Article ID 240203-S-19

Pseudocereals: The Future of Sustainable Energy

Ranjan Kaushik*[1], Kanika Pawar[2] and Rekha Phogat[3]

[1]Centre of Food Science and Technology, CCS Haryana Agricultural University, Hisar-125004, Haryana, India

*Corresponding Author: rkaushik.1410@gmail.com

Pseudocereals are a group of plants resembling true cereals like wheat, rice, and maize in their nutritional content and culinary versatility, yet they are classified under different botanical families. The term "pseudocereal" is used because these plants are often consumed and prepared in similar ways to true cereals, but they are not members of the grass family (Poaceae), which is characteristic of true cereals (Haros and Schoenlechner, 2017). In India, the cultivation of pseudocereals such as quinoa, chenopods, amaranth, chia seeds, buckwheat, and breadnut has been practiced for several years. However, despite their extensive history of cultivation, the adoption of these crops by consumers has been restricted to a small range of traditional products (Patil and Jena, 2020).

How pseudocereals structurally different from cereal grains?

Pseudocereals, such as buckwheat, quinoa, chia seeds and amaranth, differ structurally from cereal grains like wheat and barley as elucidated in studies by Henrion *et al.* (2020) and Martinez-Villaluenga (2020).

- **Botanical:** Pseudocereals are dicotyledonous plants, meaning their seeds contain two embryonic leaves (cotyledons), whereas common cereal crops like wheat are monocotyledonous, with seeds containing a single embryonic leaf. This difference in seed structure influences their growth patterns and internal structures.
- **Fruits:** Pseudocereals typically produce dry fruits, which are referred to using various terms such as seeds, achenes, or grains. This diversity in terminology reflects the different botanical structures and classifications among pseudocereal species.
- **Nutrient Composition:** Pseudocereals often have grains that contain proportionately more bran fraction compared to cereal grains. This higher bran content contributes to their nutritional richness, providing additional dietary fiber, vitamins, and minerals.
- **Utilization of Greens:** The foliage of pseudocereals can also be utilized as nutritious leafy vegetables. In contrast, the foliage of grass cereals contains higher levels of non-starch polysaccharides, making it less suitable for direct human consumption.

Table 1. Commonly used pseudocereals and their botanical information

Common name	Scientific name	Family	Origin
Quinoa	*Chenopodium quinoa*	Chenopodiaceae	Andean region of South America
Buckwheat	*Fagopyrum esculentum F. Tataricum* L.	Polygonaceae	Turkestan to Manchuria
Amaranthus (Love lies bleeding)	*Amaranthus hypochondriacus Amaranthus cruentus Amaranthus caudatus*	Amaranthaceae	South East Asia
Chenopod (Bathua)	*Chenopodium album*	Chenopodiaceae	Europe
Chia seeds	*Salvia hispanica S. columbariae*	Lamiaceae	Central and Southern Mexico
Kaniwa	*Chenopodium pallidicaule*	Chenopodiaceae	South American Andes
Huauzontle (hairy Amaranth)	*Chenopodium berlandieri spp. Nuttalliae*	Amaranthaceae	Mexico

Health benefits of Pseudocereals: Pseudocereals offer a myriad of health benefits, as highlighted in various studies including those by Mir *et al.* (2018), Thakur and Kumar (2019), and Kaur *et al.* (2023). These include their higher dietary fiber content, which supports digestive health and may aid in lowering cholesterol levels, and their gluten-free nature, making them suitable options for individuals with gluten intolerance or celiac disease. With protein levels comparable to other cereals, pseudocereals provide essential amino acids crucial for muscle integrity, immune function, and overall growth and development. Additionally, they contain elevated levels of indispensable amino acids, ensuring nutritional adequacy. Pseudocereals boast high protein bioavailability and complex carbohydrates, making them beneficial staples for managing diabetes. Rich in healthy fats such as α-linolenic acid, they also serve as abundant sources of antioxidants, vitamins (including vitamin E and B-complex vitamins), and essential minerals like iron, copper, and potassium, contributing to bone health, blood cell formation, nerve function, and overall well-being.

Thus, incorporating pseudocereals into a balanced diet can offer numerous health benefits, supporting overall health and well-being.

Utilization of pseudocereals as value-added food

Pasta/Noodles: Studies have shown that pasta made from legumes and pseudocereals has high polyphenol content, with wholegrain pasta having more than refined flour pasta (Carcea *et al.,* 2017). Optimized formulations using quinoa, kiwicha, and cushuro resulted in pasta with higher fiber, protein, and minerals, lower glycemic index, and retained nutritional profile after cooking (Paucar-Menacho *et al.,* 2023). Noodles fortified with amaranth and buckwheat flours exhibited increased polyphenol content and antioxidant capacity, with higher buckwheat content showing the highest antioxidant levels (Kiss *et al.,* 2019).

Beverages: Garcia *et al.* (2022) developed a fermented huauzontle-infused beverage using *Lactiplantibacillus plantarum* strains, demonstrating viable cell count, antioxidant activity, and anti-inflammatory properties, suggesting health benefits. Cela *et al.* (2022) explored the use of unmalted gluten-free grains in crafting gluten free beer, finding reduced extract and alcohol content compared to control beer, with quinoa-based beer showing promising attributes.

Chapatti/Indian flat bread: Masih *et al.* (2021) enhanced chapati's shelf life and flexibility by adding jowar and buckwheat to wheat flour, with samples showing no spoilage after 72 hours at 5 °C. Sensory analysis favoured buckwheat samples. Gomathi and Parameshwari (2022) improved physicochemical and functional properties of chapati by incorporating whole buckwheat flour, resulting in increased protein and fibre content, along with elevated phenolics, flavonoids, and antioxidant capacity.

Biscuits/Cookies: Krasina *et al.* (2021) made biscuits with amaranth, quinoa, and buckwheat, resulted in texture variations. Higher buckwheat content led to darker colour and increased hardness, while quinoa and amaranth contributed to greater volume. These gluten-free biscuits provided 429.65 kcal/100 g. Paucar-Menacho *et al.* (2022) optimized biscuits with sprouted grain flours for high antioxidant activity and phenolic compounds. Yadav and Mathur (2023) created gluten-free cookies with millets and pseudocereals, scoring higher in sensory attributes as compared to maida cookies.

Other products: Quinoa flour can be used to create gluten-free products like cookies, chapatti, mathri, parantha, ladoo, and pop-ups, which received high acceptability scores ranging from 7.02 to 8.04. Nutritional analysis revealed that these products had higher levels of crude protein, crude fat, total ash, and crude fibre compared to control samples. Notably, they also contained elevated lysine, methionine, tryptophan, calcium, magnesium, iron, and zinc content (Bathal and Kaur, 2018).

Conclusions

The cultivation of pseudocereals holds significant potential benefits for farmers. Beyond contributing to crop diversification, these hardy plants are adaptable to various environmental conditions, including marginal lands, providing farmers with options for sustainable and resilient agriculture. Pseudocereals offer a nutritious yield, rich in proteins, dietary fibre, vitamins, and minerals, presenting an opportunity for farmers to meet the evolving demands of health-conscious consumers. Moreover, the

versatility of pseudocereals in different food products, as highlighted in the research, opens avenues for value addition and market opportunities, potentially leading to increased income for farmers. As the cultivation of pseudocereals aligns with sustainable and organic farming practices, it not only offers economic benefits but also promotes environmentally friendly agriculture, making it a viable and promising choice for farmers seeking diversification and enhanced agricultural sustainability.

References

Bhathal, S. K., and Kaur, N. (2018). Nutritional analysis of gluten free products from quinoa (*Chenopodium quinoa*) flour. *International Journal of Pure and Applied Bioscience*, 6(2), 826-836.

Carcea, M., Narducci, V., Turfani, V., and Giannini, V. (2017). Polyphenols in raw and cooked cereals/pseudocereals/legume pasta and couscous. *Foods*, 6(9), 80.

Cela, N., Galgano, F., Perretti, G., Di Cairano, M., Tolve, R., and Condelli, N. (2022). Assessment of brewing attitude of unmalted cereals and pseudocereals for gluten free beer production. *Food Chemistry*, 384(1), 132621.

Das, S., and Das, S. (2016). Pseudocereals: an efficient food supplement In Amaranthus: a promising crop of future. *Springer*, pp. 5-11.

Garcia, H. S., Santiago-Lopez, L., Gonzalez-Cordova, A. F., Vallejo-Cordoba, B., and Hernández-Mendoza, A. (2022). Evaluation of a pseudocereal suitability to prepare a functional fermented beverage with epiphytic lactic acid bacteria of Huauzontle (*Chenopodium berlandieri* spp. *nuttalliae*). *LWT- Food Science and Technology*, 155(5), 112913.

Gomathi, G. K., and Parameshwari, S. (2022). Evaluation of buckwheat flour addition on the sensory, nutritional and materialistic properties analysis of Indian flat bread. *Materials Today: Proceedings*, 66(5), 988-995.

Haros, C. M., and Schoenlechner, R. (Eds.). (2017). Pseudocereals: chemistry and technology. *John Wiley & Sons Ltd.*, pp. 1-223.

Henrion, M., Labat, E., and Lamothe, L. (2020). Pseudocereals as healthy grains: an overview In *Innovative processing technologies for healthy grains*. John Wiley & Sons Ltd., pp. 37-59.

Kaur, H., Shams, R., Dash, K. K., and Dar, A. H. (2023). A comprehensive review of pseudo-cereals: nutritional profile, phytochemicals constituents and potential health promoting benefits. *Applied Food Research*, 3(2), 100351.

Kiss, A., Takacs, K., Nagy, A., Nagy-Gasztonyi, M., Cserhalmi, Z., Naar, Z., Halasi, T., Csaki, J. and Nemedi, E. (2019). In vivo and in vitro model studies on noodles prepared with antioxidant-rich pseudocereals. *Journal of Food Measurement and Characterization*, 13(4), 2696-2704.

Krasina, I. B., Filippova, E. V., Kurakina, A. N., and Fedorova, M. A. (2021, November). Use of pseudo cereals in food production. In *IOP Conference Series: Earth and Environmental Science*, 845(1), 012112.

Martinez-Villaluenga, C., Penas, E., and Hernandez-Ledesma, B. (2020). Pseudocereal grains: nutritional value, health benefits and current applications for the development of gluten-free foods. *Food and Chemical Toxicology*, 137, 111178.

Masih, M., Saini, S., and Mishra, R. C. (2021). Value addition with flours for increased shelf life of Chapati, 10(10), 807-816.

Mir, N. A., Riar, C. S., and Singh, S. (2018). Nutritional constituents of pseudo cereals and their potential use in food systems: a review. *Trends in Food Science and Technology*, 75, 170-180.

Patil, S. B., and Jena, S. (2020). Utilization of underrated pseudo-cereals of North East India: a systematic review. *Nutrition and Food Science*, 50(6), 1229-1240.

Paucar-Menacho, L. M., Castillo-Martínez, W. E., Simpalo-Lopez, W. D., Verona-Ruiz, A., Lavado-Cruz, A., Martinez-Villaluenga, C., Penas, E., Frias, J. and Schmiele, M. (2022). Performance of thermoplastic extrusion, germination, fermentation, and hydrolysis techniques on phenolic compounds in cereals and pseudocereals. *Foods*, 11(13), 1957.

Paucar-Menacho, L. M., Vasquez Guzmán, J. C., Simpalo-Lopez, W. D., Castillo-Martinez, W. E., and Martinez-Villaluenga, C. (2023). Enhancing nutritional profile of pasta: the impact of sprouted pseudocereals and cushuro on digestibility and health potential. *Foods*, 12(24), 4395.

Thakur, P., and Kumar, K. (2019). Nutritional importance and processing aspects of pseudo-cereals. *Journal of Agricultural Engineering and Food Technology*, 6(2), 155-160.

Yadav, P., and Mathur, R. (2023). Development of gluten free flour and gluten free cookies and their sensory evaluation. *International Journal of Nutrition and Lifestyle*, 3(2), 105-130.

* * * * * * * *