

***Amaranthus cruentus*: Nutrient Assessment and Expanding its Role Beyond Fasting Foods**

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Abstract

Amaranthus cruentus, commonly known as *rajgira* (Marathi), is an ancient pseudocereal deeply rooted in Indian tradition, predominantly consumed during fasting periods. Its utilization in regular dietary pattern is limited in India. The aim here is to look beyond that conventional framing and explore the potential of *Amaranthus cruentus* as a nutritious pseudocereal suitable for year- round consumption. Based on nutritional evaluation backed by experimental data and existing literature, this chapter looks at what makes *rajgira* stand out is its strong macronutrient profile, good protein quality with notably higher lysine content compared to common cereals like *Triticum aestivum*, and the fact that it is naturally gluten-free, making it a suitable option for people with celiac disease or gluten intolerance. Additionally, its relatively low glycaemic index also makes it relevant for managing metabolic conditions through diet. Beyond its nutritional profile, this chapter also introduces new food preparations using amaranth that go beyond the traditional fasting preparations, demonstrating its adaptability to ever day culinary practice. By integrating nutritional data and practical food applications, this work presents *Amaranthus cruentus* as a functional and sustainable pseudocereal with significant potential in contemporary nutrition and food innovation strategies.

Keywords: *Amaranthus cruentus*, pseudocereals, nutritional evaluation, gluten-free grains, functional foods, food innovation.

Introduction

Amaranthus cruentus, popularly known as *rajgira* in India, occupies a distinctive place in traditional dietary customs, particularly during religious fasting (*vrata*). Botanically, it is classified as a pseudocereal because it does not belong to the grass family Poaceae, which includes staple cereals such as *Triticum aestivum* (wheat) and rice. Instead, it belongs to the family Amaranthaceae (Rastogi and Shukla, 2013). Owing to this botanical distinction,

rajgira is culturally regarded as a “non-cereal” grain and is therefore permitted during fasting periods when conventional cereals are avoided.

Fasting practices in India often restrict grains believed to be heavy or difficult to digest. *Rajgira*, being light, energy-dense, and gluten-free, is considered suitable for sustaining energy levels without causing digestive discomfort. It is commonly consumed in the form of *laddoos*, *chikkis*, *puris*, and *rotis* during *Navratri* and other ritual observances. However, this strong association with fasting has confined its perception to a seasonal food, limiting its integration into everyday diets.

Nutritionally, *A. cruentus* exhibits superior protein quality, higher lysine content compared to wheat, significant dietary fiber, and valuable bioactive compounds (Mlakar et al. 2012; Rastogi and Shukla, 2013). Restricting it to fasting occasions represents nutritional underutilization. Therefore, this chapter evaluates its composition and explores its potential for broader, year-round dietary integration.

Proximate and Micronutrient Profile

Carbohydrate content was measured at 46% in grain and 43% in bread, indicating that amaranth remains a substantial energy source after processing. Fat content decreased from 9% in grain to 6.02% in bread, likely due to formulation adjustments and thermal treatment. Dietary fiber was recorded at 6% in grain and slightly higher at 6.7% in bread, suggesting favorable retention during product preparation.

Compared to conventional cereals such as *Triticum aestivum*, which typically contain 10–12% protein and lower lipid fractions, amaranth demonstrates superior protein concentration and appreciable healthy fat content. Literature reports protein levels ranging from 13–18%, closely aligning with the present findings (Alvarez-Jubete et al. 2010; Rastogi and Shukla, 2013).

Beyond macronutrients, amaranth is recognized for its micronutrient density, including iron, magnesium, phosphorus, calcium, and selenium, along with B-complex vitamins such as folate and vitamin B6. The presence of bioactive constituents such as squalene and phenolic compounds further enhances its functional relevance (Zhu, 2015; Kumar et al. 2018). Collectively, these attributes position *Amaranthus cruentus* as a nutritionally dense pseudocereal with significant potential for broader dietary incorporation.

3. Protein Quantity and Amino Acid Superiority

One of the most defining nutritional attributes of *Amaranthus cruentus* is its elevated protein concentration and superior amino acid balance. The present analysis recorded 17.3% protein in raw grain, positioning it above most conventional cereals. Literature reports protein levels ranging from 13–18%,

validating its classification as a high-protein pseudocereal (Rastogi and Shukla, 2013).

Beyond quantity, protein quality is of greater nutritional importance. Unlike *Triticum aestivum*, which is limited in lysine, amaranth contains approximately 30–40% higher lysine content (Alvarez-Jubete et al. 2010). Lysine, an essential amino acid critical for growth and nitrogen balance, often limits the biological value of cereal-based diets. The improved lysine concentration enhances amino acid complementation and elevates Protein Digestibility Corrected Amino Acid Score (PDCAAS), indicating favorable digestibility and biological value.

These characteristics are particularly relevant for vegetarian populations and individuals with celiac disease, for whom amaranth serves as a nutritionally superior, gluten-free protein alternative.

4. Glycaemic Index and Metabolic Health Relevance

The glycaemic index (GI) of *Amaranthus cruentus* has been reported to be approximately 45, classifying it as a low to moderate GI food. In contrast, commonly consumed cereals such as *Triticum aestivum* and rice typically exhibit GI values around 70, producing higher postprandial glucose responses. Chaturvedi et al. (1997) demonstrated that grain amaranth preparations elicited significantly lower glycaemic responses compared to wheat- and rice-based products in non-insulin-dependent diabetic subjects.

The relatively lower GI of amaranth may be attributed to its higher protein content, appreciable dietary fiber, and complex carbohydrate matrix, which collectively slow gastric emptying and glucose absorption. These structural and compositional characteristics contribute to moderated insulin demand and improved glycaemic stability.

For individuals with diabetes or insulin resistance, inclusion of low-GI foods is associated with enhanced glycaemic control and reduced metabolic fluctuations. Thus, beyond its nutritional density, amaranth presents considerable potential as a functional dietary component in metabolic health management.

Bioactive Phytochemicals and Functional Properties

Beyond its macronutrient composition, *Amaranthus cruentus* contains a diverse range of bioactive phytochemicals that enhance its functional food value. The grain is reported to contain phenolic acids such as ferulic acid, *p*-coumaric acid, gallic acid, and caffeic acid, which exhibit strong free radical scavenging activity (Zhu, 2015). These compounds mitigate oxidative stress by neutralizing reactive oxygen species, thereby contributing to cellular protection and reduction of chronic disease risk.

Flavonoids including quercetin and rutin have also been identified in amaranth (Kumar et al. 2018). These bioactive molecules possess antioxidant, anti-inflammatory, and vasoprotective properties, supporting cardiovascular and

metabolic health. In addition, amaranth contains saponins and bioactive lipids such as squalene, which have been associated with cholesterol-lowering effects through modulation of lipid metabolism and reduced intestinal cholesterol absorption (Mlakar et al. 2012).

Emerging evidence further suggests that peptide fractions derived from amaranth proteins demonstrate antioxidant and anti-inflammatory activity. Collectively, these phytochemical constituents significantly enhance the nutraceutical potential of amaranth beyond its basic nutritional composition.

Food Innovation and Culinary Applications

The functional versatility of *Amaranthus cruentus* was assessed through development of gluten-free bread, puri, and roti to evaluate its feasibility for regular dietary incorporation beyond fasting contexts.

Gluten-Free Bread Development

Bread was formulated using amaranth flour as the primary ingredient, combined with water, yeast, oil, salt, and corn starch as a structural support agent. In wheat-based systems (*Triticum aestivum*), gluten proteins form an elastic network that traps carbon dioxide during fermentation and provides structural integrity. In contrast, amaranth dough lacks gluten and relies on starch gelatinization and hydration properties for stability (Alvarez-Jubete et al. 2010). Corn starch enhanced gas retention and improved crumb softness. The final bread exhibited 36.07% moisture, producing a soft and palatable texture.

Roti and Puri Preparation

Flatbread products required optimized water incorporation and controlled manual shaping due to reduced extensibility. Despite lower elasticity than wheat dough, acceptable structural integrity and sensory quality were achieved.

Processing Considerations and Popularity Index.

Moderate water and oil absorption capacities supported moisture retention and mouthfeel. Consumer evaluation revealed 65% preference for bread, 20% for puri, and 15% for roti, indicating stronger acceptance of structured bakery applications.

Sustainability and Agricultural Relevance

Amaranthus cruentus offers notable agronomic advantages alongside its nutritional value. As a C4 crop, it exhibits enhanced water-use efficiency and tolerance to heat and drought stress, making it suitable for India's rain-fed and semi-arid systems (Rastogi and Shukla, 2013). Its adaptability to sandy, loamy, and marginal soils allows cultivation in regions where conventional cereals may underperform.

In India, grain amaranth is cultivated in Uttarakhand, Himachal Pradesh, Rajasthan, Gujarat, Jharkhand, Odisha, Karnataka, and Tamil Nadu. Yield studies report productivity levels of approximately 1000-1500 kg per hectare under typical conditions (Kumar et al. 2018). Owing to relatively low irrigation and moderate nutrient requirements, amaranth cultivation may reduce input intensity compared to high-input cereal systems.

Its resilience and efficient resource utilization support climate-adaptive agriculture and align with national priorities for sustainable food security and diversified cropping systems.

Market Potential and Future Directions

The expanding global gluten-free market, driven by increased awareness of celiac disease and lifestyle-related disorders, presents significant opportunities for *Amaranthus cruentus*. Growing demand for plant-based, sustainable, and nutrient-dense foods further enhances its commercial relevance (Grand View Research). Owing to its high-quality protein, low glycaemic index, and bioactive phytochemicals, amaranth is well positioned within health-oriented product segments (Rastogi and Shukla, 2013; Alvarez-Jubete et al. 2010). However, research gaps remain. Long-term clinical evidence supporting its role in glycaemic control, lipid regulation, and anti-inflammatory effects is limited. Future research should prioritize controlled clinical trials and large-scale standardization studies to improve processing efficiency, shelf stability, and cost-effectiveness, thereby strengthening scientific validation and market integration.

Conclusion

Amaranthus cruentus emerges as a nutritionally superior pseudocereal, distinguished by high-quality protein, elevated lysine content, a favorable glycaemic response, and diverse bioactive compounds (Rastogi and Shukla, 2013; Alvarez-Jubete et al. 2010). The successful development and consumer acceptance of gluten-free products such as bread, roti, and puri highlight its functional adaptability in daily diets. Beyond its nutritional merits, its climate resilience, low agronomic input requirements, and suitability to Indian agro-ecological conditions underscore its role in sustainable food systems. Collectively, these attributes position amaranth not merely as a traditional fasting grain but as a strategic crop for health-focused and climate-resilient dietary patterns.

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