

Protocols standardized for harvesting, preservation and valuation of *ker* fruits

This study at ICAR–Central Institute for Arid Horticulture, Bikaner, Rajasthan, focused on *ker* or *kair* (*Capparis decidua*), an underutilized arid fruit of high nutritional and economic value. Traditional sun-drying practices reduce sensory and medicinal qualities, limiting commercialization. To address this, protocols for harvesting, acidity removal, preservation, and packaging were standardized. Innovative techniques, including lactic acid-based fermentation, brining, and freezing, were developed to retain fruit colour, quality, and phytochemical content, extending shelf-life up to 20 months. Market-oriented packaging technologies were also optimized. These interventions ensure year-round availability, enhance consumer acceptability, and promote livelihood security through sustainable, climate-resilient arid horticulture.

KER or *kair* (*Capparis decidua*) is a xerophytic shrub that bears edible fruits with diverse uses. It is a well-documented component of the Thar Desert flora and possesses immense horticultural potential, both for nutritious food products and ecosystem services in the arid and semi-arid regions of Rajasthan. It occurs naturally in the drier parts of Rajasthan, Haryana, Gujarat, and Madhya Pradesh. Despite its importance, organized cultivation is absent, and fruits are largely collected by local inhabitants. The tender green fruits, highly valued for pickles and vegetable dishes, are available fresh only for a short period of 15–21 days during the fruiting season due to lack of technical know-how.

At present, no standardized criteria exist for determining fruit maturity, post-harvest handling, or product diversification. Traditional preservation through sun-drying considerably reduces sensory attributes and diminishes medicinally important phytochemicals. To overcome these limitations, ICAR–Central Institute for Arid Horticulture (ICAR–CIAH), Bikaner, has standardized harvesting stages and developed innovative preservation protocols such as brining and freezing, which retain sensory properties and phytochemical content. Additionally, consumer-oriented packaging and labeling techniques have been introduced to enhance marketability, consumer preference, and the commercialization potential of this premium-priced, underutilized fruit.

Fruiting of *ker*

Well-protected *ker* plants bear fruits profusely twice a year, during April–May and September–October. The tender fruits, although acrid in taste, possess significant horticultural value and are widely utilized in culinary

preparations after minimal traditional processing. However, marketable quality fruits are available only for a short duration of 15–21 days, as immature fruits rapidly advance toward maturity. Therefore, defining growth stages for harvesting maximum tender fruits and adopting scientific preservation techniques is crucial to ensure year-round availability and marketing. Fresh, green, immature fruits at the pea-size stage are available for only a few days and require frequent pickings at 3–4 day intervals.



Fruiting in *ker* plant

Fruit harvesting

In *ker*, fruiting occurs in clusters, but fruits within a cluster do not mature simultaneously. This lack of uniformity complicates harvesting, as some fruits are suitable for processing, while others remain immature

or become over-mature, making large-scale commercial harvesting difficult.

Fruit growth is rapid, with tender fruits reaching harvestable maturity for fresh consumption and processing within 8–12 days after fruit set. At horticultural maturity, fruits are characterized by green skin and pulp, soft inseparable seeds, and average dimensions of 0.43–0.56 g in weight, 6.95–8.48 mm in length, and 6.10–7.32 mm in diameter. Once seed hardening begins, bitter compounds accumulate, rendering fruits unsuitable for pickling or culinary use. At this stage, seeds become bold and separable, and the pulp changes from green to yellow with violet tinges on the fruit shoulder.

Therefore, timely, selective, and staggered harvesting based on fruit developmental stages and maturity indices is essential for obtaining high-quality *ker* fruits suitable for processing. To maximize the yield of marketable fruits, harvesting should be conducted three to four times between 8–12 days after fruit set, at intervals of 3–4 days.



Fruit development stage

Green fruits



Overmatured fruits with bold seeds and yellow pulp unsuitable for processing

Removal of fruit acidity

Traditionally, the removal of acidity or bitterness from *ker* fruits involves a prolonged process in which the

fruits are dipped in a buttermilk and salt solution. This method takes 6–8 days and often results in deterioration of the fruits' natural colour. The treated fruits are then used for making pickles, vegetable preparations, or dehydrated products.

To overcome these limitations, an innovative and expedited method for acidity removal has been standardized at ICAR-CIAH, Bikaner, with a complete protocol developed. This novel technique employs a lactic acid-based fermentation process that significantly reduces the time required for bitterness removal while preserving the desirable colour and quality of the fruits.

The standardized method involves dipping freshly harvested, sorted, and graded fruits in a water-based solution containing specific additives for three days. The process promotes the growth of naturally occurring *Lactobacillus* spp. present on the fruit surface by lowering the pH of the dipping solution. This acidic environment accelerates lactic acid fermentation, resulting in rapid and effective acidity reduction.

Compared to conventional practices, the lactic acid fermentation method offers a faster (three-day) and cost-efficient alternative for bitterness removal, with the added benefit of maintaining superior fruit quality, colour, and appearance.

Innovative methods of *ker* fruit preservation

Traditionally, fresh *ker* fruits are preserved through sun-drying for off-season consumption and marketing. However, this practice leads to considerable losses in medicinal and nutritional properties and drastically affects texture, colour, cooking quality, and overall sensory attributes of the fruits. Moreover, dried *ker* fruits require rehydration before culinary use, which further diminishes their sensory qualities such as colour, texture, and palatability.

To overcome these limitations, ICAR-CIAH, Bikaner has standardized and developed innovative preservation techniques, specifically brining and freezing methods, which enhance the shelf-life of *ker* fruits while retaining their desirable qualities and bioactive compounds.

(a) Brining technique

Following the de-bittering (acidity removal) stage, *ker* fruits are preserved by immersing them in a 5% sodium chloride (NaCl) solution with the addition of 120 ppm potassium metabisulphite, which inhibits microbial growth during storage. The prepared fruits are then sealed in glass jars or food-grade plastic containers. This method effectively preserves the fruits for 8–10 months, maintaining their natural green colour and minimizing the loss of nutraceutical components. Brined fruits are ready for consumption or cooking, though they should be rinsed with clean tap water to remove excess salt before use in culinary preparations such as pickles or vegetable dishes.

(b) Freezing technique

In this method, de-bittered *ker* fruits are blanched in hot water for two minutes, air-dried, and then packed in food-grade polyethylene bags. The fruits are stored in deep-

freezers at -5°C , which extends their shelf-life to 18–20 months and provides a wider window for fruit availability. This preservation approach ensures minimal degradation of green colour, bioactive compounds, and medicinal properties. Before use, the frozen fruits should be soaked in tap water for about one hour to prevent condensation (“sweating”) and to raise the temperature to ambient conditions.

Market-oriented packaging

ICAR-CIAH, Bikaner, has finalized protocols and, for the first time, standardized consumer-friendly packaging technology to promote *ker* fruits in modern markets. Processed fruits were packed in small, consumer-oriented units to facilitate easy transportation and ensure year-round availability through retail chains, shopping malls, and app-based home delivery systems.

Fruits were packed in 200–300 g glass jars or food-grade plastic bottles containing 5% brine solution, catering to the needs of nuclear families. Similarly, frozen green *ker* fruits were packed in 200 g food-grade polyethylene bags, offering convenience and improved accessibility for urban consumers while maintaining fruit freshness and quality.



Consumer-oriented packaging of processed and preserved *ker* fruits

Advantages of innovative preservation technology

- Extended the storage life for quality fruits and year-round availability.

- No significant changes in fruit colour, taste and texture during storage.
- Fruits are converted to ready to use or ready to consumption form.
- Minimal loss of medicinally important phytochemicals during storage.
- Enhanced consumer appeal and market acceptability.
- Extended *ker* fruits availability at distant market and branded shops, and
- The technology offers to develop production and product market system from rural areas.

Culinary, nutritional, and medicinal significance of *ker*

Ker is an underscored arid-zone fruit of high value (fresh fruits priced at ₹250–400/kg), rich in nutrition (crude protein – 13.2%, crude fibre – 14.5%, fat – 5.2%, calcium – 1.44%, potassium – 0.52%, and phosphorus – 28 ppm) and globally recognized for its diversified uses.

Although the tender fruits are highly valued, they are not palatable in their raw form due to acidity and thus require primary processing (de-bittering) before being used in culinary preparations and value-added products. Processed fruits are commonly utilized in pickles, vegetable dishes, or dried for long-term storage. A wide variety of *ker* pickles, renowned for their geographical uniqueness, are widely consumed and are gaining increasing popularity in markets due to their distinct taste and medicinal properties. Dried *ker* fruit is also an integral component of *Panchkutta*, a traditional and royal delicacy of western Rajasthan.

Beyond its culinary appeal, *ker* possesses significant pharmaceutical potential. Its fruit powder exhibits hypoglycaemic and hypocholesterolemic activity, reduces lipid peroxidation, and provides protective benefits to the liver, kidneys, and heart. In Ayurveda, *ker* pickles and vegetable preparations are traditionally recommended for alleviating stomach ailments, particularly constipation and loss of appetite.

CONCLUSION

Ker or *kair*, a high-valued arid fruit with immense nutritional, medicinal, and commercial importance, remains underutilized due to challenges such as acidity removal, short shelf-life, and inadequate preservation methods. Innovative technologies standardized at ICAR-CIAH, Bikaner, safeguard fruit nutrition and sensory attributes while ensuring superior quality and year-round availability. By enhancing consumer accessibility, these interventions provide sustainable solutions for processing and packaging. Their demonstration among growers, rural women, and youth creates new avenues for entrepreneurship, livelihood generation, and commercialization, thereby positioning *ker* as a promising horticultural crop for resource-constrained arid environments.

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