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Nutritional Properties of Underutilized Arid Produce: Review On Current Trends and Future Prospects

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Abstract

Sangri (*Prosopis cineraria*), the immature pod of the khejri tree, is an important indigenous food resource in India, particularly in the arid and semi-arid regions of Rajasthan. It plays a significant role in supporting rural nutrition, livelihood security, and traditional food systems. Sangri is highly valued for its rich nutritional profile, comprising carbohydrates, dietary fiber, essential minerals, vitamins, and various bioactive phytochemicals. Despite its nutritional and economic significance, its utilization is constrained by high perishability and seasonal availability, which pose considerable challenges for post-harvest handling, storage, and year-round supply. Drying is the most commonly employed preservation method to extend shelf life and facilitate safe storage; however, the process can affect physicochemical attributes, nutrient retention, and functional properties. Recent advancements in processing technologies, including optimized drying techniques and the development of value-added products, have created new opportunities for enhancing the utilization and market potential of Sangri. This review provides a comprehensive evaluation of the nutritional and functional characteristics of Sangri, examines the impact of processing and preservation on product quality, assesses storage stability, and discusses emerging prospects for commercialization and value addition. Furthermore, it highlights the potential role of Sangri in promoting sustainable agriculture, strengthening nutrition security, and supporting rural economic development.

Keywords: *Prosopis cineraria, Drying,* value addition

1. Introduction

India possesses a rich diversity of underutilized food resources that support the nutritional and economic well-being of rural populations. Among these, Sangri is highly valued due to their nutritional value, and cultural significance.

Prosopis cineraria, commonly known as Sangri, Jandi, Ghaf, and Khejdi, is a versatile native tree species renowned for its ability to withstand harsh climatic conditions. In Ayurveda it is referred to as Kalpataru because of its numerous beneficial attributes. Owing to its ecological, medicinal, and economic importance, it is often called the “Wonder Tree” and the “King of the Desert.”(S Sachdeva, V Kaushik, 2014) Sangri refers to the immature green pods of *Prosopis cineraria* (Khejri), a drought-resistant tree native to arid and semi-arid regions. It forms an important component of traditional Rajasthani cuisine and

is particularly famous in the preparation of Ker-Sangri and Panchkuta. The pods are rich in protein, dietary fiber, minerals, and bioactive compounds, making them valuable functional foods. It grows in dry and arid regions of Arabia and in regions of India mainly Rajasthan, Haryana, Punjab, Gujarat, Western Uttar Pradesh and drier parts of Deccan. Due to their high moisture content and seasonal availability, Sangri deteriorate rapidly, making drying a critical post- harvest preservation technique. Vegetables and fruits are generally classified as perishable crops; and if not quickly preserved after harvest, they rot away rapidly, especially under hot conditions. Studies on drying of desert crops indicate that controlled drying methods improve nutrient retention, colour stability, and product quality compared to open sun drying. Khejri is a small moderate sized evergreen thorny tree, with slender branches armed with conical thorns and with light bluish-green foliage (Rani, B., Singh, U., Sharma, R., Gupta, A., Dhawan, N. G., Sharma, A. K., ... & Maheshwari, 2013).

Therefore, this review has been designed in such a way to focus on recent advancement in utilization of sangri as food and its future prospective regarding its value addition.

2. Area and Production

Khejri (*Prosopis cineraria*) is a widely distributed tree species in India, particularly in western Rajasthan. It is crucial for maintaining the ecological balance of arid and semi-arid regions, especially in the Thar Desert. This species is highly tolerant to frost and drought and can endure extreme temperatures, ranging from 40–45°C in summer to below 10°C in winter. It also grows in areas receiving annual rainfall between 100 and 600 mm. Remarkably, the tree survives the harshest hot winds and prolonged dry conditions, thriving in environments where most other plants fail to grow (Chaudhary N, Kumari M, Pawariya V, S S Bhati, 2020).

3. Botanical Description and Distribution

Sangri (*Prosopis cineraria*)
Family: Fabaceae
Common names: Khejri, Shami, Jand
Edible part: Tender immature pods (Sangri)
Distribution: Rajasthan, Gujarat, Haryana, Punjab, and arid regions of western India (Malik, S., Mann, S., Gupta, D., & Gupta, 2013).

P. cineraria pods are locally called "sangar" or "sangri". The pod is considered astringent in Punjab. Sangri pods are known to prevent protein and mineral deficiency. Cooked pods of Khejri are used as a functional food in Rajasthan (Malik, S., Mann, S., Gupta, D., & Gupta, 2013).

4. Processing of Sangri

In processing operations like collection of material, pods detachment, drying, stamen removal, storage are carried out in this phase.

4.1 Collection

The unripe green pods of khejri, locally known as sangri. Sangri used as a vegetable in fresh and dried form. Fresh sangris are plucked and collected for its treatment.

4.2 Pre-processing

Pre-processing treatment of fresh sangri comprising of washing, grading and blanching with preservatives can be performed.

4.3 Drying

People pluck the sangris from trees during the season and follow the conventional drying process by drying the sangri in open sunlight for 3-4 days in sunlight (40 to 43°C) for drying and store at home for the latter consumption (Bal, Jijnasha, Kumar, V. Kavan, Panwar, 2026).

4.4 Storage

The dried sangri and mahua flowers are packed in polyethylene bags and stored at safe places. Processed Sangri, pack them in suitable packaging material and market this product all over India. The community are making money by realizing the sale of dried sangri and mahua at excelling cost.

5. Nutritional and Medicinal Importance

Khejri is a multi-function tree and ensuring nutrition rich leaf-fodder, pods and seeds and also fuel-wood. Sangri pods are very nutritious and contain enormous medicinal properties. The dry pods are comprised of 40-58% carbohydrates, 8-20% protein, 24-28% crude fibre, 3.2-4.1% fat, 5.4% ash content, 0.33% calcium and 0.44% phosphorus. Moreover, sangri contains the high quality amino acid composition (Gurjar, P. S., 2024). The iron content of dry pods amounts reasonable high (208-639 ppm), while copper (13-16 ppm), manganese (22 ppm) and zinc content (13-16 ppm) are also appreciable for human consumption. The khejri tree is called as kalptru since the different plant parts have been utilized for medicinal purpose in one form or another. As the root part is used as antidysenteric and the smoke of leaves is used to cure eye infections (Chaudhary N, Kumari M, Pawariya V, S S Bhati, 2020).

6. Uses

Khejri is a multipurpose tree that provides nutrient-rich fodder, pods, seeds, and fuelwood. It enhances soil fertility and ecological balance through nitrogen fixation, its deep taproot system, and a single-layered canopy. Being a perennial component of many land-use systems, it offers valuable environmental benefits. Its deep roots minimize competition with nearby crops for water and nutrients, while its sparse winter shade supports crop growth. Studies have shown that soils under khejri trees contain higher levels of organic matter, nitrogen, phosphorus, and calcium, along with a lower pH, contributing to improved field productivity. The tree recorded abundant flowers and valued for honey production (Pareek, 2002) (Kaushik, N., & Kumar, 2003) (Samadia, D. K., Purohit, A. K., & Pareek, 2002).

The Bishnoi community is widely recognized for its strong commitment to environmental conservation, particularly the protection of trees, which is deeply rooted in their religious beliefs. In recognition of this legacy, the Government of India established the Amrita Devi Bishnoi National Award for Wildlife Conservation. The award commemorates Amrita Devi Bishnoi, who, along with 363 fellow villagers, sacrificed her life in 1731 to prevent the felling of khejri trees in Khejarli, near Jodhpur. This historic act remains a symbol of dedication to environmental and wildlife conservation (Samadia, D. K., *et al.* 2021). Rural communities actively promote the cultivation of khejri on farms, grazing lands, and common areas due to its ecological and economic benefits. Its extensive root system helps stabilize sand dunes, while its dense green foliage provides effective windbreaks, shelterbelts, and support for afforestation. The tree is widely protected because it offers valuable shade and shelter to farmers, livestock, and wildlife during the hot summer season. Khejri is much valued for it leaf fodder (loong or loom) and is a major source of nutritious animal feed. Both green and dry loong is used as feeding in winters is much beneficial. Khejri provide quality wood and used in house-building as rafters, posts, doors, boxes, tool-handles and agricultural implements. In desert, container manufacturing is wood-based industry and

depends largely on native trees. It wood contains high calorific value fuel (5000 kcal/kg) and good for charcoal making (Samadia, D. K., *et al.* 2021).

7. Value Addition

Tender pods of khejri are commonly dehydrated on a large scale, and the resulting dry sangri is extensively used in preparing various vegetable dishes and pickles. Mature dry pods, known as *khokha*, have a sweet taste and are often consumed by rural communities and livestock, although a significant portion goes unused. These ripe pods, particularly those containing seeds, are nutritionally valuable, providing 9–14% crude protein, 6–16% sugars, 0.3% phosphorus, 1.6% calcium, 0.06% iron, and considerable energy. To utilize this nutritious resource, studies were carried out to develop biscuits using khokha flour as a partial substitute for wheat flour (maida) at levels of 15%, 20%, and 25%. The results showed that biscuits containing khokha flour were more nutritious than those made solely from wheat flour. Biscuits with 25% khokha flour exhibited significantly higher levels of protein, starch, calcium, potassium, and sodium, regardless of whether the flour included seeds. Moreover, biscuits prepared with 25% seed-containing khokha flour also had increased amounts of carbohydrates, reducing sugars, and phosphorus. These results suggest that biscuits made from ripe khejri pods can be an effective nutritional supplement and may help reduce nutrient deficiencies prevalent in rural diets (Samadia, D. K., *et al.* 2021).

8. Conclusion

Sangri have long been valued for their nutritional properties, which have been traditionally recognized for generations. Plant-based foods such as flowers, and vegetables are vital for human health as they provide essential nutrients, including carbohydrates, fats, proteins, vitamins, and minerals. Antioxidants are the key compounds responsible for the health-protective effects of vegetables. Natural antioxidants present in these foods have gained significant attention. The major industrial use of mahua flowers is in liquor production. The supply chain from sangri collection to processing units should be improved and optimized to maintain quality, prevent spoilage, and ensure their use as a viable raw material for food industries. This approach would help better utilize this valuable resource, ultimately benefiting rural communities and the nation. The quality of fresh sangri vegetable is declining due to improper traditional method handling used by tribal communities for their preservation. Due to inadequate processing and preservation practices, this highly nutritious and valuable tree is often considered underutilized. To overcome these challenges, there is a need to adopt improved technologies for producing a range of value-added food products and ensuring their availability throughout the year, along with proper commercialization.

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