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Nutritional, Functional and Therapeutic Potential of Traditional Rice Varieties (Oryza sativa) with Special Reference to Andhra Pradesh: A Comprehensive Review

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ABSTRACT

Rice (Oryza sativa L.) is a staple cereal that sustains more than half of the global population, particularly in Asia. In addition to its role as a primary energy source, rice exhibits considerable variation in nutritional composition, glycaemic response, and functional properties depending on varietal diversity and processing methods. This review critically synthesizes existing literature on rice diversity, nutritional composition, glycaemic index, and bioactive compounds, with special emphasis on traditional rice varieties of Andhra Pradesh, India. Evidence indicates that traditional and semi-polished rice varieties possess higher dietary fibre, micronutrients, antioxidants, and lower glycaemic index compared to refined rice. Pigmented rice varieties such as red rice demonstrate enhanced phenolic content and improved metabolic health benefits. However, the widespread shift toward polished rice has reduced nutritional intake and increased diet-related disorders. This review highlights the importance of conserving traditional rice germplasm and promoting their consumption to enhance nutritional security and sustainable agricultural practices.

INTRODUCTION

Rice is one of the most widely cultivated cereal crops globally and serves as the primary dietary component for over half of the world's population [1]. It contributes significantly to daily caloric intake, especially in Asia, where rice-based diets dominate [20]. India is one of the largest producers of rice and is recognized as a major centre of genetic diversity for rice cultivation [16].

Historically, India possessed a vast diversity of rice varieties; however, the introduction of high-yielding varieties during the Green Revolution led to a substantial decline in traditional landraces [3]. Traditional rice varieties (TRVs) are adapted to local agro-climatic conditions and are known for their superior nutritional quality, resilience, and medicinal value [21].

Rice domestication dates back thousands of years in South and Southeast Asia, with archaeological evidence indicating early cultivation in ancient civilizations [14,29]. Over time, rice diversified into multiple subspecies, including Indica and Japonica, with Indica being predominant in India [31].

In Andhra Pradesh, rice cultivation plays a crucial role in agriculture and food systems. Traditional varieties such as Sona Masuri (indigenous forms), Chitti Muthyalu, and Red rice (yerra Biyyam) are widely recognized for their nutritional and functional significance. In

Andhra Pradesh on Makara Sankranthi also known as "Pedda Penduga", is observed in the month of January in the honour of Indra' the God of Heavens, who is supposed to control clouds and usher seasonal rains causing thereby abundance and prosperity in the country. The ancestors believe that food should be cooked not with the object of eating out but only to serve the purpose of sacrifice and offering to God, hence newly harvested rice is cooked as an offering to Sun. Most of the munchkins or naivadyam or food offered to God are prepared with different rice varieties during the festivals by the people of Andhra Pradesh, showing the significance of rice. [23].

METHODOLOGY

Study types included: A narrative review approach was adopted. Relevant literature was collected from peer-reviewed journals, institutional reports, and published studies on rice nutrition, glycemic index, and bioactive compounds. Studies were selected based on relevance to traditional rice varieties and their nutritional and functional properties, with particular emphasis on Indian and Andhra Pradesh rice varieties peer-reviewed research articles, review papers, and institutional reports. This review is based on data provided in the manuscript and its cited references.

Approach: narrative synthesis focusing on: nutritional composition, glycaemic index, bioactive compounds and therapeutic properties. Special emphasis was given to traditional rice varieties of Andhra Pradesh and their relevance to health and nutrition. Total references analysed for the study were [36].

RESULTS AND DISCUSSION

Origin and Diversity of Rice

Globally, two major cultivated species of rice are recognized: *Oryza sativa* (Asian rice) and *Oryza glaberrima* (African rice) [15]. Among these, *Oryza sativa* is the most widely cultivated species and is further classified into *Indica* and *Japonica* subspecies. The *Indica* group predominates in tropical and subtropical regions such as India due to its adaptability to high temperature, humidity, and diverse soil conditions [31].

Rice is believed to have originated in South and Southeast Asia, where favourable climatic conditions supported its early domestication and diversification [13,28,31]. Archaeological and historical evidence suggests that rice cultivation dates back several thousand years, with the Indian subcontinent recognized as one of the important canters of origin and early domestication [25,28]. Due to its remarkable adaptability, rice gradually spread across diverse agro-climatic regions, including irrigated lowlands, uplands, flood-prone areas, and drought-affected ecosystems [31].

Rice Diversity in India

India is considered one of the richest centres of rice genetic diversity, historically possessing a vast number of indigenous rice varieties adapted to specific ecological niches [16,25]. These traditional landraces evolved over centuries through natural selection and farmer-driven selection practices, resulting in varieties with unique agronomic and nutritional characteristics.

Traditional rice varieties in India exhibit several desirable traits, like tolerance to drought, salinity, and submergence, resistance to pests and diseases, diverse grain qualities such as aroma, texture, and pigmentation and enhanced nutritional and medicinal properties [20,21].

However, the introduction of high-yielding varieties during the Green Revolution led to a significant reduction in traditional rice diversity, replacing many indigenous landraces with uniform cultivars [3,25]. Despite this decline, several traditional varieties such as Basmati, Navara, and pigmented rice types continue to be cultivated and are increasingly recognized for their nutritional and functional benefits [20].

Rice Diversity in Andhra Pradesh

Andhra Pradesh is one of the major rice-producing states in India and contributes significantly to the country's rice production [1]. The state encompasses a wide range of agro-ecological zones, which support diverse rice cultivation systems, including:

- Coastal delta regions (Godavari and Krishna districts) characterized by irrigated rice cultivation,
- Rayalaseema region, which is semi-arid and supports drought-tolerant varieties,
- Tribal and hilly regions (Araku Valley and Eastern Ghats) known for traditional and pigmented rice landraces.
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These varied agro-climatic conditions have enabled the cultivation and preservation of several traditional rice varieties unique to the region.

Traditional rice varieties of Andhra Pradesh, including Chitti Muthyalu, Garika Sannalu, Erra Biyyam (red rice), and indigenous forms of Sona Masuri, exhibit important agronomic and nutritional characteristics. Many of these varieties are: adapted to low-input and sustainable farming systems, resilient to environmental stresses such as drought and soil variability and rich in micronutrients and bioactive compounds, contributing to improved dietary quality [20,30].

In particular, pigmented rice varieties cultivated in tribal regions such as Araku Valley are rich in antioxidants and phenolic compounds, which enhance their nutritional and functional properties [18,22]. Similarly, traditional varieties grown in drought-prone regions contribute to agricultural resilience and sustainability. Traditional rice varieties therefore represent an important genetic reservoir for future crop improvement, particularly in the context of climate change, food security, and nutritional enhancement [21]. Their conservation and promotion are essential for maintaining biodiversity and supporting sustainable rice-based farming systems in Andhra Pradesh and across India.

Nutritional Composition of Rice

Rice grains are composed mainly of carbohydrates (75–80%), along with moderate protein and low fat content. They also contain essential micronutrients such as iron, zinc, magnesium, and phosphorus [31]. Polishing significantly reduces the nutritional quality of rice by removing the bran layer, resulting in loss of fiber, vitamins, and minerals [9]. Studies have shown that up to 90% of certain micronutrients can be lost during milling [9,11].

Table 1. Nutritional Comparison of Rice Types

Parameter	Polished Rice	Brown Rice	Traditional Rice
Fiber	Low	Moderate	High
Micronutrients	Reduced	Moderate	High
Antioxidants	Minimal	Present	Abundant
Glycemic Index	High	Moderate	Low

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Table 2. Detailed Nutritional Composition of Selected Rice Varieties

Rice Variety	Carbohydrates (g)	Protein (g)	Fiber (g)	Fat (g)	Iron (mg)	Zinc (mg)	Magnesium (mg)
Sona Masuri	77–79	6.5–7.5	0.5–0.8	0.3–0.5	0.7–1.2	1.0–1.5	20–30
Traditional Sona Masuri (semi-polished)	75–77	7–8	1.5–2.5	0.5–0.8	1.5–2.5	1.5–2.0	40–60
Chitti Muthyalu	76–78	6–7	1–2	0.4–0.6	1.2–2.0	1.2–1.8	30–50
Erra Biyyam (Red rice)	74–76	7–9	2–3.5	0.8–1.2	2–5	1.5–2.5	50–80
Kala Jeera (local types)	75–77	7–8	1.5–2.5	0.5–0.7	1.5–2.5	1.5–2.0	40–60
Garika Sannalu	76–78	6–7	1–2	0.4–0.6	1–2	1.2–1.8	30–50
Kappakar	74–76	7–8	2–3	0.6–0.9	2–4	1.5–2.5	50–70
Brown rice	75–77	7–8	2–3.5	1–2	1.5–2.5	1.5–2.5	100–150
Black rice	72–75	8–9	2–4	1–2	2–4	2–3	100–150
Wild rice	70–73	13–15	3–4	1–1.5	1.5–2.5	2–3	150–180
Basmati rice	77–79	7–8	1–1.5	0.4–0.6	0.7–1.5	1.2–1.8	30–50
Ponni rice	78–80	6–7	0.5–1	0.3–0.5	0.5–1	1–1.5	20–30
Surti Kolam	78–80	6–7	0.5–1	0.3–0.5	0.5–1	1–1.5	20–30

Values are per 100 g edible portion; ranges reflect variation in literature and varietal differences

Traditional rice varieties (red, black, semi-polished) contain higher fiber, minerals, and bioactive compounds compared to polished rice [8,30]. Pigmented rice varieties show elevated phenolic and anthocyanin content, contributing to antioxidant activity [18,22]. Brown and semi-polished rice retain bran layers, which are rich in dietary fibre, essential fatty acids, micronutrients [17]. Higher amylose content in traditional rice results in slower digestion and lower glycaemic response [26].

Glycaemic Index, Cultivation Regions of Traditional Rice Varieties of Andhra Pradesh

As shown in the table 2, Studies conducted on Indian rice varieties demonstrated that polished rice types such as Sona Masuri, Ponni, and Surti Kolam exhibit high glycaemic index values due to reduced dietary fiber and rapid starch gelatinization. These varieties result in faster postprandial glucose release and may contribute to insulin resistance when consumed frequently [19]. In contrast, traditional rice varieties and pigmented rice types show significantly lower glycaemic index values due to the presence of: higher amylose content, resistant starch, intact bran layers, phenolic compounds, and antioxidant-rich pigments [18,21]. Pigmented rice varieties such as red rice and black rice are particularly rich in anthocyanins and flavonoids, which reduce starch digestibility and improve insulin

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sensitivity [18,22]. Amylose-rich rice varieties are digested more slowly compared to amylopectin-rich varieties, thereby reducing the rate of glucose release into the bloodstream [26]. Traditional rice varieties typically contain: higher resistant starch, increased insoluble dietary fiber, and intact germ and bran layers, which collectively delay gastric emptying and carbohydrate digestion [17,23].

The glycaemic index (GI) is a physiological classification that measures the rate at which carbohydrate-containing foods elevate postprandial blood glucose concentrations [19]. Foods with GI ≤55 are classified as low GI, 56–69 as medium GI, and ≥70 as high GI [3,17]. Traditional rice varieties consumed in Andhra Pradesh and South India generally exhibit lower GI values compared with highly polished white rice due to retention of bran layers and higher phenolic content [21,26].

Table 3. Glycaemic Index, Cultivation Regions, and Nutritional Significance of Traditional Rice Varieties Relevant to Andhra Pradesh

Rice Variety	Major Growing Region / Availability	Type	Reported Glycaemic Index	Glycaemic Index Category	Nutritional & Functional Significance
Sona Masuri	Andhra Pradesh (Godavari, Krishna, Guntur)	Medium-grain white rice	72 ± 4.5	High	Easily digestible; widely consumed staple [30,32]
Traditional Sona Masuri (semi-polished)	Andhra Pradesh, Telangana	Semi-polished	51–58	Low–Medium	Retains bran; improved fiber and glycaemic control [8,30]
Chitti Muthyalu	Coastal Andhra Pradesh	Fine traditional rice	50–60*	Low–Medium	Light, easily digestible; suitable for elderly [20,30]
Erra Biyyam (Red rice)	Araku Valley, tribal regions	Pigmented rice	~55	Low	High iron, antioxidants, phenolics [18,22]
Kala Jeera (local types)	North Coastal Andhra	Aromatic rice	50–55*	Low	Enhances digestion; antioxidant-rich [20,30]
Garika Sannalu	Rayalaseema & Coastal AP	Fine aromatic rice	55–60*	Medium	Balanced starch composition

					[20]
Kappakar	Dryland & tribal regions	Coarse indigenous rice	50–58*	Low–Medium	Mineral-rich; drought resistant [20,30]
Brown rice	Widely available	Whole grain	50–55	Low	High fiber and micronutrients [17]
Black rice	Specialty/tribal markets	Pigmented rice	42–45	Low	Anthocyanin-rich; strong antioxidant [18,22]
Wild rice	Specialty markets	Whole grain	~45	Low	High protein and resistant starch [5,30]
Basmati rice	Commercial markets	Aromatic long grain	50–58	Low	High amylose; slow digestion [30,32]
Ponni rice	South India markets	Refined rice	70.2 ± 3.6	High	Rapid glucose release [32]
Surti Kolam	Commercial markets	Polished rice	77 ± 4.0	High	Highly digestible starch [32]

**Estimated based on compositional characteristics and glycaemic behaviour of similar traditional rice classes* [20,21,26,30].

Bioactive Compounds and Therapeutic Benefits

Rice contains several bioactive compounds including phenolics, flavonoids, and γ-oryzanol [15]. These compounds provide multiple health benefits: antioxidant activity [18], antidiabetic effects [26], cardioprotective properties [21], anti-inflammatory and anticancer potential [27] Pigmented rice varieties, particularly red and black rice, are rich in anthocyanins, which enhance their functional properties [18,22].

Socio-economic and Agricultural Challenges

Rice farming faces several constraints including poor farmer income, lack of modern technology, and irrigation limitations [6,9]. These challenges affect productivity and sustainability of rice cultivation.

Conservation and Future Prospects

The decline of traditional rice varieties poses a serious threat to biodiversity and nutritional security [5]. Conservation efforts are essential to preserve these genetic resources and promote sustainable agriculture.

CONCLUSION

Traditional rice varieties of Andhra Pradesh represent a valuable resource for improving nutrition and public health. Their superior micronutrient content, bioactive compounds, and

lower glycaemic index make them beneficial compared to polished rice. However, declining cultivation necessitates urgent conservation strategies. Promoting traditional rice consumption can enhance food security, reduce lifestyle diseases, and support sustainable agricultural systems.

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