

Indian arid zone miracle plants for food and livelihood security

Dheeraj Singh*, Chandan Kumar, M.K. Choudhary and H.R. Mahla

ICAR- Central Arid Zone Research Institute -Krishi Vigyan Kendra, Pali-Marwar-306 401, Rajasthan, India

*Email: dheerajthakurala@yahoo.com

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Abstract

*Developing countries are being encouraged to diversify their food exports by developing new products and adding more value to existing products. Adding value to and diversifying food exports depends not only on changing production but also processing system. The traditional Indian arid fruits are very rich in nutritional parameters and a variety of by products can also be prepared from them. As consumers today are increasingly conscious of health and nutrition, there is a tendency to avoid chemicals and synthetic foods, thereby choosing natural foods. In this context, underutilized fruits have unlimited potential in fresh and processed form for their therapeutic, medicinal and nutritive values. A number of species are already being used and marketed as antioxidants, staple food, food supplements and sources of condiments, spices, thickening agents, flavours, edible oil, etc. Some of the underutilized fruits and nuts are rich sources of vitamin C, proteins and Vitamin A. They contain pectin and celluloses, which stimulate the intestinal activity and protect human body against diseases. Value of underutilized fruits in traditional medicines is well known as a major source of raw materials for drugs since antiquity. In India, the fruits of *Embllica officinalis* (aonla), *Terminalia chebulla* (harar) and *Terminalia bellerica* (bahera) are the most common, entering into 219 patented drugs.*

Keywords : Underutilized fruits, vitamins, food supplement, livelihood, food security.

INTRODUCTION

Underutilized fruits provide food, nutrition, and substances to tile native communities and are an additional source of income. Though the wild and domesticated diversity is composed of nearly 3000 tropical fruit species, only a few have been cultivated on large scale (Vietmeyer, 1990). The global scenario indicated that worldwide about 600 tropical, and sub tropical species are better known in their areas of diversity (Negy and Shaw, 1980). Many fruit species have not yet been utilized to full potential inspite of their economic value. The role played by underutilized species is indeed central to reducing poverty and empowering the poor so as to allow poor rural communities to pursue resources-based rather than commodity-based development. But the people who benefit from underutilized species in a globalized world are not just for the poor. The benefits in terms of more balanced diets, diversified income to farmers as well as related sectors of the society, better maintenance of agro-ecosystems and greater use of marginal lands along with enhanced preservation of cultural identity (Padulosi, 1999) can be shared by all the humankind.

An attention to the minor fruits can play a significant role in increasing the income, providing

employment opportunities, uplifting of the poor, small and marginal farmers and the development of value added products. Increased reliance on major food crops has been accompanied by a shrinking of the food basket which humankind has been relying upon for generations (Prescott and Prescott, 1990). Although 'hidden hunger' affects mainly developing countries, particularly children and older people (FAO, 1997), it is increasingly being recorded also among the more vulnerable social groups in developed nations. If the 20th Century witnessed the undertaking of systematic collecting to rescue the genetic resources of staple crops (Pistorius, 1997) the 21st Century has started with the awareness on the need to rescue and improve the use of those crops left aside by research, technology, marketing systems as well as conservation efforts.

These underutilized crops (referred to also by other terms such as minor, orphan, neglected, underutilized, underexploited, underdeveloped, lost, new, novel, promising, alternative, local, traditional, niche crops) have been included in world-wide plans of action after having successfully raised the interest of decision makers. Leading international research organisations such as the Consultative Group on International

Agricultural Research (CGIAR) are also among those taking a keen interest in strengthening the work on these species (Swaminathan, 1999). This global “opening” towards underutilized species is the result of a gradual change of attitude towards biodiversity and plant genetic resources by many countries. The Global Forum on Agricultural Research (GFAR) in 1999 also emphasized the role of underutilized species in raising income of the rural poor. Hence, diversifying production and consumption of underutilized fruits can therefore contribute significantly to improve health, income generations and ecological sustainability. In nutshell, use of underutilized fruits has a vital role in imparting nutritional security to people. The father of green revolution, Dr. M.S. Swaminathan has also rightly stated that “Fruits and vegetables are the food of the future” (Kurian and Peter, 2007). This paper addresses aspects related to composition, nutritional value, processing and utilization of some of the neglected and underutilized fruits of origin.

India (Hindustan), the centre of origin for many tropical fruit tree species, (Table 2) most of which are not commercially cultivated but provides significant source of livelihood support for many rural communities. Attention to underutilized species may also originate from considerations that are not directly related to food security or poverty alleviation, but to the need to safeguard artistic, landscape and cultural values of these species.

Fruits are important in the human diet, as they act as:

As a source of food: Arid and semi-arid zone vegetation comprises a wide range of edible fruit-bearing and food-producing species: *Tamarindus indica*, *Ficus spp.*, *Manilkara spp.*, *Aegle marmelos*, *Beehannan lanzan*, *Grewia asiatica*, *Salvadora oleoides*, *Balanites aegyptiaca*, *Cordia spp.*, *Ziziphus spp.*, *Prosopis cineraria.*, *Capparis decidua*, *Salvadora persica* 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 (Rathore, 2009).

The highest energy available is from tamarind pulp (142 calories) with low moisture and high carbohydrate (34g) content, while *A. squamosa*

supplies half the energy, but has 70.5% moisture and 11.8g carbohydrates (Table 4). On the dry basis, the energy content will be 127, 178 and 179 cal. and carbohydrate content of 45, 40 and 43g for dates, seethaphal and tamarind pulp, respectively. In fact, on the dry basis there is not much difference between the various fruits. Fibre provides good motility to intestine, which helps the digestive process. Most of these fruits are good source of fibre with *Ficus spp.* having the highest amount (3.2 to 5.0 g).

As a Source of nutrients: The tribal people of arid zone are severely malnourished along with multiple nutrient-deficiency disorders due to ignorance about importance of fruits and vegetables in their diets. The tribal areas are full of biodiversity having natural vegetation which is not harnessed fully. Due to which a wide gap is formed between health and optimal use of natural sources of nutrients, i.e., underutilized crops. As underutilized fruits, nuts, and vegetables are rich of source of carbohydrate, fat, protein, energy, vitamins-A, B₁, B₂, B₃, B₆, B₉, B₁₂, C, folic acid, and minerals-Ca, P, Fe, and dietary fiber. Thus, they have the nutritional capacity to prevent and cure various diseases like kwashiorkor, marasmus, night blindness, anaemia, diabetes, cancer, hypertension, and hidden hunger. Underutilized fruits contribute significantly in maintaining tribal population nutrition, especially as very good source of vitamins {ascorbic acid (vitamin C), carotenoids (vitamin A), thiamine (vitamin B₁), riboflavin (vitamin B₂), niacin (vitamin B₃), pyridoxine (vitamin B₆), folacin}, minerals, fat, protein and dietary fibre. Some underutilized fruits like wood apple (7.10 mg100gm-1 pulp) are very good source of protein, tamarind (17.01 mg100gm-1 pulp) and karonda (39.14mg100gm-1 pulp) are richest source of iron, kumquat (2575 IU) and drumstick (190 IU) are excellent source of vitamin A, aonla (500-625 mg100gm-1pulp), ber (39-166 mg100gm-1 pulp) and Chinese jujube (188-544 mg100gm-1 pulp) are good source of vitamin C, wood apple (3.70-3.75 mg100gm-1 pulp) have good amount of fat, bael (31.80 mg100gm-1 pulp), tamarind (67.40 mg100gm-1 pulp) and date palm (70 mg100gm-1 pulp) are very good source of carbohydrate.

Underutilized fruits such as ber, bael, ker, khejri pod and jamun are more nutritious than other

Table 1: Major regions of diversity and domestication of less known/ underutilized fruits and nuts.

Region/ Category	Less known edible types		Species diversity/distribution
	Fruits	Seeds/ nuts	
Tropical/ Subtropical			
Indo-Chinese-Indonesian	61	14	Maximum diversity occurs in humid tropical/ subtropical species
Chinese-Japanese	50	18	Maximum diversity occurs in subtropical and temperate species
South American	69	12	Maximum diversity occurs in humid tropical species
Central American	36	8	Rich diversity
Hindustan (India)	17	11	Rich diversity in humid tropical species; also of species adapted to drier/ moist tropical/subtropical/ temperate climate
African	13	21	More diversity in types adapted to subtropical/tropical dry-moist climate; relatively very low proportion of cold adaptable types
Temperate/Subtropical			
North American	38	4	Diversity suited more to colder climate pome, stone and soft fruits
European-Siberian	14	6	More diversity in types adapted to very cold conditions; pome and stone fruit/several nuts
Mediterranean	5	7	Diversity in subtropical and temperate species including cold adaptable types
Central Asian	19	4	Diversity in subtropical/ temperate fruits; more in pomes and stone fruits
Near Eastern	13	10	Diversity in subtropical/ temperate fruits and nuts
Australian	4		Diversity limited, largely in humid tropical/ subtropical species

Source: Arora (1985)

commercial fruits. Ker (*Capparis deciduas* (Forssk.) Edgew) also a underutilized fruit of Rajasthan is very good source of protein (4.24 gm), fat (2.0 gm), fibre (4.24 gm), carbohydrate (18.2 gm), energy (107 Kcal) and vitamin C (50 mg) in 100 Gm⁻¹ of fresh fruit. The unripe green pods of khejri (*Prosopis cineraria* (L.) Druce) commonly known as sangri are very good source of digestive protein (5.1 gm), fiber (6.7 gm), carbohydrate (14.15 gm) and energy (82 Kcal) in 100 Gm⁻¹ of fresh pods. A good balanced diet should supply sufficient amount of the major nutrients protein, fat and carbohydrate and the minor constituents-

vitamins and minerals. Minerals and vitamins are largely supplied by the fruits and vegetables. Although most of the common fruits are low in protein, some of the underutilized fruits and nuts are rich sources of vitamin C, protein and Vitamin A. Ker (*Capparis decidua* (Forsk.) Edgew) of the family capparidaceae, is one of the prominent wild flora of the arid zone of India. Its immature fruits contain 8.6 and 5 percent crude and true proteins respectively, besides the minerals immature acid fruits are used for making vegetable and pickle.

Arid zone vegetation comprises a wide range of edible fruit bearing and food producing species viz.

Table 2: Some Promising/ potential underutilized fruits and nuts from different regions of diversity:

Region	Fruits
Indochinese-Indonesian	<i>Artocarpus altills</i> (Breadfruit), <i>Averrhoa carambola</i> (Carambola), <i>Citrus grandis</i> (Pummelo), <i>Diospyros discolor</i> (Velvet apple), <i>Garcinia mangostana</i> (Mangosteen), <i>Mangifera foetida</i> (Horse mango), <i>Mangifera odorata</i> (Kuwini mango), <i>Syzygium</i> spp.
Australian	<i>Inocarpus fragifer</i> (Tahiti chestnut), <i>Macadamia integrifolia</i> (Macadamia nut), <i>Santalum acuminatum</i> (Quandong), <i>Terminalia catappa</i> (Indian almond), <i>Terminalia kaernbachii</i> (Okari nut).
Hindustan	<i>Aegle marmelos</i> (Bael), <i>Artocarpus lakoocha</i> (Monkey jack), <i>Borassus flabellifer</i> (Palmyra palm), <i>Buchanania lanzan</i> (Chironji), <i>Capparis decidua</i> (Ker), <i>Carissa congesta</i> (Karonda), <i>Citrus medica</i> (Citron), <i>Dillenia indica</i> (Elephant apple, Chalta), <i>Embllica officinalis</i> (Aonla), <i>Feronia limonia</i> (Wood apple), <i>Garcinia indica</i> (Kokam), <i>Madhuca indica</i> (Mahua), <i>Manilkara hexandra</i> (Khirni), <i>Porkia roxburghii</i> (Tree bean), <i>Phoenix sylvestris</i> Roxb (Date sugar palm), <i>Prosopis cineraria</i> (Khejri), <i>Syzygium cumini</i> (Jamun), <i>Ziziphus mauritiana</i> (Indian jujube), <i>Zizyphus nummularia</i> (Jharberi).
Central Asian	<i>Morus nigra</i> (Black mulberry), <i>Pinus gerardiana</i> (Chilgoza nut), <i>Pistacia vera</i> (Pistachio nut).
Near Eastern Mediterranean	<i>Punica granatum</i> (Pomegranate).
African	<i>Argania sideroxylon</i> (Argan tree).
African	<i>Adansonia digitata</i> (Monkey bread), <i>Annona senegalensis</i> (Wild custard apple), <i>Balanites aegyptiaca</i> (Desert date), <i>Carissa grandiflora</i> (Natal plum), <i>Garcinia livingstonei</i> (African mangosteen), <i>Phyllanthus acidus</i> (Otaheite gooseberry), <i>Tamarindus indica</i> (Tamarind).
European-Siberian	<i>Corylus colurna</i> (Turkish filbert), <i>Hippophae rhamnoides</i> (Seabuckthorn).
South American	<i>Anacardium giganteum</i> Hancock ex Engler (Wild cashew), <i>Annona cherimola</i> Mill. (Cherimoya), <i>Carica candamarcensis</i> Hook.f. (Mountain papaya), <i>Carica pentagona</i> Heilb. (Babaco), <i>Passiflora edulis</i> (Purple granadilla).
Central American and Mexican	<i>Annona diversifolia</i> Safford (Ilama), <i>Annona purpurea</i> (Soncoya), <i>Pithecellobium, dulce</i> (Manila tamarind), <i>Annona reticulata</i> (ramphal), <i>Annona muricata</i> (Soursop), <i>Malpighia glabra</i> (Barbados cherry), <i>Pereskia aculeata</i> (Barbados gooseberry).
North American	<i>Annona atemoya</i> (Atemoya), <i>Juglans cinerea</i> (Butternut).

Source: Pareek and Sharma 1993

Capparis decidua (Ker), *Cordia dichotoma* (lasoda), *Ziziphus mauritiana* (ber), *Zizyphus 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 undervalued and underutilized as more exotic fruits become accessible. Amongst fruits, Table 6 Aonla (300 mg) is the best source of vitamin C. Ber (38 mg), Cape gooseberry (25 mg) and Mahua (20 mg) comes next with values comparable to that of citrus fruits (Singh,1990). Fruits like Cape gooseberry (714 µg), Loquat (280 µg), Khirni (248 µg) and Phalsa (210 µg) are rich in carotene. Pilu (Bara jal) or Toothbrush tree (*Salvadora aleoides* Decne)

Table 3: Flowering and fruiting time of arid underutilized fruits

Arid Fruits	Botanical Name	Flowering Time	Fruiting Time
Ber	<i>Ziziphus mauritiana</i>	Sept-October	Nov- February
Phalsa	<i>Grewia subineaqualis</i>	Feb- March	April-May
Custard apple	<i>Annona squamosa</i>	July-August	Sept-October
Fig	<i>Ficus indica</i>	Feb-March	July- September
Pomegranate	<i>Punica granatum</i>	June- July	Dec-January
Khejri	<i>Prosopis cineraria</i>	Feb.- March	April- May
Aonla	<i>Emblica officinalis</i>	March- April	Nov- January
Sapota	<i>Achras zapota</i>	Oct- November	Jan-February
Karonda	<i>Carissa carandus</i>	Jan-February	May- June
Bael	<i>Aegle marmelos</i>	April- May	March-April
Mahua	<i>Madhuca latifolia</i>	March-April	May- July
Jamun	<i>Syzigium cuminii</i>	March-April	June- August
Chironji	<i>Buchanania lanzan</i>	Feb- March	May- June
Tamarind	<i>Tamarindus indica</i>	July-August	Feb.- March
Khirni	<i>Manilkara hexandra</i>	February - March	April- May
Kair	<i>Capparis decidua</i>	February - March	April- May
Lasura	<i>Cordia dichotoma</i>	February - March	April- May
Mulberry	<i>Morus spp.</i>	Dec- January	Feb- March
Pilu	<i>Salvadora aleoides</i>	March-April	May-June

Table 4: Comparison of Non conventional fruits with the traditional fruits

	Conventional fruits				Non conventional fruits				
	Apple	Oranges	Guava	Mango	Banana	Phalsa	Jamun	Bael	Khirni
Energy (Cal.)	59	48	51	74	116	72	62	137	134
Carbohydrate (g)	13.4	10.9	11.2	16.9	27.2	14.7	14.0	31.8	27.7
Fibre (g)	1.0	0.3	5.2	0.7	0.4	1.2	0.9	2.9	-
Minerals(g)	0.3	0.3	0.7	0.4	0.8	1.1	0.4	1.7	0.8
Calcium (mg)	10	26	10	14	17	129	15	85	83
Phosphorus (mg)	14	20	28	16	36	39	15	50	17
Iron (mg)	1	0.3	1.4	1.3	0.9	3.1	1.2	0.6	0.9
Carotene (øg)	0	1104	0	2743	78	419	48	55	495
Vitamin C (mg)	1	30	212	16	7	22	18	8	16
Thiamine (mg)	0.04	0.08	0.03	0.08	0.05	-	0.03	0.13	0.07
Riboflavin (mg)	0.03	0.03	0.03	0.09	0.08	-	0.01	0.03	0.08
Niacin (mg)	0.2	0.2	0.4	0.9	0.5	0.3	0.2	1.1	0.7

Source: Rathore, 2009

Table 5: Nutrient content of some important fruits from arid zone (50 g of edible portion of fruit)

Species	Moisture (%)	Energy (Kcal/g)	Carbohydrate (g)	Fibre (g)	Fat (g)	Protein (g)
<i>Tamarindus indica</i>	20.9	142	34	2.8	0.05	1.6
<i>Manilkara elangii</i>	54.7	80	18	2.2	0.50	0.9
<i>Phoenix dactylifera</i>	59.2	72	16.9	1.9	0.20	0.6
<i>Aegle marmalos</i>	61.5	68	15.9	1.5	0.15	0.9
<i>Manilkara hexandra</i>	68.6	67	13.9	-	0.20	0.3
<i>Feronia limonia</i>	64.2	67	9.1	2.5	1.85	3.6
<i>F. indica</i>	67.8	57	11.4	2.4	0.90	0.9
<i>Annona squamosa</i>	70.5	52	11.8	1.6	0.20	0.8
<i>Ficus bengalensis</i>	74.1	36	5.9	4.3	1.00	0.9
<i>Embllica officinalis</i>	81.8	29	6.8	1.7	0.05	0.3

Source: Pareek and Sharma 1993

Table 6: Vitamin content of some fruits (50 g of edible portion)

Fruits	Vitamin C (mg)	Carotene (µg)	Thiamine (µg)	Riboflavin (µg)	Niacin (µg)
Aonla	300.0	4.5	15	5	100
Timru	0.5	180.0	5	20	1150
Gular	2.5	81.0	30	25	300
Ber	38.0	10.5	10	25	350
Khirni	8.0	248.0	35	40	350
Phalsa	11.0	210.0	-	-	150
Mahua	20.0	154.0	-	-	-
Tamarind	1.5	30.0	-	35	350

Source: Singh, 1990

Table 7: Mineral content of certain fruits (50 g of edible portion)

Fruits	Mineral (g)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
<i>Tamarindus indica</i>	1.45	85	55	5.5
<i>Ficus religiosa</i>	1.15	145	45	-
<i>Cordia dichotoma</i>	1.10	20	30	-
<i>Manilkara elangii</i>	1.15	106	15	-
<i>Feronia limonia</i>	0.95	65	55	0.3
<i>Aegle marmelos</i>	0.85	43	25	0.3
<i>Bcehannan lanzan</i>	0.85	39	14	-
<i>Ficus tunia</i>	0.80	94	20	-
<i>Grewia asiatica</i>	0.55	65	20	1.6

Source: Pareek and Sharma 1993

Table 8: Medicinal values of some minor fruits

<i>Arid fruits</i>	<i>Medicinal value</i>
Bael	Cures dysentery, diarrhea, Appetizer, stomachic, cooling, restore vitality
Bullock's heart	Arthritis, bile disease, vomiting, weakness, anaemia, blood dysentery
Cordia	Anthiliniatic, diuretic, demulcent, and expectorant
Custard apple	Arthritis, bile disease, vomiting, weakness, anaemia, blood dysentery, Storehouse of Vitamin C acts as antioxidant, Vitamin A present is good for hair, eyes, healthy skin, rich source of dietary fibre so helps in digestion, expectorant, coolant, stimulant, haematinic
Emblica	Hemorrhage, diarrhea, dysentery, anemia, jaundice, dyspepsia and cough
Feronia	Antiscorbutic, used as liver and cardiac tonic and, when unripe, as a means to halt persisting diarrhea and dysentery and effective treatment for hiccup, sore throat, and diseases of the gums.
Phalsa	Blood purification, anemia, tonic and aphrodisiac, fruits allay thirst and burning sensation, remove and cure inflammations, good for heart and blood disorders, fevers and diarrhoea, for the troubles of throat. , cures urinary troubles , rheumatism.
Jamun	Cures Stomach ache, anaemia, improves haemoglobin in blood, Diabetes, Diarrhoea, Dysentery, Nocturnal emission, sores, ulcer, leucorrhoea and stone in kidney.
Kair	Cardiac trouble, useful in cough, asthma, inflammation, rheumatism, intermittent lever. Cures biliousness, asthma, inflammations, fever, cough, stomach pain, vomiting, arthritis, diabetes and hypertension, laxative
Karonda	Bleeding, kalajor, scabies, worm, Antiscorbutic, remedy of several diseases like biliousness, anemia and also used as aphrodisiac for women, antiparasitic, antifungal, antimicrobial, topical wound treatment (juice) and skin remedy
Khejri Pods	Help in blood purification, cures skin disease, respiratory problem and piles, cures ringworm infection, dyspepsia and fevers.
Khirmi	Cures anaemia, improves haemoglobin content in blood
Pomegranate	Leprosy, diarrhoea, dysentery, jaundice, bleeding, worm
Salvadora	Rheumatic pains, cough and purgative, root bark is vesicant, fruit is useful in cnlarge spleen and low lever. Helps in blood purification and digestion
Tamarind	Diarrhoea, paralysis, cold, dyspepsia, head ache, teeth ache, asthma, Useful in heart care and against stone, cure infections in urinary system
Wild date palm	Weakness, worm, heart disease, fever, stomach disease, weakness, diarrhoea, renal diseases, Supply instant energy, natural laxative, nicotinic content cures intestinal disturbances, checks growth of pathological organisms
Zizyphus	High potency, longevity, lofty thinking, blood purification and improves digestion

Source: Pareek and Sharma 1993

Table 9: Processed products from underutilized fruits

Product	Fruits
Jam	Jamun, Karonda, Aonla, Jackfruit, Aonla, Ber, Mulberry, Soursop, Tamarind, Wood apple, West Indian Cherry, White sapota, Star apple, Tree tomato, Brazilian grape, Surinam Cherry, Carambola, Natal plum, marula nut, seabuckthorn, tamarind and wood-apple.
Jelly	Tamarind, Jamun, Karonda, Imbu (<i>Spondias tuberosa</i>), Barbados cherry, wood-apple
Preserve	Ber, Ker, Sangri, Bael, Karonda, Soursop, Aonla, Palmyra palm
Candy	Aonla, Karonda, Tamarind, Ber
Glazed fruits/ Confectionary	Tamarind, Annanas, Aonla, Ber, Fig
Juice/Syrup/Sharbet/ Beverage / Squash	Aonla, Ber, Bael, Jamun, Karonda, Phalsa, Jujube, Mulberry, Pomegranate, Soursop, Wood apple, Tamarind, Natl plum, Seabuckthorn, Aonla
Wine	Jujube, Barbados cherry, Ber, Indian fig, Karonda,
Chutney	Karonda, Woodapple, Anola, Carambola,
Sauce	Karonda, Tamarind, Woodapple, Pomegranate,
Pickle	Jujube, Jackfruit, Tamarind, Ker, Lasoda, Carambola, Gonda (<i>Cordia</i>),
Dehydration	Aonla, Karonda, Ker, Bael, Ber, Custard apple, Wild apricot, Indian jujube, Indian fig, Karonda, Mulberry, Phalsa, Siberian crab apple, Peach, Plum, Longan
Frozen Puree	Bael, Karonda, Phalsa, Tamarind, Custard apple
Canning	Aonla, Ber, Ker, Prickly Pear, Karonda

Source: Ghosh, 2000

Table 10: Underutilized fruit crops and Waste lands

Waste lands	Suitable underutilized crops
Degraded forest lands	Custard apple, Indian jujube, Kair, Bael, Anola, Tamarind, Fig, Jamun,
Sandy Waste land	Ber, Bael, Bullock Heart, Custard apple, Kair, Pilu
Gullied and runoff area	Jamun, Ber, Custard apple, Mulberry, Tamarind, Rayan
Salt affected lands	Ber, Date palm, Jamun, Mulberry, Rayan, Pilu
Industrial waste land	Jamun, Tamarind, Ber, Custard apple, Phalsa
Undulated upland	Custard apple, Jamun, Aonla, ,Phalsa, Pilu, Gonda, Kair
Degraded pasture, and grazing land	Aonla, Tamarind, Jamun, ,Kair, Fig

Source: Pareek and Sharma 1993, Singh and Singh 2011, Singh *et al.*, 2012

belongs to the family Salvadoraceae its fruit is sweet in taste, eaten fresh and sweet pulp contains 1.7-1.86% glucose, fructose and sucrose and are used by villagers to prepare squash. Fermented drinks are also made from fruits (Rathore, 2009).

Calcium, phosphorous and iron are the major mineral constituents required by the human body in addition to sodium and potassium. Most of the requirement can be fulfilled by vegetables, but inclusion of fruits makes further addition of calcium and phosphorus responsible for the growth of bones. The amount of minerals in 50 g of the edible portion of the fruit is presented in Table 7.

Highest mineral content is present in *T indica* (1.45g) followed by *C. dichotoma*, *M. elangii* and *F. religiosa*. All fruits except *C. dichotoma*, *M. oleifera*, *B. arundinacea* have higher iron content than the other fruits listed here. It is also higher than that present in apricot and peaches.

As a Source of medicine: These fruits have been a major source of raw materials for drugs since time immemorial and had provided a number of products used in traditional medicines. Today, for instance, an increased interest is recorded among national and international research organisations towards medicinal and aromatic species in view of their role in improving the health of poor and their contribution to combat poverty through income generation. In India, the fruits of *Emblica officinalis* (aonla), *Terminalia chebulla* (harar) and *T belliricaria* (bahera) are the most common, entering into 219 patented drugs. *Aegle marmelos* (bael) is used in 60 drugs (Khurdiya, 2001). The demand for products threat enters into the manufacture of popular medicines for common ailments find home remedies in truly large. "Chyavanpras" based on *Emblica officinalis* (aonla) is other excellent example. Ker (*Capparis deciduas* (Forsk.) Edgew.) tender branches and leaves are used as a plaster for boils and swellings and to relieve toothache on chewing. Its stem bark is used as a laxative, diaphoretic and anthelmintic. Lasoda (*Cordia myxa* L.) fruit has anthelmintic, diuretic, demulcent and expectorant properties. Bael (*Aegle marmelos*) pulp contains marmelosin which acts as a laxative and diuretic and in strong doses as cardiac depressant. Jujube (*Zizyphus mauritiana*) fruits are used as an ingredient in the preparation of "joshanda" (an

ayurvedic medicine used in chest trouble), jamun seeds in diabetes and black mulberry in docking of AIDS virus on human cells (Anon, 2006). Fruits of prickly pear and their products help in treating diabetes, high blood cholesterol and obesity (Hegwood, 1990). They contain pectin and celluloses, which stimulate the intestinal activity and protect human body against diseases. Jharber (*Zizyphus nummularia* (Burm. f.) bark is used as ointment for foul sores and scabies. Value of underutilized fruits in traditional medicines is well known (Ali and Rab, 2000). These have been a major source of raw materials for drugs since antiquity and have provided bulk of products used in the traditional system of medicine (Ogle and Grivetti, 1995).

As a source of raw material for processing industry: The galaxy of underutilized fruits available in the tropical and subtropical world desperately needs to be popularised. Many of these fruits are highly perishable and not possible to keep them for more than 24 hours under ambient conditions. Some of them are not easy to eat out-of hand because of the hard shell, mucilaginous texture and numerous seeds; as a result these are is not popular as a dessert fruit. A few of the fruits are not acceptable as a fresh fruit because of its high acidity content and strong astringent taste. However, these fruits have unlimited potential in the processed form and consumers all over the world can get the opportunity to enjoy the fruits in the form of their products. Several under-exploited fruits provide raw material for processing industry. Commercial production of food products from under-exploited fruit species has helped to reduce wastage and promote widespread marketing of these items (Pareek and Sharma 1993). A number of products that could be produced commercially from under-exploited plants are listed in Table 9.

As a source of fodder: Jharber (*Zizyphus nummularia* (Burm. f.) fruits are small in size and edible. Its leaves contain appreciable amounts of nutrients and minerals and form the most valuable fodder for camel, goats and cattle fodder during November-December months. Lasoda (*Cordia myxa* L.) fruits are rich in minerals and the leaves are used for making pattal (trays) and as fodder. Phalsa leaves are also very much used as fodder for small ruminants.

Underutilized fruit crops for Ecological/ Environmental Conservation: The increased demand for food, clothing and shelter arising out of the population growth had its adverse effects on the environment of tropical regions. A vast area has been denuded and has deranged the delicate environment balance at micro level. Due to unprincipled removal of the forest trees and setting of industries and buildings there is major degradation in the environment conditions necessary for well beings of flora and fauna. Many of the underutilized and unexploited fruit species can tolerate heavy rains, drought, shallowness of soil profile, hot as well as wet soil and summer hardness, so can be grown in different types of Waste lands.

Industrial use of oils, fats and essential oils

Sources of plant products: Products from underutilized fruits can generate substantive income for the rural and tribal people. Small scale forest based industries can serve as a source of income especially for rural landless people in developing countries. Raw materials can be collected from the forest and supplied to these industries which have significant potential for improvement to develop commercially viable enterprises.

Sugars and sweetness: In arid zone of India palms are the oldest sources of crystal sugars and palm sugar is still considered important. Palm sugar and jaggery contains 12- 17 per cent sucrose (Rehm and Espig, 1991). Palmyra palm (*Borassus flabellifer*) yields 3-4 litres, toddy or kittul palm (*Caryota urens*) produces 7-14 liters of sap per day per inflorescence (Rehm and Espig, 1991). Wild date palm i.e. *Phoenix sylvestris* yields 20 tonnes sugar per hectare by trapping of trunk. Besides, major proportion of juice is commercially used for production of palm wine (toddy) from which vinegar or arrack is produced (Macmillan, 1991).

Starch: The average daily human energy need of 6.7 to 8.4 MJ can be provided by 400- 500 g starch which is generally met from cereals, roots and tubers. Seeds of water chestnut, breadfruit and tamarind are rich sources of starch. Sometimes palms such as *Caryota*, *Phoenix* and fruits of plantain are also used for starch production (Rehm and Espig, 1991).

Gums and resins: A number of underutilized fruits produce gums of good quality. *Sterculia ures*, a deciduous tree found in central India produces *Karaya* gum. It is used in textiles, cosmetics, cigar, paste and ice cream industries. Bael produces two distinct types of gums. Chirongi (*Buchnanian lanzan*) produces gums suitable for dressing textiles, tanning and for use in diarrhoea and inter costal pains. The trunk and branches of wood apple produces gums similar to gum Arabic (Macmillan, 1991). Tamarind gum is the major component of tamarind kernel powder and forms major component of thickening and stabilizing of foods. Trees of *Termanalia bellirica* also produce gums (Rehm and Espig, 1991). Indian gamboges tree (*Garcinia morella*) yield resin on tapping the bark. It is used as an additive to paint colour. It is a strong purgative in veterinary medicine. Resins are also used as fixative in perfume industry and for varnishes (Macmillan, 1991).

Essential oils and fats: Essential oils or volatile oils possess pleasant taste and strong aroma, The two principal groups of essential oils are the terpenes which are hydrocarbons and the oxygenated and sulphurated oils. They are used in toiletry, perfumery and food industry. About 100 peels of *Citrus aurantium* var. Bergamia yields 850 g of perfume bergamot oil. Unexpended flower buds of *Capparis spinosa* yields flavour oil (Rehm and Espig, 1991). Oils and fats from some of the underutilized fruits have potential for use as edible oils. These are also used as raw materials for production of soaps, paints, varnishes, hair oils, plastics, candles, pharmaceutical bases and lubricants. Mahua (*Madhuca indica*) seeds yield 51.1% fatty oil which contains 23, 15, 46 and 14 percent respectively of palmitic, stearic, oleic and linoleic acids, and traces of linolenic acid (Rehm and Espig 1991). It is used for cooking in some rural areas of central India, but is primarily used in the manufacture of soaps. Refined oil is used in the manufacture of fatty alcohol and lubricating greases. Tamarind seed oil is used for making varnishes, paints and burning oil lamps (Singh *et al.*, 2007). Kokam (*Garcinia indica*) seeds yield 23-26% of a valuable edible fat known in commerce as kokam butter. The oil is used as a vaseline and also for soap making. Kokam butter is rich in stearic and oleic acids and is used as

confectionery butter. It is also suitable for candle and soap manufacture.

Tannins, Dyes and colours: Jharber (*Ziziphus nummularia* (Burm. f.) bark of twigs and roots contain 12% tannin and is used for leather tanning. Fruits of harad (*Terminalia chebula*) contain 25-30 per cent tannins. Dried nuts of *Terminalia bellirica* are used for dyeing and tannin. Leaves of aonla and marking nut are used for tanning (Macmillan, 1991). Tamarind seed testa is used for tanning leather and imparting fast colour to the wools. Bark and leaves are used for tanning hides and dyeing (Singh et al., 2007). The plastid pigments (chlorophyll, carotenoids) being soluble in fats are used in fatty foods and cosmetic preparations. These can also be used in fat-free food stuffs with help of dispersing agents and emulsifiers (gums, starch derivatives). The pigments (Anthocyanins and betacyanins) are water soluble and use in drinks and confectionary industries.

Spices and condiments: Spices and condiments are used for flavouring foods, and as medicine, and in pharmaceutical, perfumery and cosmetic industry. Tamarind pulp is used for culinary preparations. These are used for flavouring foods and medicines and in perfumery, cosmetics and pharmaceutical industries. Pulp of Kokam is used to flavour other fruits. *Anaradana* i.e. dehydrated seed of *Punica granatum* is used for acidification of chutney and as a very prominent spice (Singh and Singh 2004).

CONCLUSION

Minor fruits play an important role in the security of food and nutrition. These fruits are known for their typical flavour and taste. 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, underutilised fruits have unlimited potential in their processed form. Appropriate process technology needs to be developed to popularise these fruits. Neglected and underutilized crops are essential to the livelihoods of millions of poor farmers throughout the world. As noted above, they are part of the (threatened) biological assets of the rural poor. In identifying research and development issues, which should be addressed, it is essential to approach the problem from this

perspective. The filiere concept can be considered an evolution of networking concept for plant genetic resources based on more efficient partnership and participatory approaches. The filiere would thus bring about greater participation of local actors to ensure the addressing of local needs properly. It would also ensure the wider representation and participation of stakeholders of food processing and marketing sector as well policy makers who have traditionally been left aside from PGR activities (Padulosi, 1999).

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