**Underutilised Fruits and Biotechnological Interventions for their promotion**

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**Abstract**

Global population is increasing; on the other hand, the natural resources are shrinking and degrading. To meet the ever intensifying demand for food and primary production, maximum is to be produced from minimum natural and non-renewable resources. Despite meeting food requirements there is need to produce nutritionally rich crops to combat malnourishment. India abounds with varieties of underutilized fruits. These are versed with the high medicinal and nutritional properties. So, increased production of underutilized fruits extending their growing season, self life with the help of biotechnological tools offers a major opportunity in India for nutritional security of large population.

**Key words:** Underutilised fruits, medicinal and nutritional properties, biotechnological tools.

World population is expected to reach 900 billion by 2050. Even today about 30% people on the planet are affected by malnutrition. 159 million children are reported to be stunted with low BMI due to lack of nutritionally complete diet. It is also estimated that globally about two billion people are deficient in one or more micro nutrients. Narrow food basket with inclusion of very few crop derivatives is the main reason behind the surging malnutrition among the human being. Widening food basket diversity is imperative to mitigate this issue. Neglected underutilised fruits and vegetables which were the important sources of food for mankind before dawn of civilization, appear to hold promise to overcome the malnutrition situation. Nowadays these fruits have market value but not widely grown in the field, thus rarely found in the market and referred as Underutilized fruits. Underutilized crops are lesser-known plant species in terms of marketing and research, but well adapted to marginal and stress conditions. Underutilized fruits have a huge potential to alleviate malnutrition in the challenging environmental conditions. Being tolerant to biotic and abiotic stresses, these fruit species are suitable for growing in the adverse agro climatic conditions too. Exploitation of underutilized fruit cops can become a solution to the social problem of nutrition insecurity, poverty and unemployment. This chapter aims to describe the importance of major underutilised fruit crops and scope of their improvement through bio-technological interventions.

**Aonla**

Aonla (*Phyllanthus emblica*, family Euphorbiaceae) is an important fruit crop grown in tropical and subtropical parts of India. It is rich source of vitamin, tannins and considered ‘’Wonder Fruit for Health’’. Aonla is a deciduous fruiting plant and second known richest natural source of vitamin C (ascorbic acid) contains 500-1500 mg of ascorbic acid per 100g of pulp, which causes its highly valued wider use in Ayurvedic medicine system. Its fruit contains potent anti-oxidant, anti-tumor, anti-microbial, anti-ulcerogenic, adaptogenic, and hepatoprotective qualities. Hence, used for treating chronic dysentery, diabetes, diarrhea, bronchitis, dyspepsia, jaundice, fever and coughs etc. Owing to its significant medicinal and nutritive value, it finds a prominent place in ancient Indian mythological literatures like Vedas, Askandhpuran, Shivpuran, Padma-puran, Ramayana, Kadambari, Charak Shanghita, Sushrut Shanghita, *etc*. and considered as Amrit Phal.

**Bael**

Bael (*Aegle marmelas*, family Rutaceae) is an important fruit of Indian origin. ). In Ayurveda, it is more commonly known as Bilva, its name in Sanskrit language. Bael has great medicinal, spiritual and religious significance. Bael is known for its great properties of keeping blood sugar levels under control for which it is being explored far and wide. It is also great for digestion and helps to keep the intestines healthy. Among the fruits it is considered richest source of riboflavin. Different parts of this herb are used for different purposes. It is very popular due to its medicinal and nutritional properties and it is regarded very beneficial in curing diarrhea and dysentery. The importance of bael fruit also lies in its curative properties, which make the tree one of the most useful medicinal plants of India.

**Ber**

Ber or Indian Jujube (*Zyziphus mauritiana*) belongs to the family Rhamnaceae, and native of India. Popular as poor man’s fruit it is one of the richest sources of nutrition. Fruits of ber contains fair amount of vitamin C, A, B Complex and also Ca, K, Br, Rb, La. Its fruits are used for preparation of various value added products like chutney, dried ber, murabba, jelly, wine etc. Decoction from root and bark is used for treatment of dysentery and diarrhea, whereas leaf decoction gives relief as gargle in sore throat and in bleeding gums. The roots powder of ber is beneficial for curing ulcer, wounds and fever. Secondary metabolites found in ber fruits like saponins, lignins, flavonoids, glycosides, sterols and phenols are reportedly effective against pathogens. The different parts of ber plant like root, bark, leaves, flowers, seeds are used for treatment of various diseases and also used as blood purifier and appetizer.

**Bullock’s heart**

*Annona reticulata* Linn a member of Annonaceae family, traditionally important plant used for the treatment of various oilments. Sweet, astringent, heart shape fruits with smooth rind and yellowish red colour, are useful in blood complaints. It has smooth seed, blackish in color. Traditionally the plant has been used for curing cardiac problem, dysentery, epilepsy, worm and parasitic infestations, dysuria, haemorrhage, bacterial infection, fever, constipation and ulcer. Its leaves contain insecticidal properties thus widely used for insect control in plants as well as animals. Bark of this plant is considered as a powerful astrigent and used as a tonic whereas leaves are used for the treatment of helminthiasis.

**Chironji**

Chironji (*Buchanania lanzan*, family Anacardiaceae), native species of Indian subcontinent. Seed’s nutritional composition depicts it as a potential source of fat, protein, energy and dietary fiber. Chironji is a good source of calcium, magnesium, iron and phosphorus. This fruit crop has high potential as commercial fruit species. Juicy and sweet fruits are used for preparation of various value added product like ready to serve (R.T.S.) drinks, squash and nectar after juice extraction. Chironji kernel contains about 52% oil, used mostly in cosmetic industry as substitute for olive and almond oils. Both medicinal and nutritional value of the fatty acids, phytosterols, polyphenols and stigmasterol found in seed extract has been well known.

**Custard apple**

Custard apple (*Annona reticulata* family Annonaceae) is an underutilized exotic fruit in India. It is a good source of minerals, natural antioxidants, phenolics compounds and moderate source of copper as well as manganese which protects us from cardiac disease and control our blood pressure. Fruits medium sized, flobular, green skin, conspicuous reticulation on surface, are considered to be great for eyes, and cures indigestion problems. Inclusion of this fruit in daily diet gives relief from constipation and helps to treat diarrhea and dysentery due to copper content.

**Fig**

Fig (*Ficus carica*, family Moraceae), highly nutritious fruit, was an important food crop in ancient civilization. Fruit contains iron, calcium, protein, thiamine and vitamin A at varying concentrations and highest fiber as well as high calories. Nutritive index of fig is 11 whereas for apple, raisin and dates it is 9, 8 and 6 respectively. Fig is a multiple fruit that develops from an entire inflorescence. It is consumed fresh, dried, preserved candied or canned. Fresh fruits are used as dessert or for making jam, jelly, cakes, pudding etc.

**Grape fruit**

Grape fruit (*Citrus paradise*, family Rutaceae) has been used as a traditional medicine in many countries as antifungal, antibacterial, antimicrobial, antiinflammatory, antioxidant, and antiviral, preservative and astringent. Fruits bear in cluster with pink to red flesh contains high levels of vitamin C, folic acid and potassium. It has also been used for prevention from cancer, lowering cholesterol, cellular regeneration, detoxification, lupus nephritis, heart health maintenance, rheumatoid arthritis and weight loss.

**Jack Fruit**

Jack fruit (*Artocarpus heterophyllus*, family Moraceae) indigenous crop of India, have a distinctive, sweet and fruity aroma. Its evergreen tree bears the largest edible fruit in the world, seeds are also relished as nutritious nuts when boiled or roasted and eaten or cooked in dishes. Despite its uses as a table fruit as well as vegetable purpuse, jack is a popular fruit for making pickles, sweets and thin round papad, canned jackfruit pieces, syrup, jam, jelly and candy. The fruit contains carbohydrate, protein, fibre, fat, calcium, phosphorus, iron, carotene, thiamine, riboflavin, niacin and vitamin C in various concentrations. In traditional medicine system whole jack fruit tree is used for treatment of various diseases. Secondary metabolites present in jack have biological activity, thus when eaten, it replenishes energy and revitalizes the body instantly. Jackfruit is rich in dietary fiber, which makes it good bulk laxative. Vitamin A content of Jackfruit is useful for maintaining integrity of mucosa and skin which helps to fight wrinkles, getting a glowing complexion and flawless skin. Jack seeds promote healthy blood circulation, provide healthy digestion and considered very beneficial in hair growth. Traditionally, jackfruit is used in healing ulcers when ash of jackfruit leaves, burned with corn and coconut shells, is used alone or mixed with coconut oil to it.

**Jamun**

Jamun (*Syzygium cumini*, family Myrtaceae) is important underutilized fruit crop, found in most of the states in neglected areas, forest, marshy lands and roadside plantations. The fruit has very high nutritive value. The gallic and ellagic acid content present in seed minimize blood glucose level by converting starch into sugar. It is also effective in the treatment of inflmmation, ulcers and diarrhea. High anthocyanin content of Fruit pulp can be a good source of natural food colorants for the food processing industries. The vinegar from slightly unripe jamun juice is diuretic, stomachic and carminative.

**Jujube**

Jujube (*Ziziphus jujube*, family Rhamnaceae) is a plant of great nutritional and medicinal value, which is most suitable fruit for arid and semi-arid regions. Its fruits are rich source of Vitamin C, A and B-complex. Because of secondary metabolites and phenolic compounds like alkaloids, terpenoids, flavonoids, pectin, triterpenoic acid, saponin and lipids ber has excellent medicinal properties. Fruits have hemolytic, sedative, anxiolytic and sweetness inhibiting properties. Ber fruits can also be used for making chutney, dried ber, murabba, jelly, wines etc. The root and bark decoction is good for treatment of dysentery and diarrhoea, whereas leaf decoction is useful as gargle in sore throat and bleeding gums. The seed kernels are aphrodisiac.

**Karonda**

Karonda (*Carissa carandas*, family Apocynaceae) Indian native fruit taste is sour and astringent. It is very rich source of iron as well as contains a good amount of vitamin C, protein, fat, carbohydrates, calcium and fibre. Karonda fruits are processed to prepare jelly, sauce, Carissa cream or jellied salad, pickles and chutney. Dried karonda fruits may act as a cheap substitute for raisins. Antiscorbutic karonda fruit is considered very useful in curing anaemia and stomach ache. Root extracts this plant are used in lumbago, chest complains and venereal diseases. Karonda fruits are traditionally used for treatment of malaria, nerve disorder, relieve of pain and fever, headache, blood purifier and leprosy.

**Khirni**

Khirni or Rayan (*Manilkara hexandra*, family Sapotaceae) with Indian origin is a socio-economically important underutilized fruit species of western- central India. A commercially and medicinally important tropical tree species, also a significant nutritional and livelihood source for tribal population of many areas. Mature khirni fruits have good economic value due to sweet taste and a good source of minerals, sugar, protein, carbohydrate and vitamin A. Bark and fruits are used for treatmant of ulcers, dyspepsia, opacity of the cornea, bronchitis, urethorrhea, leprosy etc.

**Kokam**

Kokam (*Garcinia indica*, family Guttiferae) mostly found west coast of India, as well as in some extent in the forests of eastern states. The fruits contain citric acid, acetic acid, malic acid, ascorbic acid, hydroxyl citric acid and garcinol. Bioactive compounds present Kokam fruit contains antioxidant, anti-bacterial and antifungal properties. It is effective against several cancer cell lines, including breast cancer, liver cancer and leukaemia. Kokam has been utilized as a medicine for diarrhoea treatment, skin infection and wounds healing since ages. Dried kokam fruit rinds are used in cooking for adding sweetish-tangy flavour to the food.

**Lasoda**

Lasoda or Indian cherry, (*Cordia* mixa, family Boraginaceae), is grown in all over plains and plateau regions of India. Immature fruits of Lasoda are used as vegetable and for preparing pickle. Fruit is pulp good source of protein, lipid, crude fiber, carbohydrates and ascorbic acid. The fruit is naturally rich source of antioxidants, minerals, crude fiber, protein, ascorbic acid, ash and vitamins. It improves digestion, act as anti-tumor, anti-helmentic, diuretic, demulcent and expectorant as well as improve hair growth.

**Mahua**

Mahua (*Madhuca longifolia*, family Sapotaceae), a multipurpose tree, fulfil three fundamental needs of tribal culture i.e. food, fodder and fuel. Flower of plant are edible and have high nutritive as well as economic importance. Mahua flowers are rich source of sugar and subsequently having good amount of vitamins, proteins, minerals and fats. High sugar content in flower makes it suitable to act as a sweetener in preparation of numerous traditional dishes. Mahua flowers are considered as to be cooling agent, carminative, galactagogue and astringents in Ayurveda. It is also beneficial for heart, skin and eye diseases.

**Tamarind**

Tamarind (*Tamarindus indica*, family Leguminosae) has wide range of adaptability, and it is an ideal tree for avenue plantation and agro-forestry systems. It bears terminal and lateral drooping bisexual flowers and forms fruit as pendulous pods. Tamarind fruit pulp and seeds are rich source of tartaric acid and have good amount of reducing sugar, tannin, pectin, cellulose, fiber, potassium, calcium, phosphorous and other minerals. The fruit pulp is used for souring sauces, curries, chutneys, beverages, food colorants and it is considered a great delicacy. Parts of tamarind plant are valuable for food, fodder, timber, fuel, textile, nutritional and pharmaceutical industries. It is used as a refrigerant, carminative, antiscorbutic and laxative.

**Passion Fruit**

Passion fruit (*Passiflora edulis*, family Passifloraceae) native to tropical America is a perennial, vigorous, climbing, woody vine, produces round or ovoid fruits. It produces fruits with smooth waxy dark purple or yellow rind having faint, fine, white specks. Fruit contains orange pulpy juicewith numerous small, hard dark brown to black pitted seeds. Fruit juice possesses unique flavour and aroma suitable for fresh consumption and processing with high nutritional and medicinal properties. Passion fruits are fair to good source of provitamin A, ascorbic acid, riboflavin and niacin and have high minerals content such as sodium, magnesium, sulphur and chloride. The fruit pulp added to fruit salads, ice-cream or fruit juice as well as other processed products like juice, jelly, jam, squash etc.

**Phalsa**

Phalsa (*Grewia asiatca*, family Tiliaceae) is a highly perishable summer season fruit crop originated in India. The fruit of phalsa is mostly used to eat fresh as dessert or processed into ready to serve drink, squash, syrup and pickles. It is considered as rich source of vitamin A, B and C, as well as minerals, protein and carbohydrates. Phalsa fruit is having various medicinal properties like treatment of respiratory and cardiac problems, blood disorders, inflammation, fever, nausea, vomiting, morning sichness, motion sickness, pustules and eruptions, etc .

**Star fruit**

Star fruit or carambola (*Averrhoe carambola*, family ) is native to Sri Lanka and also referred as five corner fruit. The fruit color ranges from greenish yellow to yellow and is crisp and tart in taste due to oxalic acid content. Carambola fruit is an extremely low-calories fruit that is rich in dietary fibre, reducing sugar, ascorbic acid and minerals. It has high amount of antioxidants like polyphenolic compounds, quercetin, gallic acid and epicatechin. Sweet type of fruits can be eaten fresh and sour type used for pickle, tamarind substitute or refreshing drinks. Fruits are also used for preparing good quality squash, jelly, preserve and candy.

**Sour sop**

Sour sop (*Annona muricata*, family Annonaceae) is an evergreen plant that is mostly distributed in tropical and subtropical regions of the India. The fruits of annona muricata are very large, dark green, surface outlined in rhomboidal areas with short fleshy spine and juicy, white, woolly pulp. Fruit pulp extensively used to prepare syrups, candies, beverages, ice creams and shakes. It is used as natural medicine for arthritic pain, diarrhea, dysentery, neuralgia, arthritis, fever, rheumatism, skin rushes parasites and worms. Fruits are also eaten to elevate a mother’s milk after child birth. The leaves are used to treat cystitis, headches, diabetes and insomnia.

**Wood apple**

Wood apple (*Feronia limonia*, family Rutaceae) also known as monkey fruit, curd fruit and keth bel. It is native to dry plains of India and Sri Lanka. The ripe fruits contain sweet aromatic pulp rich in protein, carbohydrates, riboflavin, vitamin C and minerals, which is used for making fruit bar, powder, syrup and chutney.

**Sea Buckthorn**

Sea Buckthorn (*Hippophae rhamnoides*, family Elaeagnaceae) is storehouse of several plant medicines. Fruits of sea buckthorn have strong anti-oxidant, anti-stress and anti ageing properties. It promotes wound healing and effective in treatment of coronary heart diseases. It is one of the only fruit contains omega-7 fatty acid assisted with growth and development as well as responsible for treatment of arthritis, heart diseases, hypertension etc.

**Biotechnological interventions required for promotion of underutilised fruit crops**

1. **Micropropagation-** Micropropagation technology ensures true to type, disease free, rapid and mass multiplication of plants. It also facilitates safer and quarantined movements of the germplasm. Commercialisation of protocols for multiplication of underutilised fruit crops will help in rapid area expansion of these crops.
2. **Genetic diversity assessment-** Molecular markers are excellent tools for analysis of genetic diversity and relationship among genotypes. Polymerase chain reaction (PCR) based random amplified polymorphic DNA (RAPD) markers have been extensively used in DNA finger printing. RAPD analysis available genotypes underutilised fruits can estimate genetic diversity which will further be useful in improvement of these crops.
3. **Marker assisted selection-** The use of molecular markers can greatly accelerate the pace of selection in underutilised fruit crops with inherent long juvenile period and when trait under study is controlled by the recessive gene and incorporating more than one gene for disease resistance or any other specific character.
4. **Genetic transformation-** Process of transfer, integration and expression of transgenes in the host cells is known as genetic transformation. Resistant to biotic stress, higher tolerance to abiotic stress i.e. salinity, flood, drought etc., shortening the juvenile growth phase and quality improvement such as shelf life improvement is now possible through genetic transformation. This intervention can improve the availability of underutilised fruit crops to larger area and distant markets.
5. **Identification of quantitative trait loci** (**QTLs)-** Many important heritable characters are a consequence of the joint action of several genes. Identification of these can help in enhancing productivity, quality and stress resistance in underutilised fruit crops.

**References**

1. Avinash Gugal and Amit Kotiyal (2022). A review on current status and challenges in cultivation of underutilised fruits crops of India. The Pharma Innovation Journal; 11(5): 2255-2259
2. Dr. Barkha Sharma, Jagdish Patidar, Dr. DR Pachauri and Dr. Sarvesh Tripathy (2019). Contribution of minor fruits crops to household nutritional security and health for rural population. International Journal of Chemical Studies; 7(3): 2942-2949.
3. Anuradha, Subhash Chander and Arvind Malik (2017). Biotechnology a Modern Tool for Fruits Production - A Review. International Journal of Current Microbiology and Applied Sciences; 6 (11) pp. 1902-1912.
4. Meena, V.S.; Gora, J.S.; Singh, A.; Ram, C.; Meena, N.K.; Pratibha, A.; Rouphael, Y.; Basile, B.; Kumar, P. (2022). Underutilized Fruit Crops of Indian Arid and Semi-Arid Regions: Importance, Conservation and Utilization Strategies; Horticulturae, 8, 171.
5. Simrandeep Kour, Parshant Bakshi, Arti Sharma, V.K. Wali, Amit Jasrotia and Shilpy Kumari (2018). Strategies on Conservation, Improvement and Utilization of Underutilized Fruit Crops. Int.J.Curr.Microbiol.App.Sci ; 7(3): 638-650
6. Bikash Hazarika, Manha Bathari, Vinod Upadhyay, Sunil Kumar Paul, Mahadev Uzir Basumutary, Palash Thengal and Utpal Kotoky. (2020). An overview of the unexplored underutilized fruit crops of Assam, India. Journal of Applied and Natural Science, 12(3): 442 - 453.
7. Bidyut C. Deka, A. Thirugnanavel, R. K. Patel , Amit Nath and Nishanth Deshmukh (2012). Horticultural diversity in North-East India and its improvement for value addition. Indian J. Genet., 72(2): 157-167.
8. Md Mokter Hossain, Md Abdur Rahim, Md Rezaul Haque (2021). Biochemical properties of some important underutilized minor fruits. Journal of Agriculture and Food Research; 5 (2021) 100148.