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## Edible spineless cactus (*Opuntia* spp.): As alternative forage for animals in scarcity

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#### Abstract

The spineless cactus (*Opuntia ficus-indica*) stays green even in the summer and can be used as a source of food during times of famine. It does not require well-drained soil and is more tolerant to salinity. Cactus may yield 20-200 tonnes of dry matter per hectare per year. Animals may find cactus to be a valuable supply of water, especially during the dry season. Water, sugar, ash, and vitamins A and C are abundant in cactus cladodes, but crude protein and fiber are few. They have a high Ca: P ratio and are extremely tasty. Spineless cactus can be utilized as an alternative green fodder for cattle, especially small ruminants, and can withstand extreme drought conditions with year-round availability, which is critical in light of climate change. Spineless cactus has spawned a plethora of cultivars and clones.

**Keywords:** Green fodder, dry matter, ruminants, spineless cactus

#### Introduction

Climate change has emerged as one of the most significant obstacles to long-term crop production. People who have to survive in droughts and desertification in India's hot dry zone, where the rural poor and smallholders are most seriously affected, are among the difficulties they encounter. As a result, their crops must be able to survive more severe calamities, such as drought, extreme temperatures, and poor soils. Because of their distinctive qualities, spineless cactus crops are garnering increasing interest around the world, particularly the cactus pear or prickly pear (*Opuntia ficus-indica*). Cattle, buffaloes, goats, and sheep number 193.46, 109.85, 148.88, and 74.26 million in India, respectively [1]. In India, there is a 44 percent shortfall in concentrate feed ingredients, 35.6 percent in green fodders, and 10.95 percent in dry roughages [2]. The Indian government has designated 30 percent of the country's surface as wasteland. Due to its sustainability, spineless cactus (*Opuntia ficus-indica*) can be potential alternative fodder for livestock in the face of continued climate change, frequent and severe droughts, land degradation, and green fodder scarcity. The spineless cactus is a xerophytic plant that has adapted well to arid circumstances. It stays green even in the summer and can be used as a source of food during times of famine. It has a great water efficiency and can grow in poor, deteriorated soils where other plants would fail to thrive. Cladodes are employed to propagate spineless cactus vegetatively. Cactus pear has the advantage of providing water to animals, especially during the dry season. It tolerates poor soil conditions and generates a high biomass production with appropriate substitute feedstuff, making it ideal for small ruminants in dry and semi-arid areas.

#### Distribution and Production of Cactus

Cactus may be found in a variety of habitats, from sea level in the Californian deserts to 4700 meters (mean sea level) in the Peruvian Andes, and from tropical sections of Mexico with temperatures exceeding 50 degrees Celsius to parts of Canada with temperatures as low as -400 degrees Celsius [3]. It's grown throughout North and South America, Asia, Africa, Europe, and Oceania. Cactus cultivation covers over 1650 hectares in Argentina. Cactus cladodes derived by pruning cactus plantations intended for fruit production are also used for cattle nutrition in some areas. Thus enabled integration is also employed for animals in cactus production, which returns nutrients and organic matter to the cactus growth through manure, while also supplementing the farmer's revenue. It is difficult to determine the role of cactus in various livestock production systems due to a lack of information on the areas under cactus cultivation.

Infertile soils and irrigation produce a lot of fruit. It may also thrive in arid climates and with minimal water.

It does not require well-drained soils and may withstand salinity to a greater extent. Cactus may yield 20-200 tonnes of dry matter per hectare per year<sup>[4, 5]</sup>. It is possible to produce enough forage to maintain 4-5 cows per year with such a high biomass production (a 60-fold increase over rangeland productivity). Commercial cactus growing has yet to begin in India. Many public sector research organizations in India, particularly those working in dry agriculture crops, have performed research during the previous two decades, but the results have yet to reach farmers. Because of their crassulacean acid metabolism, cacti may create 4-5 times more DM per mm of rainfall than any other plant. Different edible cactus clones/varieties have been developed, such as 1269, 1270, 1271, 1280, 1281, 1380, CAZRI Botanical Garden, Mount Abu, 1458, AHCP-2, and so on, however, their production practices and nutritional value have yet to be determined<sup>[6]</sup>. According to the ICAR-Central Soil Salinity Research Institute in Karnal, Haryana, the highest survival rate was discovered in clone 1271 (67 percent), followed by 1270 (65 percent), 1280 (64 percent), and 1287 (48 percent) among edible cactus clones.

### Chemical Composition and Spineless Cactus

Water, sugar, ash, and vitamins A and C are abundant in cactus cladodes, but crude protein and fiber are few. They have a high Ca:P ratio and are quite tasty<sup>[7]</sup>. Cladodes (1 to 3 years) are abundant in water in the winter and spring (85-90 percent), but not so much in the summer (75-85 percent). Water content is higher in younger cladodes. Cladodes as forage can help with livestock watering, however, their poor dry matter content should be considered when considering diet composition. To make up for the low dry matter content,

the ruminant eats a lot of cladodes, which might cause diarrhea. Fibrous feedstuffs and suitable supplements, notably nitrogen-rich ones, are consequently recommended. It was reported that if caged sheep had unrestricted access to fresh cactus, they could survive for 500 days without drinking water. *Opuntia* cladodes have a high ash percentage as compared to standard feedstuff. The ash concentration varies from 10 to 25 percent DM depending on the species and cultivar. The most prevalent mineral in the cladodes is calcium, followed by potassium. However, the high quantity of oxalate and the exceptionally high Ca:P ratio limit the availability of calcium to the rumen microbiota and host animals<sup>[8]</sup>.

The cladodes of spineless (6-13 gm/kg fresh material) and spiny (6-14 gm/kg fresh material) cactus have a high mucilage content. Summer mucilage concentrations are at least twofold higher than winter mucilage concentrations. It decreases ruminant salivation, preventing a sudden drop in rumen pH. During development, carotenes, titratable acidity, and carbohydrate content increase, whereas protein and fiber levels drop. Cladodes have a high concentration of malic acid, which swings due to a CAM-based diurnal cycle. Cactus cladodes contained 17.7% DM, according to Ben Salem *et al.* (2004). OM, TDN, CP, NDF, ADF, ADL, Ca, P, Na, K, and Mg were found in concentrations of 76.2, 65.0, 4.6, 33.8, 16.8, 5.2, 5.21, 0.1, 0.06, 2.6, and 1.09 percent, respectively. Cu, Fe, Mn, and Zn concentrations were 6.5, 170.8, 248.9, and 31.0 ppm, respectively. The nutritional evaluation of four cactus accessions, 1270, 1271, 1280, and 1308, was carried out at the BAIF laboratory in Urulikanchan, Maharashtra, and the results are shown in Table 1<sup>[9]</sup>.

**Table 1:** Chemical composition (% DM basis) of different accessions of spineless cactus

Parameter	Cactus Accession			
	1270	1271	1280	1308
Dry matter	7.51	7.95	11.44	11.15
Crude protein	6.09	5.48	5.45	5.33
Crude fiber	11.57	13.73	17.22	20.66
Ether extract	2.54	1.98	2.60	1.60
Ash	13.11	18.05	12.10	12.95
Silica	1.23	1.01	1.65	0.96
NDF	26.34	26.52	26.43	25.26
ADF	17.66	18.24	17.42	17.16
Ca	0.53	0.47	0.50	0.53
P	0.36	0.41	0.38	0.37
K	0.27	0.36	0.29	0.30
Mg	0.11	0.10	0.09	0.10
Na	0.20	0.19	0.22	0.21

### Level of Edible Spineless Cactus in Ration and Feed Intake

The animal preferred cactus to traditional roughages like Cenchrus hay and Baru grass (*Sorghum halepense*). The addition of cactus and browse to silage enhanced the product's DM and N content<sup>[10]</sup>. By providing a degradable source of OM, the cactus can act as a connection between legume fodder and hay. Cactus-browse silage also enhances microbial protein flow to the lower gut for digestion, resulting in an increase in amino acid supply for maintenance, growth, and production. The inclusion of cactus-browse silage as a supplement improves the use of poor-quality roughages. These silages could be fed to livestock to help them live longer in drier, resource-constrained farming areas. The spineless cactus may be used as an alternate feed in semi-arid

regions, replacing up to 80% of wheat bran without impacting DM consumption<sup>[11]</sup>. In semi-arid places where feed and water are scarce, spineless cactus plus urea is a viable alternative feed choice. According to Makkar, a cow with a daily milk supply of 20 lit may be maintained with 70% cactus and 30% concentrate<sup>[3]</sup>.

Sun-dried *Opuntia* cladodes enhanced DM digestibility and tended to stimulate voluntary eating due to their comparatively high soluble carbohydrate and low fiber content. *Opuntia* cladodes have a digestibility that is comparable to high-quality hay<sup>[12]</sup>. The nutritional content of the plant varies greatly depending on the species, variety, age of the plant, season, and plant component. *Opuntia* from India's semi-arid regions contained 9.2% CP, which was greater than the typically utilized dry roughages (straw,

strovers, and grasses) in ruminant feeding <sup>[13]</sup>.

### Edible Spineless Cactus in Ration and Production Performance of Animals

Cactus inclusion in the diet or other equivalent diet improved weight gain by up to 50% on a DM basis in sheep-fed tef straw without triggering digestive issues seen in diets with high cactus inclusion <sup>[14]</sup>. Cactus supplementation with cottonseed cake and peanut cake resulted in a greater change in body weight and daily body weight growth than sheep who were not supplemented. According to Degu and co-workers, a basal diet of cactus and tef straw enhanced body weight gain in sheep, showing its use in times of feed scarcity <sup>[15]</sup>. Compared to barley-fed ewes, cactus-fed ewes accumulated more colostrum at birth and gave more colostrum at 24 hours. Up to 30 days after parturition, cactus-fed ewes produced more milk than barley-fed ewes. Cactus-legume diets had results that were equivalent to commercial diets <sup>[10]</sup>. Animals fed poor quality roughages received cheaper grade protein from browsing hay and rapidly fermentable sugar from cactus, which boosted roughage consumption. If these supplements were employed, slaughter weight might be reached sooner, resulting in a higher and faster turnover in goat production. Cactus feeding improved total body weight gain and average daily weight gain in Osmanabadi kids <sup>[9]</sup>.

### Edible Spineless Cactus as Animal Feed

For rural inhabitants living in drylands, livestock raising remains their primary source of income. Adapted perennial species could be a good way to increase feed availability in dry places. Another key limiting issue in drylands is water shortage, which threatens the long-term viability of livestock-based systems <sup>[16]</sup>. During dry years, one of the key problems affecting animal output is a lack of animal feeds, both in terms of quality and quantity. The greatest impediment to enhancing animal productivity during the dry season is the low nutritional value of feed <sup>[17]</sup>. The best alternative for ensuring cattle survival in these drought-prone locations is to use non-conventional feed supplies that are available and adaptable in arid places and use water more efficiently. Ruminants that have acclimated to these environments can make good use of non-traditional feed sources such as *Opuntia ficus-indica* <sup>[18]</sup>. *Opuntia* spp. comes in a variety of forms. Native thorny, less thorny, thorn-free, and regular types, to name a few. With a variety of nutritional compositions, all four types are appetizing. Rajasthan, Haryana, Maharashtra, and other semi-arid states have adapted well to the native thorny and less thorny varieties. When fed alone, however, cactus cladodes have a high water content, resulting in high ruminal degradability and laxative effects <sup>[19, 20, 21]</sup>, but this laxative action has no negative effects on the animal's health and results in rapid passage through the digestive system <sup>[22]</sup>. Cactus' low CP level may limit its usage as a complete feed, as it can lead to protein deficit in livestock. Its dry matter content could be increased by ensiling it with dried forage legumes, making it acceptable for ruminant feeding. According to Kauthale and co-workers, a daily ration of 40 kg cactus, 0.5 kg mineral salts, and 0.5 kg protein supplement is adequate to allow nursing cattle to develop great live weight, reproduction, and lactation <sup>[9]</sup>.

### Edible Spineless Cactus as a Nutrition

The antioxidant capabilities of the cactus are assumed to be responsible for its nutritional benefits. The nutrition and vitamin content of cactus cladodes and fruits, which include riboflavin, vitamin B6, copper, iron, fiber, vitamin A, C, K,

calcium, potassium, magnesium, and manganese, are responsible for several health advantages. When compared to other fruits, the overall antioxidant activity of cactus pear is two times higher.<sup>23</sup> Vitamin C concentration in cactus ranged from 180 to 300 mg/kg. According to reports, cactus cladodes are abundant in carbs (60 percent) and -carotene (6.5 mg/kg DM) <sup>[24, 25]</sup>.

### Conclusions

In comparison to most other cultivated crops, edible spineless cactus can be produced readily in lands with low water content and has a higher tolerance to increased soil salinity. Growing cactus as a forage source for cattle can result in the proper utilization of wastelands, and its feeding also reduces the water consumption due to its cladodes, which is important to livestock farmers, especially in draught-prone areas of the country. As a result, edible spineless cactus could provide an alternative source of green fodder for livestock, particularly tiny ruminants, in the face of climate change.

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