



Nutritional and medicinal value of some important arid zone fruits of Rajasthan

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Abstract

Arid fruits are the special gifts of nature to the human being grown in the arid climatic conditions. Arid fruits have very good nutritional values and survive in very adverse climatic condition. Protein, fat, fibers, vitamins, mineral *etc.* are found in greater amount in arid fruits as compared to tropical and sub-tropical fruits. Still very less studies has been conducted on arid fruit especially nutritional aspects. Various fruit plants found in Rajasthan having high medicinal properties. Underutilized fruits provide food, nutrition and health promoting substances to native communities and are an additional source of income. To achieve nutrition and income security for the people, particularly in arid region, suitable species are of vital importance. Arid fruits *viz.* aonla (*Embllica officinalis*), bael (*Aegle marmelos*), jamun (*Syzygium cumini*), pomegranate (*Punica granatum*), custard apple (*Annona squamosa*), karonda (*Carrisa carandus*), phalsa (*Grewia subinequalis*), lahsua/lasora (*Cordia myxa*), *etc.* possess high nutritional values. Hence, research and development work, farmers awareness and feasibility for cultivation of these less known fruits are to be given due consideration. The objective of this review article is to concisely summarize the information about the important and underutilized arid fruits of Rajasthan with reference to their nutritional values and medicinal uses.

Key words: Arid zone fruits, medicinal properties, nutritional value, underutilized fruits

Introduction

Arid zone of India covers about 12% of the country's geographical area and occupies over 31.70 m ha of hot desert. This region is characterized by low and erratic precipitation (100-450 mm), high evapotranspiration (1500-2000 mm), and poor soil physical and fertility conditions. These conditions limit the scope of crop production but favour the arid fruit production. However, most of the arid fruits are underutilized. These underutilized fruits have great nutritional and medicinal properties. These day's consumers are becoming health and nutrition conscious, thereby developing tendency to avoid chemicals and synthetic foods and choosing natural foods. Thus, the underutilized fruits have high potential for their therapeutic, medicinal and nutritive values. Some of the underutilized fruits are rich sources of vitamin C, proteins and vitamin A. However, the potential of most of the arid fruits are not be exploited due to narrow genetic pool, limited knowledge sharing on their uses, limited income generation, improper marketing and demand limitation. The unavailability of standard varieties/planting material and lack of technical knowledge further limited the production potential of arid fruits. Thus, the use of underutilized fruits has a vital role in imparting nutritional security to society. Research on nutritional and medicinal aspects of arid fruits is scattered and therefore, the objective of this review is to summarize information on underutilized arid fruits of

Rajasthan with reference to their nutritional values and medicinal uses.

1. Date palm (*Phoenix dactylifera*)

Date palm is a monocotyledonous and dioecious species belonging to Arecaceae (Palmaceae) family. It is an important crop of arid and semi-arid regions of the world. It is one of oldest cultivated plants and has more than 6000 year's history. In India, date palm plantation mostly exist in the western part such as Kachchh region of Gujarat state (Johnson *et al.*, 2013), Rajasthan (Jaisalmer, Barmer, Bikaner, Jodhpur and some parts of Churu, Sri Ganganagar, Hanumangarh, Nagaur *etc.*), Haryana and some parts of Tamil Nadu. Date palm requires high temperature (25-40°C), fertile deep (at least 2 meter) sandy loam soil with good water holding capacity. It plays an important role in the economic as well as social life of the people of arid region. Fruits are eaten as fresh fruits (hard ripe stage), dry dates (Chhuhara) and soft dates (pind khajoor) and also used in different processed products like sugar, starch, vinegar, juice, toffees, wine, chutney, jam, pickles *etc.* (Choudhary *et al.*, 2018). Date fruits are highly nutritious and contain high calorific value (3150 calories/kg of fresh fruits), 60-65% sugar, fair amount of fibre (2.5%), protein (2%), less than 2 per cent fat, minerals up to 2 per cent like iron, potassium, calcium, copper, magnesium, chloride, sulphur and phosphorus *etc.* (Gopalan *et al.*, 1985).

Internationally, there is an increasing demand for excellent quality dates (Awad, 2007). Fruit weight and size are also critical quality parameters that affect dates marketing (Al-Qurashi and Awad, 2011). Now a day, researchers more emphasize to increase the size of fruit, yield and fruit quality of date palm under hot arid conditions of western Rajasthan.

Nutritional value

Date fruit is also a good source of fiber. Date fruits contain 52-88 % carbohydrates (including 13.6-36.8 g fructose, 17.6-41.4 g glucose and 0.05-3.4 g sucrose per 100 g), 3.5-10.9 % total fibres, 0.1-1.4% fat, 1.1-2.6 % protein, 0.4-2.0 % minerals and 0.002-0.02 % vitamins (Baliga *et al.*, 2011). Date fruit is considered as a good source of dietary fiber such as cellulose, hemicellulose, lignin and pectin *etc.* (Biglari, 2009). Many minerals such as boron, calcium, cobalt, copper, fluorine, iron, magnesium, manganese, potassium, phosphorous, sodium and zinc *etc.* are also found in date fruit (Khan *et al.*, 2008; Hasnaoui *et al.*, 2011). The potassium content in date palm is very high and can reach up to 0.9%. Date fruit has reasonable amounts of vitamins including vitamin A, B₁, B₃, niacin (nicotinic acid), C and folic acid (Biglari, 2009). The carbohydrates content, fibre content and mineral concentration in date fruit is influenced by soil fertility, cultivar and ripening stages of date palm. Date seed oil is also used for edible purpose and has nutritional value (Abdul Afiq *et al.*, 2013).

Medicinal value

Date fruit is traditionally used to protect gastric mucosa from the damaging effects of the gastric acid. It is very important for human health to control excess generation of free radicals generated from inflammatory leukocytes. Date fruits are considered as an appropriate substrate for manufacturing value-added products such as organic acids, exopolysaccharide, antibiotics, date flavored probiotic fermented dairy, bakery yeast *etc.* (Aleid, 2011). Recent studies have shown that date fruit and its aqueous extract have the free radical scavenging activity, anti-mutagenic and immune-modulatory activities (Allaith, 2008). The antioxidant activity of date fruit is attributed to the phyto-chemical compounds such as phenolic acids, flavonoids, anthocyanins *etc.* and mineral selenium. Selenium can contribute to the antioxidant effect because it may play an important role in activating many enzymes related to Reactive Oxygen Species (ROS)-detoxification (Steinbrenner and Sies, 2009). Saafi *et al.* (2011) reported date fruit extract could decrease the levels of the hepatic markers enzymes (transaminases, alkaline phosphatase, gammaglutamyl transferase and lactate dehydrogenase) and hepatic levels of malondialdehyde, and concomitantly increase the levels of antioxidant enzymes (Saafi *et al.*, 2011).

2. Ber/Indian jujube (*Zizyphus mauritiana* Lamk.)

Ber is also known as desert apple or Indian plum. Chinese jujube (*Zizyphus jujuba* Mill.) is grown in temperate regions while Indian jujube (*Zizyphus mauritiana* Lamk.) is cultivated in hot arid regions of India. It belongs to the family

Rhamnaceae. It is an ideal fruit tree for arid and semi-arid regions in tropical and subtropical climate where most of the fruit crops cannot be grown either due to adverse climatic or soil conditions. Fully ripened fruits are gathered in the beginning of the winter months, dried, ground and sieved. The fruits can also be used for making several products like chutney, dried ber, murabba, jelly, squash, jam, ber powder *etc.* Honey can be obtained from the flower nectar. It is also reported that the cotyledons are removed from the seeds, fried and eaten separately or mixed with bajra (Tiwari, 2016). Wines can also be prepared from the ber fruits.

Nutritional value

Ber fruits are rich in nutritive value. Vitamin C content is very high in Chinese jujube and fairly high in Indian jujube (Pareek, 2013). Besides, it also has vitamin A, B-complex, protein, calcium and phosphorus. In general, the fruit contains 81-83% moisture, 17.0% carbohydrates, 0.8% protein, 0.07% fats, 0.76-1.8% iron, 0.03% each of calcium and phosphorus, 0.02 mg/100g carotene and thiamine, 0.020-0.038 mg/100g riboflavin, 0.7-0.9 mg/100g niacin, 0.2-1.1mg/100g citric acid, 65-76 mg/100g ascorbic acid, about 22 g/100g sugar, about 1.3 g/100g fiber, about 0.2 g/100g fat with a calorific value of 104/100g (Mortan, 1987). Galactose, fructose and glucose are the major sugars found in ber fruit (Muchuweti *et al.*, 2005).

Medicinal value

Despite its high nutritional value and its biological properties, ber is considered among underutilized fruit. The decoction from root and bark is good for dysentery and diarrhoea and leaf decoction is useful for gargle in sore throat and in bleeding gums. The seed kernels are aphrodisiac. The powder of ber roots has medicinal properties for curing ulcer, fever and wounds. Polysaccharides extracted from plants and fungi have been identified for their anti-oxidative and hepatoprotective effect (Wang *et al.*, 2012) and also for their immune-biological, anti-viral, anti-tumor and other biological activities (Gonzalez *et al.*, 2011).

3. Aonla (*Emblica officinalis* Gaertn.)

Aonla is a deciduous fruiting plant of family Euphorbiaceae cultivated in India since Vedic Era. The tree is hardy, prolific bearer and a suitable choice for arid regions (Mitra, 1999). The fruit is highly nutritious and is a rich source of pectin and polyphenols apart from ascorbic acid. Aonla fruits are sour and tangy and popularly used to prepare juices, jams and pie-fillings for centuries. It is an important ingredient in the chyavanprash, and a constituent of triphala powder (Boora and Bons, 2015). These days, aonla fruits are becoming popular to prepare food products like preserve, candy, jam, toffee, pickle, sauce, squash, juice, RTS beverage, cider, shreds, dried powder, laddoo *etc.* (Bhattacharjee *et al.*, 2011; Pandita *et al.*, 2017).

Nutritional value

Aonla is a rich source of ascorbic acid and due to high vitamin C content of fruit makes its wide use in Ayurvedic medicine. It has also a good source of nutrients like calcium,

phosphorus and iron as well as proteins and vitamins such as thiamine, riboflavin, niacin *etc.* (Boora and Bons, 2015). The calorific value of aonla is 59 cal with 0.03 mg vitamin B, 0.2 mg nicotinic acid and 700 mg vitamin C per 100 g of fruit. The vitamin C content found in aonla is easily assimilated by the human body and has been found to have great antioxidant properties (Reddy, 2016) It also contains proteins and minerals like calcium, phosphorus and iron.

Medicinal value

The nutritional values of aonla are numerous and is recommended to be included as part of the daily diet. The fruit is the richest source of vitamin C and has diuretic, aperients and laxative properties. It is used for treating ailments like common cold, gastric troubles, chronic diarrhea, dysentery, headache, constipation, enlarged liver, diabetics, bronchitis, jaundice and fever *etc.* (Chadha, 2003; Agarwal and Chopra, 2004). It also cures insomnia, constipation, as well as used as a cooling agent to reduce the effects of sun strokes. It is also useful for haemorrhage, leucorrhoea and discharge of blood from uterus (Hasan *et al.*, 2010). As an anti-oxidant, it prevents premature ageing. Aonla stimulate the isolated group of cells that secrete the hormone insulin, which reduces blood sugar in diabetic patient (Iyer *et al.*, 2009). Aonla is also used in many hair tonics as it enriches the growth and hair pigmentation. It also strengthens roots of hair, maintains colour and shine. It is the main ingredient used in the shampoo and hair dye.

4. Bael (*Aegle marmelos* L.)

Bael is an important indigenous fruit of India and belongs to Rutaceae family. It is a useful medicinal fruit known to Indian population since time immemorial and has also religious value in Hindu dharma for Shiva's devotees (Boora and Bons, 2015). It is native to India and found throughout south-east Asia. In India this fruit is grown in Indo-Gangetic plains and sub-Himalayan tracts up to the height of 500 m, north-east India and dry and deciduous forests of central and southern India. Fruit contain soft yellow or orange coloured mucilaginous pulp with numerous seed. The seeds are densely covered with fibrous hairs and embedded in a thick, gluey aromatic pulp (Kaushik *et al.*, 2002). Gehlot and Dhawan (2005) reported about all parts of the trees *viz.*, root, bark, leaves, flowers or fruits are used for curing one or other human ailments. Bael is used in the preparation of chutneys and for making jelly and jam (Srivastava *et al.*, 2014).

Nutritional value

Fruit of bael are very nutritious and contains 61.5 g of water, 31.8 g of carbohydrates, 1.8 g of protein, 3 mg of fat, 1.7 g of minerals, 2.9 g of fibre and 1.19 mg of riboflavin/100 g edible portion. No other fruit has as high content of riboflavin as bael fruit (Singh *et al.*, 2009). It also contains vitamins and minerals including calcium, phosphorus, iron, carotene, thiamine, riboflavin, niacin and vitamin C (Hasan *et al.*, 2010). Various phyto-constituents have been isolated from different parts of bael plant, namely alkaloids, coumarin and steroid (Meity *et al.*, 2009). The fatty acid composition of the oil is palmitic 16.6; stearic 8.8%; Oleic 30.5%; linoleic 36.0% and linolenic 8.1%.

Medicinal value

Bael is useful in curing dyspepsia, dysentery, diarrhea, vitiated condition of vata, vomiting, cardio palmus, stomach algia, intermittent fever, seminal weakness, swelling, uropathy and gastric irritability in infants. Bael is much used in India as a liver and cardiac tonic and when unripe as a mean of halting diarrhea and dysentery as well as for effective treatment for hiccough, sore throat and diseases of the gums. The medicinal value of bael fruit is enhanced due to presence of tannin, the evaporating substance in its rind. The rind contains 20% tannin while its pulp has only 9% of tannin. The fruit is aromatic, cooling and laxative. It arrests secretion or bleeding. It is also useful in preventing scurvy and strengthens the stomach and promotes its actions (Joshi, 2004). The unripe fruit is good for digestion and is perhaps the most effective remedy for chronic diarrhoea and dysentery where there is no fever (Bakhrui, 1997). The ripe fruit of bael contains marmelosin ($C_{13}H_{12}O_3$) which has cardioprotective, antihelminthic, antibacterial and antiulcer properties. Oxidative stress induced hyperglycemia or diabetes can be reduced to a great extent by extracts of scopoletin (7-hydroxy-6-methoxy coumarin) (Panda & Kar, 2006). Bael is rich in laxatives which makes it useful in controlling the blood sugar levels. This is because it energizes the pancreas and makes it produce enough amount of insulin necessary to control sugar level in the blood.

5. Jamun (*Syzygium cumini* L.)

Jamun is an important indigenous fruit of commercial value in the country. It belongs to the family Myrtaceae. The tree is ideally suited for wind break and roadside plantations. Its fruits are highly perishable in nature and have short life; it deteriorates at a very faster rate if proper post harvest handling practices and processing techniques are not adopted. The storage life of jamun fruits restricted to only 24 hrs at room temperature and 12 days at cool temperature *i.e.* 3 to 4°C (Ramanjaneya, 1985). Apart from eating fresh, it can also be used for making delicious beverages, juice, jam, squash, wine, vinegar and pickles. Seed contain an alkaloid jambosin and a glycoside, jambolin or antimallin, which reduces or stop diastatic conversion of starch into sugars. The anthocyanin content in jamun fruits which attributes to its antioxidant activity is also a good source of natural food colourants for the food processing industries (Namasivayam *et al.*, 2008). The fruits and leaves extract of jamun showed good efficacy to control nematode infestation in plants.

Nutritional value

Jamun is an underutilized fruit crop, gaining popularity among the consumers due to its high neutro-clinical values in rural as well as in urban masses. In addition, the ripe berries are good source of anthocyanins, vitamins, minerals, iron and pectin with fair amount of ascorbic acid. Fruit juice and preserve also hold an important position due to their richness in essential minerals, vitamins and other nutritive constituents (Bukya and Madane, 2018). The freshly picked fruits per 100 g of edible portion contains moisture 85.8 g, ether extract 0.15 g, crude fiber- 0.3 g, nitrogen 0.129 g, ash 0.32 g, calcium 8.3 mg, phosphorus 16.2 mg, iron 1.62 mg,

carotene 0.004 mg, thiamine 0.008 mg, riboflavin 0.009 mg, niacin 0.290 mg and total ascorbic acid 5.7 mg (Munsell *et al.*, 1949). Some other reported constituents of the fruit are specific gravity 1.0184, total acidity (as acetic acid) 5.33 per 100 cc; total solids 4.12 per 100 cc, ash 0.42, alkalinity of ash 32.5 (N/10 alkali), nitrogen 0.66131, total sugar 0.995, reducing sugars 0.995, non volatile reducing sugars 0.995, alcohol 0.159% by weight, oxidation value (KMnO₄, 186.4), iodine value 183.7 and ester value 40.42.

Medicinal value

Traditionally the jamun fruits, leaves, seeds as well as bark are used in ayurvedic medicine. The bark contains tannins and carbohydrates, accounting for its long-term use as an astringent to combat ailments like dysentery (Giri *et al.*, 1985). Jamun fruit reduces the sugar in the blood and is very good in the control of diabetes. All parts of the jamun can be used medicinally and it has a long tradition in alternative medicine. The plant has been viewed as an anti-diabetic plant since it became commercially available several decades ago. The fruits have been used for a wide variety of ailments, including cough, diabetes, dysentery, inflammation and ringworm (Quisumbing, 1951). Water diluted juice is used as a gargle for sore throat and as a lotion for ringworm of the scalp (Gordon and Jungfer, 2011; Shrikant *et al.*, 2012). In India the juice of the ripe fruit or a decoction of the fruit or jamun vinegar is used in cases of enlargement of the spleen, chronic diarrhea and urine retention. With regard to the antineoplastic activities studies suggest that jamun is selective in its action in breast cancer cells. Jamun reduces the tumor incidence, tumor burden and cumulative number of gastric carcinomas. Reports also suggest that ellagic acid, gallic acid, and anthocyanins present in jamun are reported to prevent experimental carcinogenesis in various organs and may have contributed to the anti-carcinogenesis (Shrikant *et al.*, 2012).

6. Pomegranate (*Punica granatum* L.)

Pomegranate xerophytic characteristics and hardy nature makes it suitable for dry, rainfed, pasture and undulating land, where other fruit crops cannot grow successfully. Commercial plantations of pomegranate exist in Maharashtra, Gujarat, Rajasthan, Madhya Pradesh, Andhra Pradesh and Karnataka owing to its preference for arid climate. Besides, being a favourite table fruit it is also used for preparation of juice and squash. Dried seeds give an important condiment coined as *Anardana*. It also has medicinal value and rind is being used for dyeing cloths. It helps in preventing the harmful effects of radioactive substances by producing biologically active substances (Bhowmik *et al.*, 2013). Pomegranate is a poly-vitamin, a unique fruit plant producing a wide spectrum of biologically active substances especially important in our present-day polluted environment.

Nutritional value

The fruit is moderate in calories, holds about 83 calories per 100 g; slightly more than that of the apples. It contains potassium, carbohydrates, protein, fat, fibre and other

vitamins and minerals. It contains no cholesterol or saturated fats. Food value, minerals and vitamins per 100 g of edible portion of pomegranate is moisture-78.0%, carbohydrates-14.5%, calcium 10 mg, protein 1.6%, phosphorus 70 mg, fat-0.1%, iron 0.3 mg, minerals 0.7%, vitamin C 16 mg, small amount of vitamin B complex and fibre 5.1%. Further, it is also good source of many vital B complex groups of vitamins such as pantothenic acid (vitamin B-5), folates, pyridoxine and vitamin-K, and minerals like copper, potassium, and manganese (Jochle, 1971). It also contains phenolic compounds like gallic acid, protocatechuic acid, chlorogenic acid, caffeic acid, ferulic acid, o- and p- coumaric acids, catechin, phloridzin and quercetin (Bhowmik *et al.*, 2013).

Medicinal value

Pomegranate is natural blood thinners. It prevents blood clots in the heart and arteries also. Dietary fibre helps in smooth digestion and bowel movements. Certain ellagitannin compounds such as granatin B, and punicalagin are found abundantly in the pomegranate juice. Consumption of fruits rich in vitamin-C helps the body to develop resistance against infectious agents by boosting immunity. The seeds prevent blood platelets from coagulating and forming clots. Studies suggest that punicalagin and tannins can be effective in reducing heart-disease risk factors by scavenging harmful free radicals from the human body. The rind of the fruit and the bark of the pomegranate tree are used as a traditional remedy against diarrhea, dysentery and intestinal parasites. Drinking pomegranate juice has been shown to have antimicrobial properties against harmful bacteria that can exist in the stomach, such as *Eschericia coli* (*E. coli*) or *Bacillus subtilis*, both of which can cause painful infections and serious stomach conditions. Pomegranate juices is remarkably rich in antioxidants viz., poly phenols, tannins and anthocyanins, thereby acting as scavengers and prevent DNA damage. The seeds and juice are considered a tonic for the heart, throat, eyes and for a variety of purposes, such as stopping nose bleeds and gum bleeds, toning skin, firming-up sagging breasts and treating haemorrhoids. Pomegranate hull and/or root extract are used both orally and intra-vaginally in preventing fertility (Razzak, 1980; Goh *et al.*, 1984), abortion and to ameliorate assorted gynaecological problems (Chaudhary and Mukkopadhyay, 2012).

7. Karonda (*Carrisa carandus* L.)

Karonda is a native plant of India belonging to family Apocynaceae and popularly known as Christ's thorn. In India, it is grown on a limited scale in Rajasthan, Gujarat, Bihar, West Bengal and Uttar Pradesh. Fruits are sour and astringent in taste. It is rich in vitamin C content and good source of iron apart from the usual contents of minerals, protein, sugar *etc.* Some of its species have economic importance and well known as a protective hedge plant yielding berry like fruits, which are edible, attractive in colour and also used as ornamental plant (Misra, 2009). Karonda is an indigenous protective fruit held in high esteem in Indian dietary. Therefore, it is also used in making jelly, jam, squash, syrup,

tarts and chutney which are of great demand in international market (Wani *et al.*, 2013). It is also used for making pickles, coloured wine and candy. Ripe fruits are eaten as raw and use for making jelly of excellent quality, which resemble to gooseberry in flavour.

Nutritional value

It is one of the richest source of iron and contains a fair amount of vitamin C and, therefore, very useful for curing of anaemia and has anti-ascorbic properties. Usually, the dry fruits contain 264 calories, 2.3 per cent protein, 2.8 per cent minerals, 9.6 per cent fats, 67.1 per cent carbohydrates and 3.9 per cent iron. Karonda fruit is rich in iron and contains a fair amount of vitamin C besides being a good appetizer (Boora and Bons, 2015). Ripe karonda fruits contain high amount of pectin.

Medicinal value

It is a popular Indian medicinal plant. It is widely used for medicinal purpose by tribals throughout India and popular in various indigenous system of medicine like Unani, Ayurveda and Homoeopathy (Wani *et al.*, 2013). Enthomediically, fruits are used as astringent, antiascorbutic and as a remedy for biliousness (Jadhav *et al.*, 2004). Traditionally the plant has been used in the treatment of scabies, intestinal worms, diarrhoea, intermittent fever and reputed for its aphrodisiac, antipyretic, appetizer, antiscorbutic, anthelmintic, and astringent and useful for cure of anaemia. Fruits are useful in treatment against anorexia and insanity. The ripe fruit is cooling and acidic; used to treat sore throat, mouth ulcer and skin disorders (Sheela *et al.*, 2015 a&b; Jayakumar *et al.*, 2015). The fruits have antimicrobial and anti-fungal properties and its juice is used to wounds healing properties. The fruit have an analgesic action as well as an anti-inflammatory property. The traditional medicinal value of karonda fruit is used to improve female libido and to remove worms from the intestinal tract. The juice can be applied to the skin to relieve the skin problems.

8. Custard apple (*Annona squamosa* L.)

Custard apple is also known as sharifa, sitaphal and sugar apple. It is one of the most delicious arid regions fruit plant and belongs to Annonaceae family. The fruit has pleasant texture and flavour. The fruit is sweet with slight acidity and delicious hence is used for table purpose. It is a subtropical small deciduous spreading tree of height 5-9 feet, with large green dropping leaves and light yellow trumpet shaped flowers, emitting pungent sweet smell during late afternoon. It starts bearing at the age of 4 to 6 years and the bearing declines after 12 to 15 years. Custard apple prefers dry climate and can withstand mild frost. The root system is confined to relatively shallow layers and therefore, these do not require deep soils. The trees withstand high amounts of lime found in calcareous soils. The fruit has the tendency to burst open if kept on the tree for a long time. To increase nutritional value and accelerate its value addition, several products have been prepared *viz.*, ice cream, carbonated beverages smoothies, cheese cakes *etc.* Often it is pressed through sieve and added to milk shakes,

custards or ice-creams. Custard apple can be made into shakes or smoothies or even into natural ice creams (Vishnupriya and Dhandapani, 2015). A delicious sauce for cake and puddings can be made by blending the seeded flesh with mashed banana and a little cream (Singh *et al.*, 2009). The fruit pulp has numerous medicinal properties which include antioxidant, anti-diabetic, anti-infective and anti dyslipidemic properties.

Nutritive value

Custard apples are usually consumed as dessert fruit. It has high calorific value, able to provide sustained energy and delicious in nature. Custard apple is full of antioxidants, which helps to combat many diseases and also enhances the immune system. It is an abundant source of dietary fibre, vitamin C, vitamin A, potassium, magnesium, calcium, iron, vitamin B6, copper and low fat levels (Geng *et al.*, 2005). The ripe custard apple fruit contains about 104 kcal per 100g of pulp, 70 % moisture, 14.5 % sugars, 3.1% of fibre, 1.6 % protein, 0.3 % fat, 1.0 % iron, calcium (0.02 %), phosphorus (0.04 %) and 0.7 % mineral matter (Nair and Agarwal, 2017). The main sugars are glucose and fructose (80-90%). Potassium removes the lethargies and helps to fight muscle weakness. The vitamin A keeps skin and hair healthy, very important for the eyes, and cures indigestion. As the fruit is high in magnesium, it maintains the water balance in our body, which helps in removing acids from the joints and reduces the symptoms of rheumatism and arthritis (Hundal and Khurana, 1993). Custard apple contains natural sugar, and hence makes a great nutritious snack and can even be added to desserts especially for children.

Medicinal value

The various chemical constituents isolated from leaves, stems, and roots of the custard apple plant include anonaine, aporphine, coryline, isocorydine, norcorydine, and glaucine (Anonymous, 2013). One class of chemicals which sets custard apple apart from other fruit species is the presence of acetogenins, which are very long chain fatty acids and only found in Annonaceous species (Johns and Clarke, 1943). Custard apple is used for treatment of malaria. Three known aporphine alkaloids were isolated from the bark. Structures of compounds were identified as N-Nitrosoxylophine, Roemerolidine and Duguevalline. The *in vitro* and *in vivo* studies revealed its anti-cancer properties and anti-hypertensive properties, which are mainly due to presence of acetogenins. The fruit has antioxidant activity making it suitable even for diabetic patients (Dickson, 1975). Despite its high sugar content the glycemic index of custard apple is low (54). Fruits have anti-microbial activities due to presence of compounds like ent-kauranes, acetogenins, essential oils and Benzylisoquinolines alkaloids (Kitagawa *et al.*, 1994). Two acetogenins, annoreticu and isoannoreticu isolated from the leaves, were found to be selectively cytotoxic to certain human tumours. It also possesses anti HIV properties. Among the 14 isolated compounds in a study, 16, 17-dihydroxy-entkauran-19-oic acid showed significant activity against HIV replication in H9 lymphocyte cells with an EC₅₀ value of 0.8 µg/ml (Kumar *et al.*, 2007).

9. Phalsa (*Grewia subinequalis* L.)

Phalsa belongs to Tiliaceae family and native to India. Fruits of phalsa are acidic and are good source of vitamin A and various other nutrients. Generally, its fruits are consumed fresh (Boora and Bons, 2015). Being highly perishable, the fruit must be utilized within 24 hours after picking. The popularity of phalsa fruit is due to its attractive colour ranging from crimson red to dark purple and its pleasing taste. The juice when extracted gives a deep crimson red to dark purple colour and is very popular. In addition, fruits are used for making excellent juice, squash, syrup and crush having cooling effect on the body (Boora and Bons, 2015; Pangotra *et al.*, 2018). Fruits contain 50-60 per cent juice and edible part of the fruits varies from 69-93 per cent. The juice is extremely refreshing and is considered to have a cooling effect especially in hot summer. The fruit is astringent and stomachic. It has been reported that when unripe, phalsa fruit alleviates inflammation and is administered respiratory, cardiac and blood disorders, as well as in fever reduction (Singh *et al.*, 2009).

Nutritional value

Fruits are low in calories and fat, and high in vitamins, minerals, fiber, antioxidants total phenolics, flavonoids, tannins and anthocyanins (Asghar *et al.*, 2008). The 100 g of phalsa fruit contains carbohydrate (21.1 g), fibre (5.53 g), protein (1.57 g), fat (<0.1 g), calcium (136 mg), iron (1.08 mg), phosphorus (24.2 mg), potassium (372 mg), sodium (17.3 mg), vitamin A (16.11 mg), vitamin B₁ (0.02 mg), vitamin B₂ (0.264 mg), vitamin B₃ (0.825 mg) and vitamin C (4.385 mg) (Yadav, 1999). Essential amino acids such as threonine and methionine are present in pulp and seeds, respectively, whereas phosphoserine, serine and taurine are the dominant amino acids in juice. The pulp contains higher concentrations of phosphoserine as compared to other free amino acids, while the hydrolyzed product contains aspartic acid, glycine, and tyrosine in large amount (Hasnain and Ali, 1988). Threonine has been found in pulp but was missing in seed extract, whereas methionine was present only in seeds, indicating that the presence of methionine in fruit juice would be the result of adulteration. Phosphoserine, serine, and taurine were the dominant amino acids in juice (Hasnain and Ali, 1992).

Medicinal value

Aqueous extracts of fruits showed significant anticancer activity against liver cancer and breast cancer. In traditional folklore medicine, the fruit has been used as astringent, stomachic and cooling agent. When unripe, it has been reported to alleviate inflammation and was administered in respiratory, cardiac and blood disorders, as well as in fever. Root and bark has been prescribed for rheumatism and its infusion is used as a demulcent. The leaves can be applied on skin eruptions. The plant has been reported to possess antioxidant, antidiabetic, antihyperglycaemic, radio-protective, antimicrobial, hepatoprotective, antifertility, antifungal, antilagesic, antipyretic and antiviral activities (Sinha *et al.*, 2015). Medicinal values of phalsa are due to the

presence of different metabolites like saponins, coumarins and anthraquinone (Sharma and Patni, 2013). Phalsa is reputed to cure upset of stomachs, some skin and intestinal infections, cough, fever, diarrhoea, dysentery, jaundice, rheumatism and have mild antibiotic properties. The plant preparations are used for the treatment of bone fracture and for bone strengthening. Their root and fruits are well known household remedy for the treatment of osteoporosis, tissue and wound healing (Sharma and Patni, 2013). They have free radical scavenging activities which may be responsible for the therapeutic action against tissue damage (Kshirsagar and Upadhyay, 2009).

10. Lasora (*Cordia myxa* L.)

Lasora is locally known as gonda, lasora or lehsua and belongs to family Boraginaceae. It is widely distributed in arid zone, mostly cultivated. It is a perennial, medium sized deciduous tree a short bole and spreading dense crown. Fruits are harvested at tender green immature stage for vegetable and are also used in pickles. Ripe fruits are also consumed. The floral buds and flowers are cooked as vegetable. It bears small sized fruits in bunches, used in traditional vegetable and pickles. Immature green fruits are used as vegetable and pickles. Sometime fruits are dehydrated after blanching to use as vegetable during off season (Singh, 2001). Being a multipurpose plant, it has long been associated with health, nutrition and other diversified uses in curing certain human ailments (Chandra and Pareek, 1992).

Nutritional value

The most important nutrients present in plants are carbohydrates, oils, proteins, minerals, ascorbic acid, and the antioxidants phenols, such as chlorogenic acid and its polymers (Spiller, 2001). Its fruit contains protein (2%), carbohydrates (92%), fat (2%), fibre (2%), phosphorous (275 mg/100g), calcium (55 mg/100g), iron (6 mg/100g), zinc (2 mg/100g), manganese (2 mg/100g) and energy (394 Kcal/100g) (Chandra *et al.*, 1994). Fruits are considered as one of richest natural sources of antioxidants *i.e.* carotenoids, ascorbic acid, phenols *etc.* Fruits are important sources of minerals, fiber and vitamins, which provides essential nutrients for the human health (Mala, 2009).

Medicinal value

Numerous natural substances existing in lasora have demonstrated promising roles in treatment and management of various forms of cancer, diabetes, degenerative disorder, and ulcerative colitis. They have activities of antimicrobial and antifungal, analgesic, antibacterial and cytotoxic, anthelmintic, gastroprotective and antiulcer, anti-inflammatory, anti-implantation, and wound healing (Inas *et al.*, 2011; Prasad *et al.*, 2013). Fruits are used for the treatment of infections of urinary tract, diseases of the lung and spleen, and as an astringent, anthelminthic, diuretic, and demulcent agent (Farida *et al.*, 2001). Because of its mucilage content, the plant fruits have been used as expectorant and emollient in treatment of cough and some respiratory problems (Rechinger *et al.*, 1997).

Promotion of arid zone fruits

A great deal is known about the virtues of the underutilized fruits of Rajasthan, but unfortunately very few of these fruit crops have ended up in farmer's orchards. They can contribute to food security, health or energy needs of people. Promotion of their cultivation and conservation is hence essential. Being local crops and harvested from the wild or found in the home gardens, they are easily available and thereby provide food security to the people.

Conclusion

Arid zone fruits play an important role in the food and nutritional security and possess medicinal properties. These fruits are the future for horticulture of 21st century as this offer a variety of potential benefits in profitability, productivity, sustainability, crop quality, food safety, environmental protection and rural economic development. A large proportion of rural population depends on locally available fruits to meet their dietary requirements. These fruits are known for their typical flavour and taste. These fruit crops have their own history of consumption. Local people are well aware of their nutritional and medicinal properties. Consumers today are increasingly conscious of health and nutrition, and there is a tendency to avoid chemicals and synthetic foods, thereby choosing natural foods. In this context, arid fruits have unlimited potential in their processed form. Most of the indigenous fruits have only a few specified varieties. Therefore, their improvement and development of ideal propagation methods and agro-techniques should also be adopted. Appropriate process technology needs to be developed to popularise these fruits. The promotion for setting up of processing industries (jams, jellies, fermented products etc.) for manufacturing of resins, gums etc. and lifestyle (e.g. cosmetics) should also be encouraged. Most of them can be grown even in wastelands without much care. Therefore, it is worthwhile to look into the organized cultivation and improvement of under-utilized crops, so that their utilization can be maximized and variety of value added products can also be prepared from them as explained above. These neglected and underutilized crops are essential to the livelihoods of millions of poor farmers throughout the world.

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