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Economically important underutilized fruits suitable for arid eco-system-A review

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ABSTRACT

The climatic conditions of western Rajasthan and parts of Gujarat are characterized by low and erratic rainfall, high thermal oscillation, and harsh weather. As a result, much of the land is barren, making it suitable for the cultivation of arid fruits that are currently underutilized. Some examples of these underutilized fruits include Kair (*Capparis deciduas L.)*, Karonda (*Carissa carandas L.*), Khejri (*Prosopis cineraria*), Pilu (*Salvadora oleoides*), Tamarind (*Tamarindus indica*), Wood apple (*Feronia limonia L. Swingle*), Cactus pear (*Opuntia ficus-indica*), Nagphani (*Opuntia elatior Mill.*), and Dansara (*Rhus mysorenis* Hene ex Wight & Arn.). These fruit crops grow naturally and have been utilized by local communities for a long time due to their nutritional value and resilience to harsh climatic conditions. This review focuses on the underexploited fruits with the potential to thrive in such environments, discussing aspects such as value addition, post-harvest management, and future prospects for these crops.

Introduction

Biodiversity plays a great role for sustainable livelihoods under arid ecosystem. It encompasses the variability of living organism including their *in situ* and *ex situ* conservation of flora and fauna along with their genetic and ecosystem levels. India is the second leading fruit producing country, sharing 11.2 percent of world's total fruit production. India exports only 1.2 per cent fruits in global market which is very less. Rajasthan is the biggest state of India but its contribution in fruit production is not so significant. The western part of Rajasthan is covered under arid-region where ample opportunities exist for production of arid fruits. Beside this, some part of Gujarat, Haryana, Karnataka and Andhra Pradesh are also covered under arid-region. In these area number of local fruits are grown which are highly nutritious. These fruits are very common in local population but new in national or international community and therefore are called as underutilized fruits (Table 1). Fruits like Kair (*Capparis deciduas* L.), Karonda (*Carissa carandas* L.), Khejiri (*Proso-*

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pis cineraria), Pilu (*Salvadora oleoides*), Tamarind (*Tamarindus indica*), Woodapple (*Feronia limonia* L. Swingle), Cactus pear (*Opuntia ficus-indica*), Dragon fruit (*Hylocereus Spp*.), Nagphani (*Opuntia elatior* Mill.), Dansara (*Rhus mysorenis* Hene ex Wight & Arn.), *etc*. are not under commercial cultivation and therefore, no recommended package of practices are available. These underutilized fruits and their by products are being utilized by the tribal's since long time. Arid fruits are rich in carbohydrates, protein, fat, vitamins A, B and C, minerals (iron, potassium, calcium, *etc*.) and dietary fiber *etc*. In Ayurveda and homeopathy also, the fresh arid fruits or their byproducts are used to control several human diseases. These fruits can be successfully grown on barren land with limited moisture and extreme weather conditions (Gupta *et al.*, 2001). Hence, underutilized arid fruits can help to overcome the malnutrition problem in our country along with better utilization of available barren land.

Table 1. Botanical description and distribution of economical importance fruit tree under arid-ecosystem

S.No.	Common name	Locally name	Botanical name	Family	Chromosome no.	Distribution	References
1	Kair	Kair, Taint	*Capparis decidua* L.	Capparidaceae	x = 7,8	Rajasthan, Gujarat, Punjab, U.P., Punjab, M.P. and Andhra Pradesh	Meghwal and Singh (2016)
2	Karonda	Karunja, Karonda	*Carissa carandas* L.	Apocynaceae	2n=22	Bihar, West Bengal, Uttar Pradesh, Uttarakhand, Maharashtra, Rajasthan and Southern India	Meghwal and Singh (2016)
3	Khejri	Khajri, Jati	*Prosopis cineraria* (L.) Druce	Mimosaceae	2n=2x=28	Rajasthan	Meghwal and Singh (2016)
4	Pilu	Chhatapilu, Jhal, Meetha Jhala	*Salvadora oleoides* Decne	Salvadoraceae	2n=24	Punjab, Haryana, and Gujarat, Madhya Pradesh, Rajasthan and southwestern parts of Utter Pradesh	Laura *et al.* (2014)
5	Tamarind	Imli	*Tamarindus indica* L.	Caesalpiniaceae	2n=24	Tamil Nadu, Karnataka, M.P., Andra Pradesh, Telangana, Gujarat, Rajasthan,	Mani *et al.* (2020)
6	Wood apple	Keth, Kaitha, Elephant apple, Monkey fruit and kathbel	*Feronia limonia* (L.) Swingle	Rutaceae	2n=18	Maharashtra , M.P., Jharkhand, U.P., Chhattisgarh and Rajasthan	Krishna *et al.* (2016)
7	Cactus	Prickly pear	*Opuntia ficus-indica* (L) Mill.	Cactaceae	2n= 22, 44, 66, 88	Rajasthan desert , Bhuj in Gujarat and Western Maharashtra	Kiesling and Metzing (2017) and Kumar *et al.* (2018)
			Opuntia albicarpa	Cactaceae	2n=22,44,66	Rajasthan	Kumar *et al.* (2018)
			Opuntia robusta Wendl.	Cactaceae	2n=22,44,66	Rajasthan	Kumar e*t al.* (2018)
8	Columnar Cacti	Koubo	*Cereus peruvianus* Britton and Rose	Cactaceae	-	Rajasthan	Mizrahi *et al*. (2002)
9	Red flower Prickly pear	Nagphani/ Thapa thor	*Opuntia elatior* Mill.	Cactaceae	-	Rajasthan	Meena (2015)
10	Dansara	Katiya/ Khatuna	*Rhus mysorenis* Hene ex Wight & Arn.	Anacardiaceae	-	Rajasthan, Haryana, Punjab, Andhra Pradesh and Gujarat	Swathi *et al.* (2015)

Economic importance of underutilized arid fruits

Underutilized fruits are rich source of vitamins, minerals, carbohydrates, proteins, and fats. They are also rich in phytochemicals having several medicinal value and can help to prevent and cure diseases like kwashiorkor, marasmus and anemia. These crops are easier to grow than major commercially grown crops and can produce a crop even under adverse soil and climatic conditions. Underutilized arid fruits require low input and can produce higher biomass than field crops per unit area. Cultivation of underutilized arid fruits crops can help to improve wastelands by preventing soil erosion, improving soil fertility, and promoting biodiversity. Further, the underutilized fruits can provide economic security to tribals by providing employment and good returns from their sale. Keeping in view the importance of underutilized arid fruits, their economic importance is described as under and nutritive value is presented in Table 2.

Kair: It is a shrub naturally grown at farm boundaries, barren and wasteland. It occurs in tropical and warm region possessing several economic significance (Vyas *et al.*, 2009). Kair provides vegetative cover, improves soil fertility, check soil erosion and increased biodiversity (Meghwal and Singh, 2016). It is a xerophytic plant with less foliage and deep root system hence, suitable for cultivation on wastelands, especially to combat soil and wind erosions. Tender and fully developed pod are used for making pickle and dried pods for making Panchkuta. Kair plant has several medicinal values and raw material for drug industry as anti-inflammatory, laxative, anti-diabetic, anthelmintic, antibacterial, astringent, digestive, diaphoretic and anodyne.

Karonda: A small bushy tree with sharp spine and evergreen foliage. It is considered as an economic and popular protective live fence plant. It can be grown in wasteland, problematic soil, unproductive land and low moisture conditions. Its fruit is called berry which is a rich source of iron, calcium, magnesium, phosphorus and vitamin C (Bairwa, 2020). Plant produce sufficient amount of fruits and fruits are sour and astringent in taste. It has medicinal uses against bilious, capillary bleeding, cold, influenza, piles, dysentery, habitual constipation and scurvy disease. Efforts are going on to domesticate this fruit and several varieties *viz*., Pant Sudarshan, Pant Manohar and Pant Suvarna have been released from GBPUA&T, Pantnagar, Thar Kamal from CHES (CIAH), Godhra (Singh *et al.*, 2013) and Maru Gaurav from CAZRI, Jodhpur (Meghwal and Singh, 2019). Fruits have nutritive value like rich source of iron, fair amount of vitamin C. However, it has not yet been popularized among national and international farming community.

Khejri: Khejri is a tree which has multipurpose uses. It is a state tree of Rajasthan and also related to very famous Khejarli massacre (Chipko movement) of Rajasthan. The immature pods are edible and rich in crude protein (18%), carbohydrates (56%) and minerals such as phosphorus (0.4%), calcium (0.4%) and iron (0.2%) (Duhan *et al*., 1992). Fruits are used after drying for making special dish "Panchkuta" that is prepared with five different nutritionally rich arid fruits and vegetable (ker, khejri, lasora, kumat and kachri) of western Rajasthan. Arya *et al*. (1991) reported that dried ripe pods contain 9-14% crude protein and 6-16% sugar; it can be powdered and used in bakery industries. Dry leaves of khejri are used as animal feeds. The Central Institute of Arid Horticulture, Bikaner is working on this plant and has developed first variety Thar Shobha by adapting bud grafting technique. Its bark extract is used to overcome the poisonous effects of the scorpion and snake bites.

Pilu: Pilu tree has a great economical and ethno-medicinal value. Ripe fruits are sweet and edible. Its fruits boosted the milk if used as cattle fed. The fresh fruits contain about 70% juice. The method of extraction of juice and preparation of squash and Jam has been standardized (Khan *et al*., 2004). The pulp contains good amount of glucose, fructose, sucrose and calcium (Duhan *et al*., 1992). Fruits have medicinal uses to control enlarged spleen, rheumatism, cough and low fever. Seeds contain fats which are used as remedy of rheumatic pains (Anonymous, 1972). Seeds are rich in fat (40-50%) and its purified oil used in soap, non-edible wax and detergent industries. After extraction of oil the cake is also useful as manure. Plants are woody and hardy in nature, hence used in making furniture and agricultural implements.

Tamarind: Evergreen and partially semi-evergreen, perennial and woody tree species. It is well adopted under harsh climatic conditions (low rainfall, high temperature, frost, *etc.)* but requires sub-tropical and dry condition for better flowering and fruiting. Its pods are considered as fruits which are slightly curved, brownish-ash coloured and contain 1-12 seed per fruit. Pods are rich in antioxidant, anti-inflammatory properties, thus it provides a huge potential for biomedical science (Singh *et al.*, 2020). They are being used by household in making chutney and other recipes (Mani et al., 2020). Different varieties have been released from different Institute viz., DTS-1 and DTS-2 (UAS, Dharwad), PKM-1 (TNAU, Tamil Nadu), Urigam (Department of Horticulture, Tamil Nadu), Pratisthan (Fruit Research Station, Andhra Pradesh), Goma Parteek (CHES, Godhra), Yogeshwari (Taluk seed farm, Ambajogai, Maharashtra). Its leaves are use in herbal medicines; fruits are rich source of antioxidant which is improving immune system in human beings. Fruit pulp is also reducing to serum lipids which overcome the cardiovascular diseases.

Wood apple: It is also known as elephant apple, monkey

fruit and kathbel. It grows naturally in waste and undulate land. Two forms of plants are form one is small with acidic fruit and second is tall with sweetish fruits. Ripe fruit are rich source of riboflavin, vitamin C *etc.* Pulp of the fruit is highly nutritious and use in liver, diarrhea, dysentery and throat problem. It is considered sacred by Hindus and is widely cultivated or naturally grown in India. Fruit pulp, seed and oil has several beneficial effects as liver and cardiac tonic. It has remedial value of bones and joints problem, bilious diseases, prevention of capillary bleeding, cold, influenza, dysentery, piles, habitual constipation and scurvy (Pal *et al*., 2019). A variety Thar Gaurav has been developed by Regional Station CHES, Godhra (CIAH, Bikaner-Rajasthan).

Cactus: Prickly pear belongs to family Cactaceae. Plants are succulent, throne and less foliage, having 122 genera with approximately 1600 species which have spines and exhibit stem succulence. In India, many species of prickly pear are found growing either as wild xerophytes plant in arid and semi-arid regions. Now-a-days, it is parts of kitchen or family gardens in arid and semi-arid areas. Cactus pear has numerous uses. It plays an ecological role in soil conservation as well as producing edible fruits and vegetable (nopalitos) for human consumption, forage for livestock and a number of other value added products. The high sugar and low acid blend of the fruit makes it delicious and palatable. The fruit has a high content of free amino acids, particularly proline and glutamine, the highest level being that of nutraceutical taurine, up to 572.1 mg/L. Traditionally cactus nopal has been beneficial for burns, wounds, edema, hyperlipidemia, obesity and catarrhal gastritis. The edible cactus pear could be considered a new expectation for wasteland development (Singh and Felker, 1995). Fruits are edible and its tender cladodes can be used to prepare salad, vegetable, pickle and also fed as fodder. Use of *Opuntia* in natural landscape and as agricultural crop has been adopted in many countries. The Opuntia *elatior* is use as live fence on the field bunds and it is grown naturally in different parts of Rajasthan. The market for species is extensive, so need to enhance marketing strategies and post-harvest technology in near future.

Nagphani: It is a succulent plant with CAM mechanism of photosynthesis. Plants have deep tap root system. It blooms attractive flower under extreme hot conditions under Thar Desert hence, also included in Prickly pear group. Fruit become reddish to reddish pink when ripe, and used to consumed directly by the tribal people (Meena, 2015). Two to eight spines found in cluster on the stem. The baked fruit is used in whooping cough and also beneficial to the diabetic, prostate problem and dentistry (Kirtikar and Basu, 1999).

Dansara: Hardy shrub plant with thorny branches. It can be grown in rocky and waste lands. It requires less amount of water and grows naturally in Rajasthan. Small brown to blackish shiny fruits are eaten by the children and especially women due to sour and sweet taste (Swathi *et al*., 2015). Leaf paste is used to overcome the rash and allergy in human beings (Umberto, 2012).

Table 2. Bowl of nutrients for the rural community

S.No.	Fruits	Major Nutrients	Quantity
1.	Kair	Protein and vitamin C	8.6 % and 7.8 mg per100 g pulp
2.	Karonda	Iron	39.1 mg per100g
3.	Khejri	Crude protein	12-18%
4.	Pilu	Alburninoides and fibre	18.9% and 5.8%
5.	Tamarind	Vitamin C and Tartaric acid	244 mg and 17.1% per 100 g pulp
6.	Wood apple	Riboflavin	170 mg per 100 g pulp
7.	Prickly pear	Vitamin C	12-81 mg per 100 g pulp

Value-added products : The arid fruit plants bear fruits in specific session and generally spoil within few days of picking due to softness and high pulp content. Storage of harvested fruits for a longer period is a big problem in these areas due to inadequate storage facility like cold storage, zero energy cooling chamber, freezer, *etc*. Hence, uses of post harvest techniques to maintain the fruit quality and reduce post harvest losses are important for livelihood of poor farmers of this region. The traditional and modern post harvest management practices are available to improve the fruit nutritional quality as well as to fulfill the consumer demand during off season. The techniques for preparing these value-added products like pickle, juice, jam, dried fruit, candy, syrup, powders, RTS, *etc*. have been standardized (Table 3). It is imperative that popularization of these value-added products shall help to enlarge the small scale industries and thus give employment to the tribal youth. These products have already caught the national and international market can share significantly in agriculture GDP in near future.

Table 3. Standardized value-added product of economical importance fruit tree under arid-ecosystem

S.No.	Fruits	Value-added products	References
1	Kair	Pickle, Panchkuta and dried fruits	Rawat and Das, 2020
2	Karonda	Pickle, Candy, Jelly, Jam, Preserve, Wine and Chutney	Singh *et al*., 2020
3	Khejri	Pickle, Panchkuta and dried fruits	Singh *et al*., 2020
4	Pilu	RTS, Nectar, Wine and dried fruits	Krishna *et al*., 2019
5	Tamarind	Tokku, Jelloe, Toffees, Sauce, Pickle, Juice concentrate, Pulp powder, Jam, Syrup, Candy and Kernel powder.	Mani *et al*., 2020; Singh *et al*., 2020
6	Wood apple	Squash, Powder, sherbet, Pickle, Chutney, Fruit bar and Feronia gum	Pandy *et al*., 2014; Yadav, 2018
7	Prickly pear	Squash, pickle, ready to serve drinks, colour from fruit and cochineal, cladodes for culinary and salad	FAO, 2013; Corrales and Flores, 2003

Conclusion

Underutilized fruits in arid regions hold significant potential but have remained neglected due to insufficient research and a lack of awareness regarding their nutritional and medicinal values. Genetic resources for these fruits are still present in farmers' fields, highlighting the need for standardized propagation techniques and the development of improved varieties. By focusing on these aspects, these fruits could significantly enhance the income of rural communities through processing, packaging, and value addition. However, to fully realize their potential, increased awareness and effective marketing strategies are essential.

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