bean, underutilized crops, traditional crop, nutritional potential, medicinal properties, bioactive compounds, commercialization, crop diversity

Introduction
Vigna Umbellata (Thunb.) Ohwi & H. Ohashi, commonly known as rice bean, is a traditional crop cultivated across South, Southeast, and East Asia. Its wild variety is found throughout the tropical monsoon forest climatic zone, from eastern India, Nepal, Myanmar (Burma), and Thailand to Laos, southern China, and East Timor. Belonging to the leguminous family Fabaceae, the rice bean is an annual legume that falls within a category of relatively lesser-known and underexploited plants.

This bean represents one of the many "underutilized crops" or "orphan crops" that have garnered increased attention in recent decades due to their limited genetic diversity and utilization within the global food supply. Indigenous to the South and Southeast Asian regions, particularly in hilly areas, rice bean is often cultivated alongside crops like maize as part of intercropping practices [1-3].

It is a leguminous grain cultivated across various regions worldwide, particularly in hilly terrain. Its cultivation is largely confined to specific geographical pockets within diverse agro-ecological zones, primarily by impoverished farming communities reliant on such crops for sustenance and livelihood. Despite its extensive utilization in traditional and cultural practices globally, this pulse's commercial significance and market value still need to be recognized. Despite its substantial nutritional and production potential, rice bean has yet to be fully harnessed to improve the livelihoods of many underprivileged populations. The rice bean plant presents as a small vine with a distinctively hairy appearance, adorned with bright yellow flowers that eventually give way to small, edible beans [4].

Despite being an unconventional and underutilized legume, rice beans are significant as a livelihood source for impoverished rural and tribal farmers across South and Southeast Asia. Known by various names such as climbing mountain bean, mambi bean, oriental bean, and Beziamah in the Assamese language, the rice bean boasts a diverse genetic profile and demonstrates remarkable agricultural and nutritional potential. It thrives in adverse conditions, showcasing impressive resistance to storage pests and prevalent diseases, offering a beacon of hope for sustainable agriculture practices.

Native to South and Southeast Asia, rice bean finds cultivation primarily in regions such as India, the Philippines, China, Myanmar, Malaysia, Korea, Indonesia, Fiji, Sri Lanka, Mauritius, Sierra Leone, Ghana, Zaire, Tanganyika, Jamaica, Haiti, and Mexico, with limited cultivation extending to the West Indies, USA, Queensland (Australia), and East Africa. In India, it serves as a vital rainfed crop across diverse terrains, including the Northeastern Hills, West Bengal, Sikkim Hills, Western and Eastern Ghats Hills, Chhota-Nagpur region, parts of Odisha in the Eastern peninsular tract, Kumaon Hills (Uttarakhand), and Chamba region (Himachal Pradesh) in the Western Himalaya. Rice bean exhibits a fascinating array of colors approximately 16 different shades including black, red, cream, violet, purple, maroon, brown, chocolate, or mottled grains against greenish, brownish, or ash grey backgrounds highlighting its richness in bioactive compounds [5-7]. In the global rice bean trade, Japan emerges as the primary importer, while Thailand, Myanmar, China, and Madagascar stand as major exporting nations. Between 1998 and 2000, annual exports reached approximately 1100 tons. Renowned for its high-quality protein content, rice bean provides all essential amino acids in a well-balanced profile. Notably, its starch boasts the lowest glycemic index compared to other legumes like mung bean, pea, pigeon pea, soybean, and cowpea. Its oligosaccharide content, responsible for producing flatulence, including raffinose, stachyose, and verbascose, is notably lower than other pulse varieties.

This nutritional profile positions rice bean as a promising candidate for commercialization through various processing techniques and value-added products. However, effective postharvest management remains crucial for rice beans, especially considering their traditional cultivation across diverse regions of Southeast Asia, which often involves varied postharvest practices [8, 9].

The cultivation and processing aim to create, utilize, and enjoy various rice bean-based products. These products have evolved within specific growing regions, influenced by traditional knowledge, consumer preferences, and local availability. Traditional rice bean-based items typically undergo simple conventional processing methods, including soaking, cooking, sprouting, fermentation, and frying, similar to those used for other grains. Consumption and utilization practices of rice beans vary significantly across regions, shaped by the dietary habits of different communities.

In Nagaland, for instance, soaked rice beans are believed to boost energy levels and aid in healing injuries sustained during wrestling competitions. Historical accounts from Khonoma, a village near Kohima, recount how inhabitants survived a month-long siege by British troops in 1879 by consuming raw rice beans. In Nepal, rice beans are considered a warming food, favored during the winter months, and avoided by individuals sensitive to cold. These beans are sacred in Nepalese society and prominently featured in religious rituals and cultural festivals. Popular rice bean dishes served during festivals include:

- Khichadi (A blend of rice and rice beans).
- Kwati (A soup made from nine varieties of whole grain legumes).
- Batuk.

A diverse array of rice bean-based dishes and snacks are enjoyed across regions, including Rice bean Curry, Sundal, Pulikulambu, Rice bean Ball Curry, Biramla, Rice bean Pork Curry, Rice bean Carp Decoction, Rice bean Decoction, Rice bean Sweetened Paste, Rice bean Coix Gruel, Eromba, Kwati Soup, Nuggets, Rice bean Kheer, Khichadi, Rice bean Dhal, Pakora, Sepu Vadi, Papad, Boondi, Bhujia, Muruku, Ladoo, Supplementary Food Beverage, Cake, Cookies, Munthiri Kothu, Halwa, Extruded Snacks, Vada, Rice bean Pickle, Complementary Food, Convenient Food Multi-mixes, and Probiotic Food Multi-mixes [10].

Rice bean, a highly nutritious legume, is recommended for individuals struggling with digestive issues. It is an excellent carbohydrate source, particularly beneficial for those engaged in strenuous physical labor. Its consumption is relatively lower among older people and children. Additionally, rice beans prove to be valuable in livestock nutrition. Its vegetative parts can be utilized fresh or transformed into hay, while the seeds are commonly employed as fodder. When using rice bean straw, it's crucial to eliminate any woody sections or parts affected by mold or dirt before feeding it to livestock. Farmers regard rice beans as a vital grain and fodder legume in the rugged terrain of Nepal's marginal hills, actively seeking dual-purpose varieties suited to their agricultural needs [11].

Seeds offer anti-inflammatory, antioxidant, and antidiabetic properties due to their rich content of bioactive compounds such as p-coumaric acid, ferulic acid, sinapic acid, catechin, epicatechin, vitexin, isovitexin, and quercetin [12-14], as well as albumin and globulin [15]. Additionally, seeds contain trypsin and chymotrypsin inhibitors, along with tannins and phytic acid [4]. Rice bean bioactivities include hepato-protective, anti-inflammatory, anticancer, antifungal, antidiabetic, antihypertensive and immunity booster activities [8].

Conclusion and Future Prospects

Rice bean (*Vigna Umbellata*) is a traditional crop grown in hilly areas across South, Southeast, and East Asia, yet it still needs to be utilized despite its nutritional richness and adaptability. Recent attention has highlighted its potential as a resilient crop with diverse genetic traits and resistance to pests and diseases. With its medicinal properties and bioactive compounds, rice bean holds promise for the food and pharmaceutical industries.

Future efforts should focus on research and development to improve varieties and agronomic practices to unlock their full potential. Commercialization strategies, including value addition and market development, are crucial for increasing farmer income and promoting widespread adoption. Sustainable cultivation practices, such as intercropping and agroforestry, can enhance resilience and contribute to environmental conservation. Capacity-building initiatives targeting rural communities can empower farmers and improve their livelihoods. Overall, the rice bean presents a valuable opportunity to address food security, economic development, and sustainability challenges in the regions where it is cultivated.

Table 1: Nutritional value of seeds [16]

Water	**9.10 g/100 g**	**Amino acid (%)**	
Carbohydrates	59.96 g/100 g	Alanine	3.9-6.0
Proteins	20.78 g/100 g	Arginine	4.1-7.5
Fat	1.74 g/100 g	Aspartic acid	10.3-14.4
Crude fiber	5.07 g/100 g	Cystine	0.1-1.5
Ash	4.44 g/100 g	Glutamic acid	13.2-20.0
Essential minerals		Glycine	3.2-5.2
Macro-minerals (g/kg)		Histidine	2.2-3.8
Calcium	2.6-6.7	Isoleucine	2.1-5.8
Magnesium	1.6-3.2	Leucine	4.2-9.5
Phosphorus	2.1-3.9	Lysine	5.3-8.7
Potassium	20.7-26.2	Methionine	0.5-1.5
Sodium	0.2-1.2	Phenylalanine	4.7-7.7
Micro-minerals (mg/ kg)		Proline	1.1-5.4
Copper	5	Serine	2.7-5.4
Iron	22	Threonine	3.1-5.4
Manganese	11	Tryptophan	0.8-1.1
Zinc	8	Tyrosine	0.8-4.7
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