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Review

Nutrient content of important fruit trees from arid zone of Rajasthan

Mala Rathore

Non-Wood Forest Products Division, Arid Forest Research Institute, PO- Krishi Mandi, Pali Road, Jodhpur-342005 (Rajasthan), India. E-mail:mala@icfre.org. Tel: 0291-2729164.

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Forests have provided food and shelter to man since ages. About 20% of the plants occurring in the forests are reported to have direct utility to mankind. Around 600 plant species in Indian forests are ennumerated to have food value. Arid zone vegetation comprises a wide range of edible fruit bearing and food producing species viz. *Capparis decidua* (Ker), *Cordia dichotoma* (lasora), *Ziziphus mauritiana* (ber), *Ziziphus nummularia* (Bordi), *Salvadora oleoides* (Jal), *Balanites aegyptiaca* (Hingota), *Prosopis cineraria* (Khejri) etc. which play an important role in the nutrition of children in rural and urban areas alike and are relished by them. Most of these fruits are rich sources of protein and energy. Ker is a rich source of fibre, vitamin A and vitamin C. Ber is richer than apple in protein, phosphorous, calcium, carotene and vitamin C. However they are often under valued and underutilized as more exotic fruits become accessible. Also most of these are not cultivated and there is only scant and dispersed knowledge about them. Their production and consumption provides a dietary supplement as well as commercial opportunity. Potential fruit species from arid region are reviewed in context with their nutrient contents.

Key words: Fruits, nutrition, protein, vitamin A, energy.

INTRODUCTION

To achieve nutrition and income security for the people, particularly in arid region, suitable species from forests are of vital importance. The arid zone of India covers about 12% of the country's geographical area and occupies over 31.7 m ha of hot desert The production and life support systems in the hot regions are constrained by low and erratic precipitation (100 - 420 mm/year), high evapotranspiration (1500 - 2000 mm/year), and poor soil physical and fertility conditions.

Forests are endowed with a number of plant species of food value which yield edible leaves, fruits, seeds, roots, rhizomes etc. About 21000 species of flowering plants are present in India and approximately 20% of the total plants found in the forests have direct utility to mankind. Although the nutrition value of majority of forest foods is not precisely known, but most of the foods obtained from the forests possess high nutritional values, viz. *Moringa oleifera, Tamarindus indica, Aegle marmelos, Ziziphus mauritiana Capparis decidua, Prosopis cineraria* etc.

Arid and semi-arid zone vegetation comprises a wide range of edible fruit-bearing and food-producing species: *Salvadora oleoides, Balanites aegyptiaca, Cordia dichotoma, Ziziphus mauritiana, Prosopis cineraria., Capparis decidua,* etc. There are around 30 plant species in arid zone known for their edible use and of these around 20 plant species are known for their edible fruits either raw or use as vegetable. Many of the above play a multiple role in dry zone agro forestry systems, providing soil cover, wind protection, fuel wood and fodder as well as food. However, they are often undervalued and underutilised, as more exciting exotic fruits become accessible. Since most indigenous fruit trees have not much been cultivated on-farm, there is only scant and dispersed knowledge about their fruit production and fruit nutritional values. Some nutritional studies on a few fruits from arid zone have been reported (Duhan et al., 1992; Mala & Meena, 2004) Present work is an effort to review the important fruit bearing species from arid region of Rajasthan with reference to their nutrient contents viz. protein, carbohydrate, fat, mineral, vitamin and energy

Table 1. Nutrient content of some important commercially available fruits (Gopalan et al., 1985).

Fruit species	Protein (%)	Carbohydrates (%)	Fat (%)	Fibre (%)	Vitamin A (IU)	Vit. B_2 (mg/100g)	Vit. C (mg/100g)	Ca (mg/100g)	P(mg/100g)	Fe (mg/ 100g)	Energy (Kcal/gm)
Apple	0.2	13.4	0.5	1.0			1	10	14	1.0	59
Banana	1.2	27.2	0.3	0.4	78	0.08	7	17	36	0.9	116
Orange	0.7	10.9	0.2	0.3	1104	-	30	26	20	0.32	48
Papaya	0.6	7.2	0.1	0.8	666	0.25	57	17	13	0.5	32
Grapes	0.5	16.5	0.3	2.9	-	-	1	20	30	0.5	71
Mango	0.6	16.9	0.4	0.7	2743	0.09	16	14	16	1.3	74
Dates (Fresh)	1.2	33.8	0.4	3.7	-	-	-	22	38	-	144
Dates (dried)	2.5	75.8	0.4	3.9	26	0.02	3	120	50	7.3	317

contents vis-à-vis commercially available fruits.

IMPORTANT FRUIT BEARING PLANT SPECIES OF ARID REGION

The fruits from forests apart from containing vitamins and minerals are rich sources of proteins, carbohydrates and energy (Tables 1 and 2). Most of the fruits of the desert species find common use as vegetables when unripe. They are also medicinally important. Many fruit trees from forests are not commercially being explored and data on their nutritional content is less (Table 3). Some common fruit trees are discussed as follows:

Salvadora oleoides (Meetha Pilu) - Family Salvadoraceae

It is popularly known as `Mitha Jal' or `Pilu' and is generally a large evergreen tree found growing wild in arid and sandy areas. It forms dominant part of vegetation of Jodhpur, Barmer, Bikaner, Jaisalmer Churu and Nagaur. It seldom exceeds 3.66 m in height and has a short, twisted or bent trunk. It has numerous stiff, divergent and whitish branches, the lower ones drooping and often touching the ground. Flowering occurs during January to March in western parts of India. Flowers are small, greenish yellow or greenish white produced in clusters. Fruiting is in the month of May (Bhandari, 1990).

The fruits are greenish yellow; red brown when ripe, globose drupe. Fruits are plucked or felled by shaking the trees vigorously. The yield of fresh fruits per tree from mature trees is 10 - 15 kg or 2 - 3 kg dried fruit (Dwivedi, 1993). Fruits have sweet agreeable aromatic, slightly pungent and peppery taste. They can be eaten raw when ripe e.g. by children or may be cooked or preferably dried and stored by nomadic tribes. They contain 1.7 - 1.86% glucose, fructose and sucrose and are used by villagers to prepare squash. Fermented drinks are also made from fruits (Duhan et al., 1992).

Ziziphus species - *Family* Rhamnaceae

In the Indian Thar desert, *Ziziphus* species (*Z. nummularia* and *Z. mauritiana*), besides their multi-purpose uses, constitutes an important source of low cost, nutritious fresh edible fruits. These are described thus:

***Ziziphus mauritiana* (Bordi):** It is a small, evergreen much branched tree or a large shrub. For good tree growth and bumper crop in ber, deep sandy loam soil with neutral to slightly alkaline reaction is desirable. However ber trees can tolerate moderate salinity and bear with low fertility of the soil. It prefers hot and dry climate. Many of its varieties have been developed which are cultivated extensively. Flowering and fruiting occurs from September to March. Fruits should be picked up at right stage of maturity. The yield of ber varieties varies from one to two quintals per tree. The fresh fruit comes in market during February - April at a time when there is a slack season for other kind of fruits. It therefore, sells readily at remunerative price.

Fruit is a drupe, 12 - 15 mm in diameter, globose, fleshy-smooth, yellow or orange when ripe. The composition of ber fruits has been quite widely reported and much of the information is cultivar specific. Fresh mature ber fruits contain

Table 2. Nutrient content of some important forest fruits from arid zone.

Species	Protein (%)	Carbohydrate (%)	Fat (%)	Fibre (%)	Vitamin A (mg/100g)	Vit. B2 (mg/100g)	Vit. C (mg/100g)	Ca (mg/100g)	P (mg/100g)	Fe (mg/100g)	Energy (Kcal/gm)	References
Balanites aegyptiaca	4.9	69.9	0.1	3.5	-	0.07	46	147	58	4	300.1	Nour et al., 1985 Tayeau et al., 1955
Capparis decidua	8.6	1.8	-	12.3	-	-	7.81	55	57	-	41.6	Duhan et al., 1992
Cordia dichotoma	2.0	92.0	2.0	2.0	-	-	-	55.0	275.0	6.0	394.0	Duhan et al, 1992 Chandra et al., 1994
Prosopis cineraria	23.2	56.0	2.0	20	-	-	523.0	414.0	400.0	19.0	334.8	Rathore and Mala, 2004
Salvadora oleoides	6.0	76.0	2.0	2.0	-	-	-	6.0	76.0	8.0	346.0	Duhan et al., 1992
Ziziphus mauritiana	0.8	17.0	0.3		0.02	0.02	76.0	4.0	9.0	1.8	73.9	Chandra et al., 1994
Aegle marmelos	1.8	31.8	0.3	2.9	0.055	1.2	-	85.0	31.8	0.6	137	Parichha, 2004
Feronia limonia	7.3(7)	15.5(17)	0.6(0.3)	5.2	-	0.170	2.0	0.13(4)	0.11(9)	0.6(0.5)	96.6	Anon, 2008

81-97% pulp. The pulp is very rich in nutritive substances. Ber is richer than apple in protein, phosphorous, calcium, carotene and vitamin C and excels oranges in phosphorous, iron, vitamin C and carbohydrates (Chandra et al., 1994; Pareek, 1983).

Fruits of ber are commonly used in Indian households as fresh fruit and dehydrated for later use. The mature green fruits are also occasionally used in India to prepare chutney, pickle and jelly. Powder is made from ripe fruits. A number of products such as murabba, candy and dehydrated ber are prepared from the fruits. Pulp made from ripe fruits is used to prepare products such as ready to serve beverage, squash etc.

***Ziziphus nummularia* (Bordi):** It is a most commonly occurring much branched thorny shrub species in the Indian desert with a height of 1 - 2 m and light coloured bark. It occupies almost all the habitat except the saline patch and the sand dunes. The average density of Jharber in nine districts of Western Rajasthan is ~ 290 plants/ha; the range is however very wide in all the districts. The fruits are mostly round berries with black skinned fruits in early stage which later turn pale and finally dark brown (CAZRI, 1981). The fruits ripen during late November and December and are much relished by children and women. The fruits are eaten fresh as well as after drying. It contains considerable amount of soluble carbohydrates. The well ripened fruits fetch better prices in market from Rs.1 - 2 /Kg. Sometimes these fruits are grounded (fruits with the stone) and sieved. This powder is consumed alone or mixed with Gur or sugar. A delicious paste locally known as Borakuti is also prepared and it is and relished by young and old alike with great interest

Table 3. Other Potentially exploitable fruit species from arid zone.

Botanical name	Local name	Family	Habit	Fruit	Fruiting period
Grewia tenax	Gangerun	Tiliaceae	Most common shrub or under shrub growing amongst Euphorbia bushes	Fruit is a drupe, deep orange in colour, sold in the market.	September-December
Cordia gharaf	Goondi	Ehretiaceae	Shrub or small tree found in arid areas	Berry is orange or reddish brown when ripe, eaten and sold in the market	May-June
Citrullus lanatus	Matiro	Cucurbitaceae	Trailing hispid annual found in open fields	Globose or ellipsoid, Dark green bands or uniform	August-December
Ephedra foliata	Lana	Gnetaceae	Dioecious much branched climbing shrub, common on sand or gravel or rocks	Fruits ovoid-globose, milky white, semi-transparent, are eaten in scarcity	January-April
Cucumis melo	Kachro	Cucurbitaceae	Common annual much branched prostate herb	Usually cylindrical, quite smooth, yellow or orange with blotches in irregular lines	November-December
Cucumis callosus	Kachri	Cucurbitaceae	Much branched very common prostate , perennial herb	Fruits are ellipsoid, ovoid, green variegated stripes, sold in the market	August-November

and pleasure.

Balanites aegyptiaca (Hingota) - Family Simaroubaceae

It is known as the date of the desert. *B. aegyptiaca* (Linn.) Del. is a slow growing small tree about 20 ft. high with bifoliate ashy green leaves. It is sporadically distributed on sandy soils under rainfall of 250 mm. The species, which occurs in arid zones, grows very slowly and has a slow fruit development. *B. aegyptiaca* is ecologically very flexible with excellent persistence. It is adaptable to a wide range of sites and climatic conditions. The tree is drought and fire resistant, and withstands up to 2 months flooding in areas near a river but it can not tolerate prolonged water logging. It is found in open sandy plains of Osian, Jodhpur and whole of north-western part. Flowering occurs in December - March and fruiting occurs from March - July.

It is mainly valued as a wild food plant. Mesocarp nourishing, sugar rich, palatable, bitter-sweet. A valuable reserve in times of scarcity (Sulman and Jackson 1959). Ripe fruits eaten raw or sun-dried and stored like dates, made into sweetmeats or fruits juice (when macerated with water) and mixed with cereals, or fermented to alcoholic beverages (Bernus, 1979; Storrs, 1982; Becker, 1983; Burkill, 1985). Fruit should not be eaten in excess as saponin content is laxative, but school children in West Africa reportedly suck 15 - 20 fruits a day. As fruits are eaten freely they may not be toxic but uncertainty prevents its promotion as food (Abu-Al-Futuh, 1983).

Kernel and seed meal are protein rich (26 - 30% in kernels) and only slightly inferior to peanuts with respect to amino acid content (Tayeau et al., 1955; Abu-Al-Futuh, 1983; Nour et al., 1985). Seeds are added to soups and made into a kind of bread (Burkill, 1985) and seed meal is eaten in Senegal, Sudan and Uganda (FAO 1967). Kernels are obtained by hand cracking (Burkill 1985) or nuts are boiled in water until shell bursts and frees seed (Bernus 1979) . Bitter principles in seed are eliminated by cooking twice (Burkill 1985), steeping for 3 - 4 days (Pipe-Wolferson, 1987) or leaching with water at 60°C for 48 h. Debittered seeds could possibly be marketed as salted, roasted nuts; used in sweets; or made into a paste like peanut butter. Seed meal tested on rats showed no gross toxicity (Abu-Al-Futuh, 1983).

Cordia dichotoma (Lasora) - Family Boraginaceae

Also known as Indian cherry, sebesten, goonda, or lasora. Medium sized deciduous tree having dense foliage distributed in rangelands of arid and semi arid ecosystem. It is generally planted along with farm boundary, roadside and in garden as shade tree however its commercial plantation is done at various places in Rajasthan. During 1991 - 1992, the area under lasora cultivation was about 7.0 ha in Rajasthan with total production of 35.0 tonnes. It is becoming popular as monoculture under agro forestry system in arid zone.

A tree starts fruit production after 4 - 5 years of planting. Flowering varies place to place. Immature green fruits are available in April - May. These are harvested and used as vegetable and in pickles. Ripe fruits are freshly eaten; they are rich source of carbohydrates. The yield of fruits is 30 - 50 kg of fruits. Chandra and Parekh reported average fruit yield of 32.4 kg per tree at Bhojha,

Jaiselmer (Singh et al., 1997).

Plucking fruits with stalk is beneficial when transporting to distant places. Fruits remain good if packed in bamboo basket. Net sum of Rs 5000 to Rs 7000/- per ha per year can be obtained if trees planted at 8m space from row to row and plant to plant (Chandra et al., 1994).

Capparis decidua (Ker) - Family Capparaceae

Ker is a densely branching shrub or small tree found growing naturally in arid and semi-arid areas of India. In Rajasthan, it occurs both on sandy and gravelly soils covered with sand dunes (Troup, 1975).The plant is drought hardy and very good sand binder. It is leafless, except for the young shoots bearing caduceus leaves. The flower appears in March - April, but sporadically in other seasons. The tree, bereft of leaves, looks quite conspicuous when covered with red flowers. It bears fruit 1.3 - 1.8 cm diameter, round, fleshy, pink or red when ripe. The pink fleshy fruits which ripen in May-June are eaten by birds. Seeds can be collected in June. In a survey conducted in saline grazing lands in Jodhpur shrub density of 2 - 56 ha^{-1} was observed. Density was higher (35 - 56 ha^{-1}) in sandy and hummocky area followed by sandy plains (22 - 34 ha^{-1}). In water logged areas only one or two shrubs were noticed.

Fruit is of high nutritional value. The edible fruits are rich in protein and minerals and have a high seed fat content. Seeds contain ~ 20% oil, 1.7% sugar and 8.6% protein. Ker was found to be very rich source of beta-carotene and vitamin C besides being rich in iron, calcium and zinc. Its unripe fruits are an important food item (Chauhan et al., 1983; Duhan et al., 1992). Women and children pick the unripe green fruits as a supplementary activity while grazing animals and are used as vegetable after processing. Dried Fruits are important constituent of Panchkuta. Another common use of the unripe fruits is its use in making pickles.

The shrubs of *Capparis decidua* hold an economics importance in desert area to enhance rural economy. The fruits of *C. decidua* (Ker) play an important role, as it is main products for delicious food value. The fruits are collected from the tribals/villagers at the rate of Rs 20 - 25 /kg. In the market they are sold at Rs 200 - 220 /kg.

Prosopis cineraria (Khejri)-Mimosaceae

It is a tree growing in dry and arid region of India. In most important areas of *Prosopis cineraria* distribution, the climate is dry to arid and rainfall shows considerable variation 100 - 600 mm annually with a long dry season. It is one of the chief indigenous trees of the plains rarely occurring on the hills. Flowering occurs in Dec-April. The greenish yellow flowers are in axillary spikes solitary or in terminal panicles. Fruiting occurs in March - June. Pods are10 - 20cm long, rigid, straight, cylindrical, glabrous, 10 - 15 seeded.

Pods locally called “sangri" are brown to chocolate colour on ripening and hang in cluster of up to 12 from the tree, each containing several seeds embedded in sweet dry yellow pulp. The dried pods are called Kho-Kha and are eaten with delight. Pods or khokha are considered as Marwari-mewa or dry fruit of arid zone. They contain sucrose (13.16%), protein (9 - 15%) and total carbohydrates (45 - 55%). They are even fed to milch cattle.

Ripe pods may be collected by hand picking or by shaking/beating the branches. Nearly 1.4 quintals of pods/ha with a variation of 10.7 % in dry locations can be obtained. The pod yield is significantly correlated with diameter at breast height of the tree. One tree of khejri gives at least 5 kg of ripen pods.

As clear from the table of nutrient contents, the fruits from arid zone are nutritionally far more superior to the comm.-ercially available fruits viz. apple, banana, grapes etc. They are rich in carbohydrates and proteins which are present in negligible amounts in commercial fruits. Also they have higher mineral contents. *Prosopis cineraria* fruit is very rich in vitamin C and Calcium and phosphorus contents. *Salvadora oleoides* and *Cordia dichotoma* are very rich sources of phosphorus. *Balanites aegyptiaca* fruits are rich in Calcium, Phosphorus and Vitamin C. In many arid zone fruits the total energy obtained is much higher than that obtained from commercial fruits. Thus, wild fruits from arid zone can provide much better nutrients when eaten and can be used parallel to the commercial fruits.

Conclusion

Indigenous fruits play an important role in the nutrition of children in rural and urban areas alike. The growing of trees for fruit production encourages the preservation of more or less permanent stands or scattered individual trees in otherwise bare lands. Such trees are often a feature of desert landscapes and form the basis of traditional agroforestry land use systems. *Capparis decidua, Balanites aegyptiaca*, *Cordia dichotoma, Ziziphus nummularia, Ziziphus mauritiana* and *Salvadora oleoides* are important fruit bearing species of the desert areas. Some are excellent sources of Vitamin A (Ker), Vitamin C (Hingota, Ber and Khejri) and Calcium (Khejri) and other minerals. Mitha jal fruits are rich source of carbohydrates. The production and consumption of these fruits in arid zones thus provides a dietary supplement as well as commercial opportunity. These fruits from forests are rich sources of protein and energy and can be very useful in treating malnutrition viz. protein energy deficiencies so prevalent in these areas particularly during famines and floods.

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