



Cactus Pear (*Opuntia ficus-indica*) in India



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Introduction and Evaluation of Cactus Pear (*Opuntia ficus-india*) in Kachchh, Gujarat as an Alternate Fodder Resource

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Kachchh is the largest district (45,652 sq km) in the state of Gujarat and the second largest district after Leh in India. The significant portion of the population depends upon agriculture and animal based farming system for their livelihood. The district witnesses both intensive high input oriented irrigated agriculture and low input, subsistence rainfed agriculture. The region is located in the North-West agro-climatic zone in Gujarat and experiences arid climate frequented with droughts and erratic rainfall. The indiscriminate use of natural resources, due to lack of awareness has started signalling its adverse impact on environment by way of deepening of water table, degradation of the quality of ground water, increase of salinity, depletion of macro and micronutrients and soil organic carbon etc (Dayal et al., 2010). Scarcity of water which is characteristic of dryland eco-systems affects primary productivity and sustenance and survival of humans and livestock (Safriel and Adeel, 2008). Increased livestock population lead to resource degradation by overgrazing natural rangelands and ultimately availability of feed resources leading to annual migration of pastoralists. Cactus pear [*Opuntia ficus-indica*(L.) Mill.], a perennial succulent plant native to Mexico, is regarded as the future forage crop in the drylands of India due to its ability to produce increased dry matter under limited water condition through specialized photosynthetic mechanism called Crassulacean acid metabolism (CAM) (Felker et al., 1997). Introduction of such species have the potential to increase fodder production and to efficiently use the wastelands (Pimienta-Barrios, 1994). *Opuntias* can tolerate water-limited conditions and high temperatures, and fare well in poor soils. Being CAM plants, it converts water to biomass fourfold more efficiently than either C4 or C3 plants (production of 1 kg DM per 162 kg water: (Han and Felker, 1997). *Opuntias* meet the most important criteria for fodder crops in drought prone regions, drought tolerance and palatability (Tegegne, 2001). In India cactus is used in the field boundaries and as ornamental plants (Singh, 2003; Gajender et al., 2014). Several spineless varieties of cactus are available that have promising multipurpose use as fodder and forage for livestock consumption, fruit and vegetable use for human, and other industrial uses (Singh, 2004). An overview of research on cactus pear in India was presented by Singh (2006). The crop is unexploited commercially so far in India, with few exceptions and there has been no attempt to cultivate this plant as a horticultural or fodder crop in India, especially in arid regions of Gujarat. In view of these characteristics and potentials of this species in arid Kachchh region, introduction of promising germplasms of Cactus pear (*Opuntia* spp) was undertaken and evaluated at ICAR-Central Arid Zone Research Institute, Regional Research Station, Kukma, Bhuj, Gujarat for growth and nutritional characteristics. The details of the study are presented in this article.

Initial introduction of different cactus accessions were undertaken through CAZRI, Jodhpur and a total of 15 accessions were introduced during July 2012. Later in March 2013 another set of 15 accessions were provided by ICARDA-India office. This was followed by introduction of another 35 accessions of cactus pear in September 2014. Apart from 65 imported accessions one local thornless accession was obtained during survey (Kukma) and another accession (CAZRI Botanical garden) from CAZRI was also included in the evaluation

programme. Presently total 64 accessions of cactus are being maintained and evaluated at CAZRI, Regional Research Station, Kukma-Bhuj (Table 1).

Table 1. List of 64 cactus accessions maintained at CAZRI, RRS, Kukma-Bhuj

Sl. No.	Accession no/ name	Sl. No.	Accession no/ name
1	CLONE NO. 1270	33	RossaRoccapalumba
2	CLONE NO. 1271	34	Bianca Roccapalumba
3	CLONE NO. 1308	35	Mexico Fodder
4	CAZRI Botanical Garden	36	Spineless
5	CLONE No.1287	37	Mamillion fodder
6	Bianco Macomer	38	TrunzaraRossa Bronte
7	Roso San Cono	39	TrunzaraGialla Bronte
8	Trunzara Red San Cono	40	Trunzara Bianca Bronte
9	Piantra-25	41	TrunzaraGialla San Cono
10	ARL Spinless	42	Mexico unknown
11	Red San Cono	43	Jalpa
12	Cristallina	44	Gialla San Cono
13	Rosa Castle Sardo	45	Bianca San Cono
14	Seedless Santa Margherita	46	Palma Grande
15	Gymnocarpe	47	Palma redonda
16	CAZRI Kukma	48	Palma miudaoudoce
17	Yellow Roccapalumba	49	IPA 20 ou clone 20
18	White Roccapalumba	50	IPA Sertaniaoubaiana
19	Zastron	51	Orelha de onca
20	White San Cono	52	Orelha de elefantemexicana
21	Yellow San Cono	53	Orelha de elefanteafricana
22	Trunzara Red Bronte	54	F8- Forrageira 8
23	Giall X Giall	55	COPENA F1
24	Red Santa Margherita Belice	56	COPENA V1
25	Blue Motto	57	IPA-90-18
26	Red Roccapalumba	58	IPA-90-73
27	Roly Poly	59	IPA-90-92
28	Algerian	60	IPA-90-111
29	Seedless Roccapalumba	61	IPA-90-156
30	Morado	62	Palma azul
31	GiallaRoccapalumba	63	Additional - 1258
32	Trunzara Bianca-San Cono	64	IPA-90-115

The cladodes received were shade dried and initially raised in plastic pots filled with potting mixture (1:1:1 sand, soil, Farm Yard Manure), by keeping one-third portion of the cladode under the soil and two-thirds above the soil surface (Fig 1). Prior to planting the cladodes were treated with Carbendazim (0.2%). The nursery raised plants were transplanted to field after three additional cladodes are emerged from the basal cladode. For transplanting nursery raised cladodes, fields were prepared by ploughing and levelling and pits were

prepared at specified spacing (3x 1.5 m) (Fig 2). The pots with plant were inverted and gently tapped to ensure smooth release of the plant along with potting mixture and were planted in the pits and covered firmly with soil. Seven days after transplanting, 5 litres of water was added to each plant. The study region experiences arid climate with very low and erratic rainfall with average rainfall of 346 mm (average of data from 1998 to 2015) with 13 rainy days in a year. The coefficient of variation of rainfall is 72%. Most of the rainfall occurs between the months of July to September in 2-4 days. The annual minimum temperature varies from 1 to 8°C and maximum temperature from 39 to 45°C. The plants were irrigated once in a month during dry season.



Fig. 1. Nursery multiplication of cactus pear at Bhuj



Fig. 2. Field evaluation of cactus pear at Bhuj

Out of total accessions received at CAZRI, Regional Research Station, Kukma-Bhuj, three accessions namely Yellow Santa Margherita Belice, White Santa Margherita Belice and Mexico Vegetable did not survive. All other 62 accessions along with two Indian accessions are being maintained and evaluated at CAZRI, Regional Research Station, Kukma, Bhuj. The list of 64 accessions is provided in Table 1. The non survival of these three accessions may be accidental since we receive only one cladode for most of the accession, and it is possible that the cladode might have been spoiled during transit.

Field planting was carried out initially during September 2012 which consisted of 15 accessions. With the field planting in August 2014 the total number of field established accessions was increased to 30. All the sixty four accessions were field transplanted in August 2016.

The field evaluation indicated that different clones exhibited wide variation with respect to height, no. of cladodes, spread, cladode thickness and other growth characteristics.

After one year of growth among 30 clones, the plant height varied from 30 to 102 cm, no. of cladodes from 3 to 34 and thickness of primary cladode from 0.7 to 4.5 mm. The clone CAZRI botanical garden recorded highest no. of cladodes (34) followed by local accession Kukma (16.7). Other promising clones were Bianca Macromer, Clone no. 1271, Morado, 1270, White Roccapalumba, 1308, Gymnocarpe, Rosa Castle Sardo which produced upto 10 cladodes per plant. The average area of cladode ranged from 113.8 to 354.9 cm². The accession Roly Poly produced thickest cladode among 30 accessions and thinnest cladodes was produced by Piantra 25. Cladode area per plant was highest for Gymnocarpe (354.9 cm²), followed by Clone no. 1287 (345.9 cm²). The accessions Red Santa Margherita Belice and Piantra 25 recorded lowest cladode area per plant (104.6 and 113.8 cm²). However the photosynthetic area was higher for accessions CAZRI Botanical garden, Kukma, Bianca Macromer, Clone no. 1271, White Roccapalumba, Gymnocarpe. The fresh weight of cladodes varied from 0.17 to 3.47 kg plant⁻¹. The accession CAZRI Kukma recorded the highest biomass of 3.15 kg plant⁻¹ followed by CAZRI botanical garden (2.89 kg plant⁻¹) and the lowest biomass was recorded by Morado (0.59 kg plant⁻¹). In 30 accessions the crude protein content ranged from 4.22 to 11.88%, crude fibre 12-19% and total ash from 15.65 to 26.15%. Among all the accessions studied fruiting was observed in accession no. 1270, 1287, Kukma and CAZRI Botanical garden (Table 2, Fig 3 & 4).

Table 2. Fruiting behaviour of cactus pear at Bhuj during 2015-16

Acc no.	Date of first flowering in the year 2015	Avg No. of fruits/plant
CAZRI Botanical garden	10-12-2015	48.90
1270	12-03-2016	19.11
1287	17-03-2016	2.58
Kukma	28-03-2016	14.00



Fig. 3. Fruiting in cactus pear accession no. 1270 at Bhuj, Gujarat



Fig. 4. Fruiting in cactus pear accession CAZRI Botanical Garden at Bhuj

A field day on thornless cactus was organised at ICAR-Central Arid Zone Research Institute, Regional Research Station, Bhuj by CAZRI, Jodhpur and KVK, Bhuj, sponsored by ICAR-ICARDA project for South Asia on 03-03-2015. The programme was attended by 89 farmers from different villages of Kachchh district of which 15 were farm women (Fig 5). Expert

classes on various aspects of cactus cultivation and uses were imparted in the meeting along with field visits.



Fig. 5. Field day on cactus at Bhuj during 03-03-2015

Another farmer's field day was organised at village Kukma, Bhuj by CAZRI and KVK, Bhuj, sponsored by ICAR-ICARDA collaborative project on 09-10-2015. The programme was attended by 50 farmers from different villages of Kachchh district of which 15 were farm women (Fig 6). Farmers showed keen interest in plantation of cactus pear and its use for oil and culinary purposes.



Fig. 5. Field day on cactus at Bhuj during 08-10-2015

On the basis of this study on evaluation of cactus in the drylands of western India, it can be concluded that cactus has a potential for growing as a fodder resource. Among the thirty accessions evaluated the accessions CAZRI Kukma, CAZRI Botanical garden and Blue Motto provided higher biomass on fresh weight basis. Among the studied accessions, the crude protein content ranged from 4.22 to 11.88%, crude fibre 12-19% and total ash from 15.65 to 26.15%. Cacti have an enormous production potential in the arid western India, both for agricultural development and environmental protection to tackle the issues of fodder scarcity and land degradation.

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