Plant Archives Vol. 26, Supplement 2, 2026 pp.3518-3522 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-2.447

VALUE ADDITION OF MILLET-BASED PRODUCTS: A REVIEW

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(Date of Receiving : 20-05-2026; Date of Revision : 14-07-2026; Date of Acceptance : 30-07-2026)

ABSTRACT

Millets, often termed nutri-cereals, are gaining global recognition for their nutritional richness and climate resilience. Value addition plays a pivotal role in enhancing their consumer appeal, marketability and economic potential. Primary processing such as cleaning, grading, dehulling and milling ensures safety, palatability and shelf stability, while secondary processing diversifies millets into modern food formats. Techniques like extrusion, baking, fermentation, and puffing transform millets into pasta, noodles, cookies, bread, breakfast cereals and probiotic-rich traditional foods. Technological advancements, including extrusion cookers, rotary ovens, automated fermenters, and innovative packaging methods such as vacuum sealing and modified atmosphere storage, have revolutionized millet utilization. These interventions ensure uniformity, hygiene, and large-scale production while preserving nutritional quality. Value-added millet products ranging from health mixes and nutribars to infant foods and gluten-free formulations address diverse dietary needs and lifestyle preferences. By bridging traditional consumption with modern food systems, value addition elevates millets from subsistence crops to functional foods with global relevance. This not only promotes nutritional security and public health but also supports sustainable agriculture and rural livelihoods, positioning millets as a cornerstone of future-ready diets.
***Keywords*:** Millets, Glycemic index, gluten-free.

Introduction

Millets are highly nutritious grains rich in fiber, protein and essential minerals like calcium, iron, and magnesium. They are naturally gluten-free, making them suitable for people with celiac disease, and their low glycemic index supports diabetes management and heart health.

Millets are small-seeded cereal grains belonging to the grass family (*Poaceae*). They have been staple foods in Asia and Africa for thousands of years and are now recognized globally as "nutri-cereals." Common types include pearl millet (bajra), finger millet (ragi), foxtail millet, proso millet, barnyard millet, and kodo millet. These grains are valued for their resilience in dry climates and their ability to grow with minimal water and inputs

Millets are widely recognized as nutri-cereals because they combine energy-giving carbohydrates, plant-based proteins, fiber, vitamins, and minerals in a balanced way. Their carbohydrates digest slowly, providing steady energy and helping control blood sugar, which makes them valuable for people with diabetes and those seeking sustained energy. They contain about 7–12% protein, supporting muscle repair and growth, and when paired with pulses, they deliver a complete amino acid profile. The high fiber content improves digestion, lowers cholesterol, and supports heart health, while also aiding in weight management. Millets are rich in minerals such as iron, calcium, magnesium, phosphorus, and potassium. Pearl millet is especially high in iron, helping prevent anemia, while finger millet is notable for its calcium content, strengthening bones. Magnesium and potassium further contribute to cardiovascular health by regulating blood pressure. In addition, millets provide B-complex

vitamins that support metabolism and nervous system function, along with antioxidants like polyphenols and flavonoids that protect against oxidative stress and chronic diseases. Being naturally gluten-free, they are safe for individuals with celiac disease or gluten intolerance. Overall, the nutrient composition of millets makes them a sustainable and functional food, offering energy, disease prevention, and long-term health benefits while also supporting climate-resilient agriculture.

Value Addition in Millets

Value addition in millets refers to processing raw grains into diverse, convenient, and nutritionally enhanced products that appeal to modern consumers. This includes cleaning, dehulling, milling, and transforming them into ready-to-eat or ready-to-cook items such as flakes, pasta, bakery products, health mixes, and fermented foods. Value addition not only improves shelf life and taste but also increases market demand, thereby enhancing farmer income and promoting millet consumption in urban diets.

Health Benefits of Millets

- **Gluten-free** – Safe for people with celiac disease or gluten intolerance
- **Rich in fiber** – Improves digestion, prevents constipation, and supports gut health
- **Low glycemic index** – Helps regulate blood sugar, making them ideal for diabetes management
- **Protein source** – Provides plant-based protein, essential for muscle repair and vegetarian diets
- **Bone strength** – Finger millet (ragi) is high in calcium, supporting bone health and preventing osteoporosis
- **Iron-rich** – Pearl millet helps prevent anaemia and boosts haemoglobin levels
- **Heart health** – Magnesium and potassium regulate blood pressure and reduce cardiovascular risks.
- **Antioxidants** – Polyphenols and flavonoids protect against oxidative stress and chronic diseases
- **Weight management** – High -Fiber and slow-digesting carbs increase satiety and reduce overeating
- **Immunity booster** – Nutrient density strengthens the immune system and overall well-being

Table 1 : Comparison: Millets vs Normal Grains

Aspect	Normal grains (Rice/Wheat)	Millets
Glycemic Index	High → spikes blood sugar	Low → steady energy release
Fiber Content	Moderate	High → supports digestion & heart health
Protein Quality	Present but limited	Higher with better amino acid balance (when combined with pulses)
Minerals	Lower calcium & iron	Rich in calcium (ragi), iron (bajra), magnesium, potassium
Gluten	Contains gluten	Naturally gluten-free
Climate Adaptability	Needs more water & inputs	Drought-resistant, grows in poor soils
Health Impact	Linked to obesity, diabetes	Prevents lifestyle diseases, boosts immunity

Why Millets Are Better

Millets outperform normal grains because they are nutritionally superior, climate-resilient and economically beneficial. They provide more fiber, minerals, and antioxidants than rice or wheat, while being naturally gluten-free. From a sustainability perspective, millets require less water and fewer inputs, making them ideal for dryland farming and climate-smart agriculture. Their versatility in value-added products also makes them attractive to health-conscious consumers, positioning them as the future of sustainable diets.

Processing

Processing in millets is a crucial step that transforms raw grains into safe, edible and market-ready products. Because millets often come with a hard outer husk and impurities such as dust, stones and soil particles, they cannot be consumed directly. Processing ensures that these grains are cleaned, dehulled and milled to improve their quality, safety and consumer acceptability. It also enhances the nutritional availability of millets by making nutrients more bio-accessible, while extending their shelf life through proper handling and storage. Beyond basic cleaning and dehusking, processing plays a vital role in value addition. By converting millets into flour, semolina, flakes, or puffed products, they become more versatile and suitable for modern diets. Advanced methods like baking, extrusion and fermentation further diversify millet-based foods into bread, noodles, pasta, cookies and traditional fermented dishes. These innovations not only improve taste and convenience but also make millets more appealing to urban consumers who are accustomed to wheat and rice products. Technological interventions have modernized millet processing, with

machines such as graders, aspirators, destoners and extrusion units ensuring efficiency and uniformity. Such technologies reduce labour, minimize wastage and enable large-scale production of millet-based products. Packaging innovations also help preserve freshness and nutritional quality, making processed millets competitive in the global market.

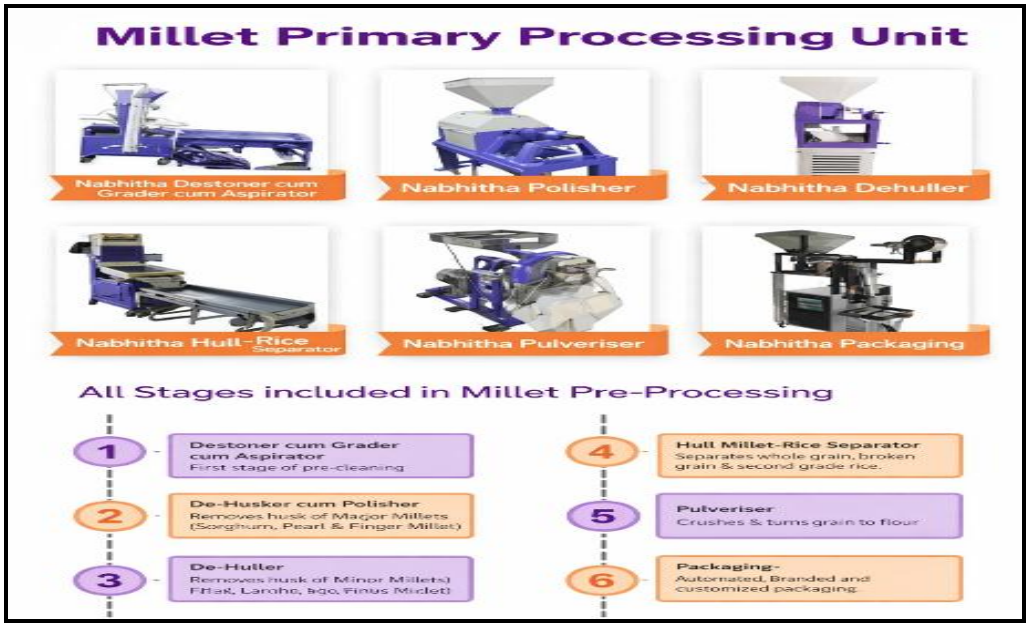

Fig. 1 : Millet Primary processing unit

Primary Processing of Millets

Primary processing includes cleaning, grading, dehulling and milling. Cleaning removes foreign matter like soil, stones and husk. Grading separates grains based on size and quality. Dehulling is crucial because most millets have a tough outer husk that must be removed before consumption. Milling then converts the cleaned and dehulled grains into flour, semolina, or grits, which can be used for cooking or further processing. These steps ensure that millets are safe, palatable, and ready for household or industrial use.

Secondary Processing of Millets

Secondary processing refers to the transformation of millet grains or flour into a wide range of value-added food products that are convenient, nutritious, and appealing to consumers. This stage enhances the usability and market potential of millets by converting them into ready-to-eat or ready-to-cook forms. It also improves the sensory qualities taste, texture, and aroma making millets more acceptable in modern diets.

Techniques and Applications

- **Baking –** Used to prepare millet-based bread, cookies, cakes, and biscuits. Baking improves palatability and introduces millets into mainstream bakery products
- **Extrusion –** Converts millet flour into noodles, pasta, and breakfast cereals. It enhances digestibility and allows fortification with vitamins and minerals
- **Fermentation** – Applied in traditional foods like dosa, idli, and malted beverages. Fermentation increases nutrient bioavailability, improves flavor, and adds probiotic benefits
- **Puffing** – Produces light, crispy snacks and ready-to-eat cereals. Puffing retains nutrients while improving texture and shelf life

Technological Advancements in Millet Processing

Modern technological innovations have transformed the way millets are processed, making production more efficient, hygienic, and scalable. Traditional manual methods often led to inconsistent quality and nutrient loss, but the introduction of advanced machinery and automation has revolutionized millet utilization across both primary and secondary processing stages.

Advanced Processing Equipment

Modern equipment such as extrusion cookers, rotary ovens, and automated fermenters enable precise control over temperature, pressure, and moisture levels during processing.

- **Extrusion cookers** help produce noodles, pasta, and breakfast cereals with uniform texture and enhanced digestibility.
- **Rotary ovens** ensure even baking for millet-based bread, cookies, and snacks, maintaining flavor and nutrient integrity.
- **Automated fermenters** standardize fermentation for products like dosa, idli, and malted beverages, improving consistency and probiotic quality.

These technologies not only enhance product quality but also reduce processing time and energy consumption, making millet-based foods more commercially viable.

Categories of Value-Added Millet Products

Value addition in millets is a crucial step to increase consumer acceptance, diversify food choices and enhance nutritional benefits. By transforming raw grains into innovative products, millets can compete with mainstream cereals like rice and wheat in modern diets. Here's a detailed explanation of the major categories:

Extruded Products

Extrusion technology is widely used to produce pasta, vermicelli, noodles, macaroni, and spaghetti. These products are convenient, quick to cook, and can be fortified with vitamins and minerals. Extrusion improves digestibility and creates appealing textures, making millets suitable for modern fast-food formats.

Bakery Items

Millet flour is increasingly used in cookies, bread, and cakes. These bakery items are healthier alternatives to wheat-based products, offering gluten-free options for those with intolerance. They are rich in fiber and minerals, and their nutty flavor adds uniqueness to baked goods.

Flakes & Puffed Products

Millets can be processed into flakes and puffed cereals, which serve as convenient breakfast options. These products are light, crispy, and ready-to-eat, often consumed with milk or yogurt. Puffing retains nutrients while enhancing shelf life, making them popular among health-conscious consumers.

Fermented Foods

Traditional fermentation techniques are applied to prepare idly, dosa, and malted beverages. Fermentation enhances flavour, improves digestibility and increases nutrient bioavailability. It also introduces probiotic benefits, making fermented millet foods valuable for gut health.

Health Mixes

Millets are incorporated into nutribars, infant foods, and gluten-free mixes. These products are designed for specific dietary needs, offering high nutritional density in convenient formats. Infant foods made from millets provide essential minerals like calcium and iron, while nutribars serve as energy-rich snacks for adults.

Importance in Food Industry

These categories of value-added products not only enhance consumer appeal but also open new markets for farmers and entrepreneurs. They align with the growing demand for functional foods, gluten-free diets, and sustainable agriculture. By diversifying millet applications, value addition ensures their relevance in both traditional and modern food systems.

Packaging and Preservation Innovations

Post-processing technologies such as vacuum packaging and modified atmosphere storage have significantly improved the shelf life of millet products. Vacuum packaging removes air to prevent oxidation and microbial growth, while modified atmosphere storage uses controlled gas mixtures (like nitrogen and carbon dioxide) to preserve freshness and nutritional value. These methods are crucial for maintaining product stability during transportation and long-term storage.

Smart and Sustainable Technologies

Recent developments include sensor-based sorting and AI-driven quality control systems that detect impurities and ensure uniform grain quality. Energy-efficient dryers and solar-powered milling units are also being adopted to reduce carbon footprints, aligning millet processing with sustainable development goals.

Impact on Industry and Research

Technological advancements have made millet processing more economically feasible and environmentally sustainable. They enable large-scale production while retaining nutritional integrity, helping millets compete with mainstream cereals like rice and wheat. Moreover, research institutions and food industries are collaborating to develop fortified millet products enriched with vitamins, minerals, and probiotics, expanding their role in functional and therapeutic foods.

Conclusion

Millets, often referred to as nutri-cereals, are recognized for their rich nutrition and resilience to climate stress. Being naturally gluten-free and

abundant in fiber, protein and minerals, they are especially beneficial for managing conditions like diabetes and heart disease. Through primary processes such as cleaning, dehulling, milling and secondary methods like baking, extrusion, fermentation and puffing. Millets are transformed into modern foods including pasta, cookies, nutribars and probiotic-rich dishes. Advanced technologies like extrusion cookers, rotary ovens and improved packaging ensure hygiene, efficiency and preservation of nutrients. Compared with rice and wheat, millets deliver higher fiber, mineral content and sustainability advantages, thriving in low-water, poor-soil environments. Their adaptability connects traditional diets with modern preferences, enhancing farmer earnings and rural livelihoods. Ultimately, millets are emerging as functional foods of the future, strengthening nutrition security, public health and sustainable farming systems.

References

Anitha, S., Govindaraj, M., & Kane-Potaka, J. (2019). Millets and nutritional security: A review. *Indian Journal of Nutrition and Dietetics*, **56**(2), 168–184.

Chandel, G., Meena, R. K., Dubey, M., & Kumar, A. (2014). Nutritional properties of minor millets: Neglected cereals with potential. *International Journal of Food Science and Nutrition*, **65**(4), 427–435.

Chapke, R. R., Tara Satyavathi, C., Das, I. K., Prasad, G. S., Hariprasanna, K., Singode, A., & Spanditha, M. (2024). *Latest millets production and processing technologies*. ICAR–Indian Institute of Millets Research, Hyderabad. ISBN: 978-93-94673-38-0.

Chapke, R. R., Tara Satyavathi, C., Srinivas, A., Anuradha, N., Sevanayak, D., & Spanditha, M. (2025). *Millets primary processing for income and nutritional security: Custom hiring models for farmers*. ICAR–Indian Institute of Millets Research, Hyderabad. ISBN: 978-93-94673-30-4.

Devi, P. B., Vijayabharathi, R., Sathyabama, S., Malleshi, N. G., & Priyadarisini, V. B. (2014). Health benefits of finger millet (*Eleusine coracana L.*) polyphenols and dietary fiber: A review. *Journal of Food Science and Technology*, **51**(6), 1021–1040. https://doi.org/10.1007/s13197-011-0584-9 (doi.org in Bing)

IJCRT. (2022). A review on nutritional and health benefits of millets. *International Journal of Creative Research Thoughts*, **10**(5), 234–240.

Mukherjee, B. M., Jha, R. K., Sattar, A., Dutta, S. D., Bhattacharya, U., Samanta, S., Huirem, B. H., Singh, S. K. S., Das, S., & Bal, S. K. (2025). Harnessing the potential of millets for climate-resilient and sustainable agriculture. *Frontiers in Plant Science*, **16**, 1574699. https://doi.org/10.3389/fpls.2025.1574699

Nambiar, V. S., & Dhaduk, J. J. (2013). Nutritional composition and health benefits of millets. *International Journal of Food Sciences and Nutrition*, **64**(1), 1–7.

Pasumarthi, P., Ghoora, M. D., Kar, S., & Moharana, S. P. (2026). Millet grain processing: Primary, secondary, and tertiary. In S. A. Mandavgane (Ed.), *Millets: A sustainable and nutritious crop* (pp. 189–210). Springer Nature Switzerland. https://doi.org/10.1007/978-3-032-16300-4_ 8

Pathak, K., & Srivastava, S. (2020). Nutritional and therapeutic potential of millets: A review. *Journal of Food Biochemistry*, **44**(5), e13131. https://doi.org/10.1111/jfbc.13131

Saleh, A. S. M., Zhang, Q., Chen, J., & Shen, Q. (2013). Millet grains: Nutritional quality, processing, and potential health benefits. *Comprehensive Reviews in Food Science and Food Safety*, **12**(3), 281–295. https://doi.org/10.1111/1541-4337.12012 (doi.org in Bing)

Sharma, P., & Meena, R. S. (2023). Insight on millet: A potential candidate for climate-smart food systems. *Agriculture & Food Security*, **12**(1), 45–59. Springer.

Singh, R., & Raghuvanshi, R. S. (2024). The role of millets in climate-resilient agriculture for conserving biodiversity and ensuring food security. *Environmental Sustainability*, **3**(2), 145–158. Springer.