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Collection, evaluation and improvement of some underutilized fruits in hot Indian desert

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Abstract

Underutilized crops have the immense potential to provide social, nutritional and environmental benefits to global community at large and local poor inhabitants in particular. Many underutilized species in arid zone are known for their edible fruits or as vegetables viz. *kair* (*Capparis decidua), lasora (Cordia myxa), jhar ber (Ziziphus nummularia), pilu (Salvadora oleoides), khejri (Prosopis cineraria), phalsa (Grewia subinaequalis), bael (Aegle marmelos), karonda (Carissa carandas), fig (Ficus carica) and tahiti lime (Citrus latifolia)* etc. However, intensive work on germplasm collection, evaluation and improvement was done on lasora, karonda and khejri which resulted in identification of some high yielding genotypes in these crops. In case of *lasora*, 13 germplasm accessions were collected and evaluated from which four high yielding accessions viz. CAZRI-G2025, CAZRI-G2021, CAZRI-G2012 and CAZRI-G2011 were found promising. Among the 8 accessions collected and evaluated in karonda, the accessions, CZK-2011, CZK-2022 and CZK-2031 have shown high yield potential. Seven germplasm collections of budded khejri including the variety Thar Shobha were evaluated for pod quality and yield. The highest pod yield was recorded in CAZRI-Kh-1(13.2kg/plant) followed by CAZRI-Kh-2(11.6 kg/plant) in seventh year.

Key words: Underutilized fruits, evaluation, improvement, selection, *lasora*, karonda, *khejri*.

Introduction

Underutilized crops have the potential to provide great social and nutritional benefits to the rural poor as well as the global community at large, and it is increasingly recommended that they are identified, researched and promoted in much the same ways and levels of resourcing as the world's main staple food plants. Under-utilized crops are defined as species with under-exploited potential for contributing to food security, health (nutritional/medicinal), income generation and environmental services. Though, Indian desert is considered very harsh climatically for growing of fruit crops but there are several underutilized fruit species mostly indigenous ones which can be grown successfully either as rainfed or with supplemetal irrigation water wherever it is available.The potential underutilized species for arid regions are *kair* (C*apparis decidua*)**,** *lasora* (*Cordia myxa*), *jhar ber* (*Ziziphus nummularia),pilu* (*Salvadora oleoides*), *khejri* (*Prosopis cineraria*), *phalsa* (*Grewia subinaequalis*), *bael* (*Aegle marmelos*), *karonda* (*Carissa carandas*), *fig* (*Ficus carica*) *and tahiti lime* (*Citrus latifolia*) etc**.** *Cordia myxa* L., locally called *gonda/ lasora/ lehsua* belongs to family Boraginaceae and is found grown all over India except high hills. It is resistant to drought and hence quite widespread in arid and semi arid regions of north India. Being a multipurpose plant, it has long been associated with health, nutrition and other diversified uses. The immature fruits of gonda are used as vegetable, pickled with raw mango and can be dehydrated for use in off season. Karonda (*Carissa carandas*) is another underutilized fruit crop with high nutraceutical value besides its suitability in biofencing. It belongs to family Apocynaceae which thrives well through out tropical and sub tropical climate including arid regions. The presence of vitamin C and anthocyanin enhances the antioxidant properties of karonda fruit (Sawant and Godghate, 2013). The fruit is used for preparation of jelly, pickle, beverage and preserve. Some improved varieties developed recently are Pant Manohar, Pant Sudarshan and Pant Suvarna.

Khejri (*Prosopis cineraria* L. Druce) is an important component of arid farming system and plays significant role in the economy of the farming community of the Indian desert. Belonging to sub family mimosoidae of fabaceae (leguminoceae) family, the tree is found growing in arid and semi-arid parts of Rajasthan, Gujarat, Haryana, Punjab, Delhi and some parts of southern India. The trees of *khejri* grow well in climatic constraints of arid zone. Because of its multiple economic value and suitability in agroforestry systems, it is conserved in arable land where its population is regulated by the farmer (Saxena,1977). One collection of Tahiti lime was also evaluated for its performance in arid climate with supplemental irrigation and it emerged a suitable species with larger and seedless fruit. Looking to the commercial and ecological significance of these multipurpose species, the work on their collection, evaluation and improvement were started during 2000-2001 and still continuing and progress is being reported in this paper.

Materials and methods

Twelve germplasm accessions of *lasora* were collected in the form of seeds or bud wood depending upon the season during 2000-2008 from different parts Rajasthan and Gujarat.The seeds were first raised in the nursery while the bud woods were budded on to the seedling rootstock of the same species in the nursery. Six months old seedling/budded plants were transplanted in the field at 6x6 m spacing at Horticulture field, ICAR-Central Arid Zone Research Institute, Jodhpur for evaluation. In case of karonda, ripened fruits of seven accessions were collected from different parts of Rajasthan while seedlings of Pant Manohar variety were obtained from G.B. Pant University of Agriculture and Technology Pantnagar (Utarakhand) during 2000-2005.The seeds from ripened fruits were first sown in nursery beds after treating them with fungicides. One-year-old seedlings were transplanted in the field at 4x4m spacing. Ten-year-old plants were evaluated for vegetative growth, flowering, and fruiting, and fruit morphological characters, fruit colour and fruit yield. Twenty mature fruits were harvested randomly from each accession to record observation on physico-chemical parameters. Fruit size (length and girth) was measured with the help of digital vernier caliper while weight was taken by digital top pan balance. The total soluble solids (TSS) were determined with Erma Hand Refractometer (0-32°Brix). The titratable acidity (%) and ascorbic acid content were determined by AOAC methods. Ten fruits from each accession were weighed and volume estimated by water displacement method. Fruit yield from were recorded every year from 7th year onwards. In case of *khejri*, six accessions and a released variety were evaluated during 2006-2015.One-year-old seedlings were transplanted in the field at 5x5m spacing in 2006.These seedlings were budded *in situ* with budwood collected from six germplasm accessions from different parts of Jodhpur district based on pod characteristics. Bud woods of variety Thar Shobha were collected from Central Institute for Arid Horticulture, Bikaner and the same was also budded *in situ* on the seedling rootstocks along with collected accessions.Uniform cultural practices were followed for maintenance of the plants of all the three species.The data on vegetative growth, fruiting, fruit yield and fruit morpho-physiological parameters were recorded as per standard methods.In case of Tahiti lime rooted layers were obtained from a private nursery of Pushkar, Ajmer (Rajasthan) and were planted in the field at 4x4m spacing and its performance with respect to fruit yield and fruit physico-chemical parameters recorded.

Results and Discussion

Germplasm collection and evaluation: The germplasm collection of different underutilized fruit crops (Table 1) were made from different parts of India over a period of 10 years. The collected germplasm has been evaluated and still being maintained in field gene bank. The results of germplasm evaluation in respect of different crops is discussed separately.

Table 1. Germplasm collection of underutilized fruits of arid region

Species	No. of accessions	Source
Lasora (*Cordia myxa*)	13	Rajasthan(Jodhpur, Pali,Ajmer,Chittor) and Guj arat(Bhuj)
Karonda (*Carissa carandas)*	8	Rajasthan(Jodhpur, Udaipur,Ajmer) and Uttarakhand(Pantnagar)
Khejri (*Prosopis cineraria)*	7	Jodhpur and Bikaner
Tahiti lime (*Citrus latifolia*)	1	Ajmer

Lasora

Thirteen germplasm accessions were evaluated for its growth, fruiting behaviour and fruit characteristics. On the basis of their performance over the years it was noted that there was not much variation in different accessions with respect to vegetative growth such as plant height and canopy area but significant variation was recorded in fruit yield per plant and fruit characteristics (Table 2). Mean bunch weight was highest (137.4g) in accession No. G 2021 while lowest bunch weight of 28.65 g was recorded in accession No. G2014. The No. of fruits per bunch ranged from 4.62 g (G 2014) to 14.80 g (G 2021). Similarly, mean fruit weight varied from 5.81 g to 10.5 g in different accessions. The stone pulp ratio was maximum (1:6.5) in accession No. G 2025 and minimum (1:5) in accession No. G 2013. Fruit yield of selected genotypes are given in Table 2. Based on continuous high fruit yield accession Nos.G2025, G2061, G2012, G2021, G2022, G2062 and G2011 were selected for further evaluation. The selected genotypes were multiplied by vegetative means (budding) to maintain their clonal purity. Based on consistent higher yield, the accession nos. CAZRI-G2011, CAZRI-G2012, CAZRI-G2021 and CAZRI-G2025 (Fig.1) have been found promising. Budded plants these genotypes have also been planted at one farmer's field to validate their superiority at outstations. All the four genotypes bigan fruiting in third year with a range of 5-15 kg per plant under limited supplementary irrigation.

The fact that the *lasora* has been traditionally propagated by seeds generating variation in plant population due to segregation. Higher variability from seed propagated progeny were recorded in respect fruit yield per plant while narrow range of variations in fruit size, shape cluster weight,

Fig. 1: Fruits of high yielding improved genotypes of lasora

Table 2. Fruit morphological characteristics and yield of 13 accessions of lasora

S.N.	Accessions	Mean bunch weight (g)	No. of fruits per bunch	Mean fruit weight (g)	Pulp: stone ratio	Fruit yield (kg plant^{-1})
1.	CAZRI-G2011	60	8.2	8.0	6.0	22.85
2.	CAZRI-G2012	62.0	10.0	7.8	5.6	27.9
3.	CAZRI-G2013	110.0	7.6	9.5	5.2	8.5
4.	CAZRI-G2014	28.65	4.62	7.91	6.0	10.5
5.	CAZRI-G2021	137.40	14.80	9.0	6.0	59.5
6.	CAZRI-G2022	57.40	8.40	5.81	5.0	13.2
7.	CAZRI-G2023	58.63	8.90	7.63	6.0	14.0
8.	CAZRI-G2025	61.5	14.0	10.5	6.5	98.2
9.	CAZRI-G2026	60.0	10.0	8.5	5.6	12.0
10.	CAZRI-G-2051	75.6	9.5	7.2	6.2	9.5
11.	CAZRI-G-2061	45.2	6.5	6.8	5.1	26.0
12.	CAZRI-G-2062	66.2	7.5	7.2	4.5	31.0
13.	CAZRI-G-2063	42.6	6.2	5.8	5.2	21.0
CD(P=0.05)		15.27	5.21	2.61	1.42	15.76

number of fruits per cluster, fruit weight and pulp: stone ratio (Meghwal *et al*., 2015). Samadia (2007) surveyed the *lasora* core variability sites in Rajasthan and reported the variability in tree height, canopy volume and fruit and seed morphological characters. He also observed two types of leaves in lasora i.e. large and small size. The large leaf types produce big fruited gonda, while smaller leaf types produce smaller fruits of wild types with no commercial value. In germplasm collection at CAZRI also both the types of germplasm are being maintained. Moreover, we have used small fruited types as rootstock for commercial big fruited types, since the former is considered more drought hardy and seed germination percent is also higher (Meghwal, 2007). Further, the evaluation of different rootstocks also revealed better performance on small fruited *gonda* rootstock in regards to higher fruit yield and longer graft compatibility (Meghwal *et al.*,2014).

Karonda

Eight germplasm (Fig. 2) including a released variety i.e. Pant Manohar were evaluated for their performance in arid region. Great deal of variation was recorded in plant height, canopy area, growth habit, precocity, morpho-physico-chemical characteristics of fruits and fruit yield (Table 3&4). The data on plant height did not show significant differences among the accessions, while canopy area and fruit yield recorded significant variation. The fruit yield of accession No. CZK2011 was exceptionally very high during all the years. The mean fruit yield of this accessions found highest (33.98 kg plant^{-1}) followed by CZK 2031(24.28 kg plant^{-1}) and CZK 2022(24.03 kg plant^{-1}). The physico-chemical characteristics of fruits of different accessions also showed significant variations (Table 3).

Rich diversity in physico-chemical characteristics of the fruits of different accessions indicate the presence of genetic diversity in karonda accessions maintained at field gene Bank in CAZRI. Variations in the germplasm of karonda with regard to physico-chemical characters and fruit yield corroborates the earlier findings from Punjab (Bal, 2003) and high degree of genotypic and phenotypic variability reported from Maharashtra by Sawant *et al.* (2003). Based on long term performance of the germplasm for fruit yield and other desirable attributes, the accession Nos.CZK2011, CZK2022 and CZK2031 may be recommended for dual purpose (bio-fencing and fruits) in arid zone.

Khejri

Wide variation exists in the natural stands of *khejri* due to occurrence of cross pollination and prevailing seed propagation. From the Horticultural quality point of view, the variability in pod quality traits is most important. Pareek (2002) observed diversity in pod characteristic such as taste (flat, bitter, acrid and sweet), tenderness (hard, semi hard, less tender, tender), fiber content (fibrous, less fibrous and

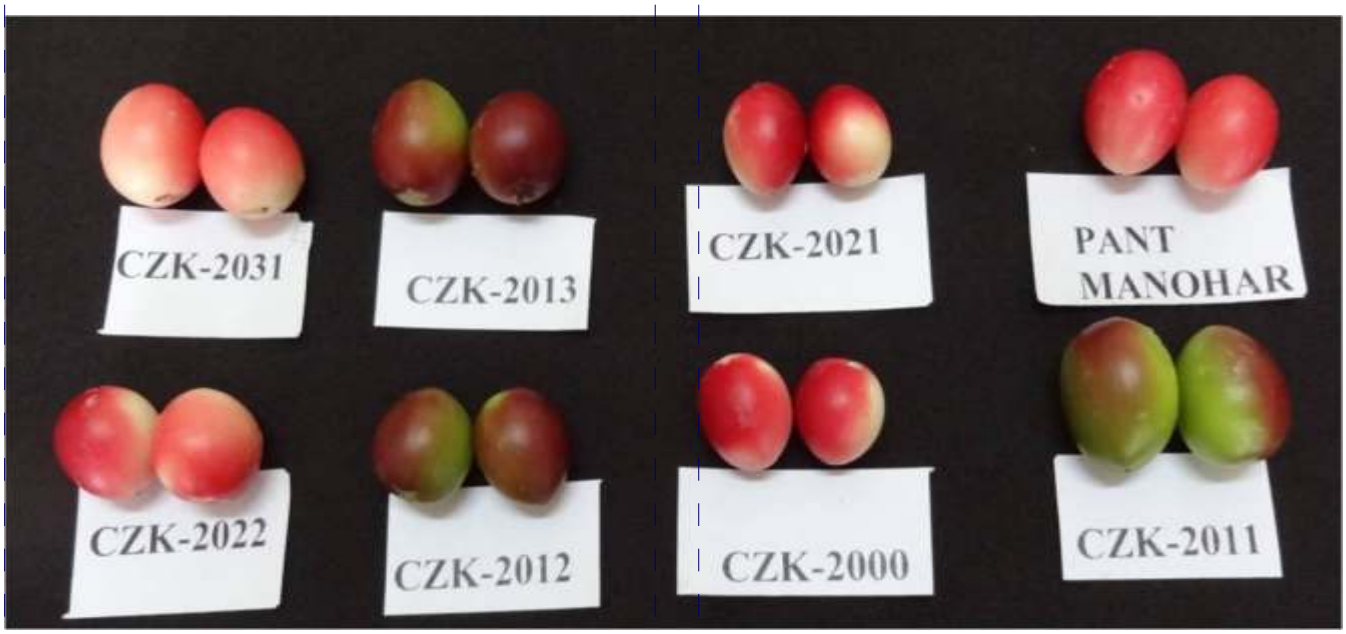

Fig. 2: Fruits of genotypes of Karonda

Table 3. Vegetative growth and fruit yield of karonda accessions (7 th year, onwards)

Genotype	Plant height(m)	Canopy area(m^2)	Fruit yield (kg plant^{-1})				Mean yield (kg plant^{-1})
			2012	2013	2014	2015	
CZK2000	2.47	11.84	16.50	17.2	18.5	20.1	18.80
CZK2011	3.06	10.45	22.60	31.5	40.6	41.2	33.98
CZK2012	2.51	4.86	13.00	12.1	15.3	18.8	14.80
CZK2013	2.90	9.62	15.20	17.0	19.8	22.5	18.63
CZK2021	2.56	6.73	14.52	16.3	17.8	18.5	16.78
CZK2022	2.38	5.14	20.2	22.4	24.8	28.7	24.03
CZK2031	2.45	6.76	18.20	21.6	25.1	32.2	24.28
Pant Manohar	2.62	6.92	16.80	18.3	20.2	23.5	19.70
Mean	2.62	7.79	17.13	19.55	22.76	25.69	
CD(p=0.05)	NS	2.14	3.27	3.71	4.60	4.45	

fibreless), colour (green, light green), pod length, thickness, seed number, seed size, protein content and mineral constituents. Among these traits, sweet taste, longer, thin, tender pods green in colour, and less fibrous ones are the desirable traits for culinary purpose. The trees having desirable pod characteristics may be identified from the natural population. Seven germplasm accessions of khejri including variety Thar Shobha were evaluated for pod characteristics. Significant variation was recorded for pod characteristics (Table 5). The bunch weight ranged from 6.2 (Thar Shobha) to 16.26(CAZRI-Kh-3), while number of fruits per bunch varied from 4.5 to 19.6. Similar variations were also recorded for mean pod weight, mean pod length, pod girth, number of seeds per pod and dry matter content. The variation for pod characteristics is quite obvious as the germplasm has been collected from natural population multiplied by seeds. The variation in pod characteristics of *khejri* validates the earlier reports of recorded variability from natural population of *khejri* in arid regions of Rajasthan (Vishal nath *et al*., 2000).

Tahiti lime (*Citrus latifolia*)

Evaluation of large fruited lime germplasm indicated that it is a fast growing, precocious bearer and cold hardy. The plant growth was very luxuriant during favourable period i.e. from July to March but it could not tolerate hot weather during April to June which resulted into leaf burning, sun scorching and shrinkage of fruits (Anon 2006). Mean fruit yield after 5 years of planting ranged from 15-20 kg per plant depending upon the weather condition during flowering and fruiting. Its flowering and fruiting can be synchronized by crop regulation in such a way that fruit harvesting is completed by end of the March to avoid heat injury to the fruits. Physico-chemical characteristic of the fruits are as follows:

Table 4. Physico-chemical characteristics of fruits of *Carissa carandas*

Accession No.	Fruit size(mm)		fruit weight (g)	Fruit volume (cc)	No. of seeds/fruit	TSS (^{0}Brix)	Acidity	Dry matter (%)	Vitamin C (mg 100^{-1}g)
	Length	girth							
CZK2000	17.37	14.32	2.60	1.95	3.5	9.2	2.90	13.56	34.32
CZK2011	21.79	16.35	3.74	3.8	6.3	9.4	2.82	12.85	35.88
CZK2012	23.05	18.29	2.96	3.2	3.6	9.5	2.92	13.19	24.96
CZK2013	23.52	19.22	4.86	4.3	6.1	8.5	2.84	12.31	43.68
CZK2021	19.29	16.05	2.76	3.1	6.6	8.0	2.75	13.83	31.2
CZK2022	22.47	19.14	4.18	4.5	4.9	8.5	2.14	12.77	31.2
CZK2031	22.66	19.57	5.01	4.7	5.4	8.7	2.95	12.96	37.4
Pant Manohar	21.52	17.15	3.34	3.4	3.5	9.0	2.90	13.00	31.2
CD (5%)	0.77	0.68	0.30	0.17	0.21	0.18	0.17	0.22	0.48

Table 5. Pod characteristics and yield of budded khejri germplasm

Acc. No./variety	Bunch weight (g)	No. of pods per bunch	Mean weight (g)	Mean length (cm)	Pod girth (mm)	No. of seeds per pod	Dry matter (%)	Mean pod yield (kg plant-1)
CAZRI-Kh-1	13.22	19.6	0.99	12.94	2.9	9.81	13.58	13.2
CAZRI-Kh-2	10.88	13.0	1.13	11.53	3.08	9.2	12.35	11.6
CAZRI-Kh-3	16.26	9.0	1.58	13.36	3.11	14.40	20.85	10.5
CAZRI-Kh-4	12.50	6.2	3.10	12.6	4.8	11.2	22.82	8.6
CAZRI-Kh-5	5.8	6.3	2.1	8.5	2.8	10.2	17.2	7.5
CAZRI-Kh-6	18.05	10.0	2.26	12.04	4.03	12.0	25.68	9.2
Thar Shobha	6.2	4.5	2.5	16.16	2.5	14.05	19.06	7.8
CD(P=0.05)	4.27	6.21	1.2	4.2	2.1	3.24	5.12	2.5

No. of fruits per cluster : 3-5
Average fruit weight : 75 g (range 60-90 g)
Rind thickness : 2.5 mm
Juice percent : 56.45
TSS : 7%
Acidity : 5.76%
Seedlessness : 100%

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