

DOMESTICATION AND POPULARIZATION OF UNDERUTILIZED AND WILD FRUITS FOR FRUIT DIVERSIFICATION : A REVIEW

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With the deforestation wild species are declining in number. Wild and underutilized fruits can play a vital role as an alternative, as the nutritional security remains a concern, inspite of the fact that various measures are being taken to increase productivity of the few domesticated crops. India's major population lives in rural areas and they depend on agriculture for living, thus domestication and diversification will help in income generation and reduces the over exploitation of natural sources in wild. They are rich in vitamins particularly vitamin C and micronutrients etc. Households had accessed to the indigenous fruit trees live whole year above poverty line. Poverty is one of the major reasons that the consumption of fruits is so low. Without sustainable use and biodiversity conservation global level struggles like hunger, poverty can't be win. Thus, currently one of major goal at global level is to widen the base of agriculture by the help of wild and underutilized fruit crops for nutritional and financial security.

Massive natural habitats degradation has resulted due to the development of industrialization, agriculture, deforestation at large scale and change in the pattern of land use leading to the loss of native diversity, thus there is need to conserve the diversity for utilizing it effectively through various management and conservation techniques (Mal *et al.*, 2011). According to the UN, annual change in the urban population is highest in India with the rate of 2%. In the last decade only, 95 million people were added to the urban population which is going to be 854 million people by the end of 2050 as per estimation in the different cities of India. Currently the 35% of India's total population is living in cities, which is expected to be increased by >40% and >65% by the end of 2030 and 2050 respectively. The collective effect of change in climate with the increasing population is not known, thus to meet the needs for next four decades there might be need of agriculture at large regions to undergo adjustments (Mayes *et al.*, 2012). In majority of the cases low consumption of fruits is due to the poverty (Bvenura and Sivakumar, 2017). We can't win the poverty and hunger like global struggles without collaborating the sustainable use and conservation of the biodiversity (Bisseleua and Niang, 2013). As a contribution to International Year of Biodiversity in 2010 an International Scientific Symposium organized by FAO and Biodiversity International, where the biodiversity concept was first linked with the issue of sustainable diets in the "Biodiversity and sustainable diets: United against hunger" to find solutions for malnutrition problem in its different forms, while addressing biodiversity loss and erosion of traditional and

indigenous food culture (Hazra, 2020). Indigenous plants offer food, medicine and raw material in addition to renewable energy and beside all this, they help us to fight against the COVID-19 by boosting immune system thus, they have high potential (Patel and Solankey, 2020). Apart from the intensive cultivation of crops, for achieving the food security for the long term there is need to give proper attention to the local issues like nutritional and dietary diversity and loss of traditional diets (Mayes *et al.*, 2012). Around 65% of the population in India lives in rural areas and most of them depends on agriculture for living, thus the diversification by domesticating wild and underutilized crops will help in generating income and provide security (William, 2002). Research works on conservation of tropical fruit tree species and their use in Asia was initiated in 1993 on recognizing the need and importance, by collaborating with national partners followed by the various donor agencies funded regional projects (Arora and Rao, 1998). Still hunger and malnutrition suffered people are around 1 billion and under nutrition and micronutrient deficiencies are shown by 2 billion people (Anonymous, 2011). Underutilized fruits are those which do have nutritional value but not grown widely at commercial level which are rarely found in big markets (Agent, 1994), lack recognition and appreciation at national level (Jena *et al.*, 2018), and a crop is called underutilized only if it fulfils certain points as crop must have nutritional food value of scientific or ethnobotanical and indigenous use, cultivated in specific geographical area less than other conventional crop, weak or no formal supply of planting material due to less attention from researchers, farmers etc. (Kaur *et al.*, 2018). Whereas, wild fruits are those which are found only in the natural wild habitat. Various phytochemicals are present in wild fruits because of different genotypes and environmental concerns, thus they are often considered healthy (Li *et al.*, 2016). Over exploitation and extinction of the wild fruit trees has resulted due to the deforestation (Akinnifesi *et al.*, 2006). Wild and underutilized fruits are rich in natural antioxidants, vitamins especially vitamin C which has high antioxidant properties as it being a strong reducing agent protects body from harmful effects of free radicles, maintains and builds tissue, infection resistance, Ca, Fe absorption, healing of wounds and vit. C is the principle vitamin supplies by fruits in diet and consumption of fruits rich in vit. C and antioxidants may lower the incidence of cancer (Khomdram and Devi, 2010). Apart from that fermentation can be done to add value to indigenous underutilized fruits and some of the new fruit flavours can be discovered from it by transforming the

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flavour of fruit into the volatile flavours (Kunene *et al.*, 2020). Few of these crops are so much neglected that now, they have been classified as lost crops due to huge scale genetic erosion of their gene pool (Williams, 2002). Commercialization of handful of crops neglecting the nutritionally rich traditionally grown fruit crops resulted in disappearance of these neglected fruit crops at a fast rate and are classified as critically endangered (Dahanayake, 2016). The various reason that restricts wild indigenous fruits to the local markets only are presence of tannins, glycosides, numerous seeds, perishability, difficulty to store, and small size etc. (Vino *et al.*, 2016). Major drivers are market and quality improvement of indigenous fruits and their products for the increased private sector investment in the production and commercialization of IFT (Akinnifesi *et al.*, 2008). Major recognized international goal is to widen the agriculture base by using wild and underutilized crops and meeting the various nutritional and income needs of the local people by their sustainable utilization (Williams, 2002). For broadening the plant species range under cultivation various international agencies like Overseas Development Agency, ICUC, IPGRI, USAID are encouraging the research (Kaur *et al.*, 2018). New opportunities are arising for the underutilized horticultural crops to enter the niche market as the demand for their products is increasing in the urban centres (Chadha, 2020). Specially in the poor regions, the 'hidden treasures' of forest in wild edibles form could help in balanced and healthy diet delivery (Bvenura and Sivakumar, 2017).

Domestication

An evolutionary ongoing process as a result of human action and cultivation of plants present in wild habitat (Hancock, 2004), it has economical as well as ecological impacts (Akinnifesi *et al.*, 2004), thus the proper understanding of production and ecological requirement is required for indigenous fruit trees sustainable conservation on farm (Akinnifesi *et al.*, 2008). Among various reasons, researchers should put effort in domesticating wild fruit plants for easy access and farmers should be encouraged by Govt. to cultivate them (Bvenura and Sivakumar, 2017). After a plant is completely domesticated, for its survival it depends on humans, thus the domestication connotes ecological adaptation change related to the morphological differentiation (Harlan, 1975). Domestication is driven by farmer and led by market (Akinnifesi *et al.*, 2006, Leakey *et al.*, 2005). It is not mandatory for market to be the domestication efforts precursor as indicated by the history of domestication of fruits like kiwi and mango, thus the domestication, development of product and its marketing is viewed without a clear start and end point as a cyclic process (Akinnifesi *et al.*, 2004). It is not necessary that all the cultivated plants are domesticated, as some of them might be a result modification by some natural selection or consciously or sub consciously selection by the farmer while cultivated for several generations (Harlan, 1975). India is bestowed with one of the richest biodiversities of the world. At global level it is estimated that nearly 250,000 flowering

plant species are found out of which 3000 species are sources of food and only 200 species are domesticated till now by the humans (Patel and Solankey, 2020). Set of changes like seed dormancy reduction, loss of dispersal of seeds etc present in the domesticated plant compared to that of wild ancestor is described by the term called 'Domestication Syndrome' (Mayes *et al.*, 2012). Both the amount of genetic variation and the structure of variation contained in the population cultivated is affected by the domestication (Millar and Schaal, 2006). In important commercial traits by understanding tree to tree variation, ideotype concept is derived on which the indigenous fruit tree domestication is based (Leakey and Akinnifesi, 2008) along with other factors like choosing clones which are superior, propagation with vegetative methods (Akinnifesi *et al.*, 2008).

Engagement in testing and adapting of fruit trees domestication by the farmers or group of farmers on their own free will can bring the domestication science of indigenous fruit trees to a scale and effective extension and dissemination by developing simple domestication guidelines for extension workers and farmers will help in stimulating production, utilization and marketing (Akinnifesi *et al.*, 2008). By considering few of the top species with highest value in terms of utilization should be introduced to food processing industries and small scale farmers and for future indigenous fruit trees development programmes such fruits should be taken as the baseline (Nkosi *et al.*, 2020). Results given by the neglected crops on research and development are very gratifying as the increase in the yield is simpler to realize in case of neglected indigenous crops than the major crops (Patel and Solankey, 2020).

Conservation of germplasm is very vital both *in situ* and *ex situ* as the modern plant breeders and biotechnologists for producing better and high yielding varieties depend upon the genetic variation available in the landraces, primitive cultivars and the wild forms (Hazra, 2020). Research on genetic diversity and phenology of the species is desirable for global conservation strategy (Lawin *et al.*, 2021). The neglected fruit crops has the potential to address various issues like food security, socio economic development and upgrades the nutritional status of the rural communities, thus the identified species should be introduced to the rural home gardens for the conservation (Dahanayake, 2016). Indigenous species also have scope in pharmaceutical industries and moreover, there is need to carry out intensive surveys, exploration, conservation (Patel and Solankey, 2020). According to the few studies performed in (carried out by Mithofer and Waibel, 2003; Mithofer, 2005). Zimbabwe concluded that hunger and poverty vulnerability can be reduced by 33% during March-August i.e., in the critical period by the incentives created by tree yield improvement and earlier fruiting of indigenous fruit trees, besides households having access to it were above poverty line throughout the year (Akinnifesi *et al.*, 2008). Many of the fruits are still underutilized because of the poor marketing strategies and the market potential depends upon better

marketing of the produce and end product's reliable supply (Dahanayake, 2016).

Importance

Mainly in the economically poor and marginalized third world countries of the world various factors like population explosion, war, drought etc. and the recent drought induced by El Nino effect are the most notable driving forces for the food insecurity which leads to the low production of food and effects poor people the most (Bvenura and Sivakumar, 2017). For a particular region including underutilized fruits as a component of food mix and growing of such crops with the staples already present helps in attaining the goals of food and nutritional security (Mayes *et al.*, 2012).

As the climate is changing over the years and the resources are degrading the interest in the crop species are increasing which are adapted more to such conditions for ecosystem stability and in both rural and urban areas, they have the potential to generate opportunities for employment through improved efficiency and profitability (Jena *et al.*, 2018).

For treating diseases fruits containing vitamins, energy, and nutrients are used in the ayurvedic and traditional medicine systems (Dahanayake, 2016).

A major challenge for future caused by missing micronutrients i.e., hidden hunger can be mitigated by biodiversity (Bisseleua and Niang, 2013). There are many underutilized fruits containing more vit. A and C than the commercial ones (Kaur *et al.*, 2018). For poor people in urban areas, sometimes they even act as convenience food apart from adding nutrients to the diet (Jena *et al.*, 2018).

Neglected and underutilized fruits can play several roles:

- It helps poor by income generation (Jena *et al.*, 2018).

- Reduces the risk of over dependency on major crops.

- By the reduction of input agriculture sustainability can be increased e.g. nitrogen fertilizers derived from fossil fuels.

- It helps to celebrate and preserve the cultural and dietary diversity (Jena *et al.*, 2018; Mayes *et al.*, 2012).

Introduction of genes from wild and underutilized fruits leads to evolution and development of species. Such plants contain genes which are resistant to various biotic and abiotic stresses. Thus, they can be sources of useful genes.

In the recent years both the number and variety of processed products availability has increased in the market to the consumer due the recognition of the health benefits due to which industry has also been benefited (Dahanayake, 2016). The wild and underutilized fruit crops can be processed into many products like: jam, jelly, juice etc.

Priority setting

In the recent years it is gaining attention with objective of identifying the species in which the research on selection, propagation and management for domestication would be the most effective (Simon and Leakey, 2004), in terms of biodiversity conservation and increasing the income of the farmers with the poor resources (Franzel *et al.*, 2008). Apart from just being an analytical process, it brings the agreement among the stakeholders involved in the domestication research (Franzel *et al.*, 1996). For an approach to be effective it should have simplicity, transparency and collaborative appraisal and the main challenge is to make a procedure that combines them in such a way that right decisions are made and for implementing those decisions proper suitable conditions are created (Franzel *et al.*, 2008).

The key steps are involved in the procedure which starts with the i) team building and planning by conducting proper workshops, after that ii) client groups are defined and iii) assessment of preferred species is done on the basis of the list of trees, farmers valued the most for some reason and they want them to be improved by the researchers followed by iv) product prioritization on the basis of the potential and value to the clients, v) key species identification is done by the participants involved in the process on the basis of the research ability, expected rate of adoption and degree to which women are likely to be benefited, vi) valuation and ranking, vii) choice of species to focus on the domestication efforts (Franzel *et al.*, 1996).

Description

Berberis asiatica (Kilmora)

High value wild edible fruit also known as kilmora and tree turmeric in english is rich in antioxidants due to the presence of 10.62 µg of carotenoid lycopene, 4.53 µg Beta-carotene, 31.96 mg ascorbic acid, 7.93 mg catechins condensed tannins, 30.47 mg tannic acid equivalents phenolic compounds g⁻¹ of the extract and have free radical scavenging activity (Pal *et al.*, 2014). It is used in Ayurvedic medicine system as a substitute to Daruharidra (*B. aristata*) and in indigenous medicine system it's roots are used for treating various diseases (Srivastava *et al.*, 2004). Berberine is the major alkaloid present (Rastogi and Mehrotra, 1993) which is used to treat severe diarrhea (Lahiri and Dutta, 1967), cholera (Dutta and Panse, 1962). Between 500-2000 m altitude, for restoration of degraded forest this species has the good potential and from roots and stem yellow coloured dye can be obtained for tanning and colouring leather (Maikhuri *et al.*, 1994).

Celtis australis (Khareek) (Khajur)

Also called Mediterranean hackberry belongs to ulmaceae family is rich in nutrients and contain 6.7% crude oil, 19.32% crude protein, 4.4% crude fibre, 16.2 kcal g⁻¹ crude energy, 15.29% ash content beside all this major minerals Sodium, Potassium, Phosphorus, Manganese, Calcium, Boron, Ba, Ms and Selenium are present in the

fruits (Demir *et al.*, 2002). Plant can be used for biomonitoring of pollution caused by heavy metals in the environment and barks can be used in measurement of accumulation of heavy metal in long term (Ozturk *et al.*, 2017).

Myrica nagi (Kaphal)

Fruit is a succulent drupe with hard endocarp, pulp consisting of 75.4% of the whole fruit can be consumed fresh and used for jam, jelly making (Patel and De, 2006). It contains myricetin, myricitrin, glycolides and the myricetin has various properties like it's anti cancerous, anti-inflammatory and antimutagenic (Sharma and Bhardwaj, 2019). It is considered as a potential income generating crop in Indian himalayas as the people can earn Rs 14 lakh season⁻¹ by selling the fruits (Bhatt *et al.*, 2000). Flower oil is used for inflammation, diarrhea, and paralysis etc. and because of its high value it has been overexploited by the localites without sustainable use (Jeeva *et al.*, 2011). Sherbat can be made from fruits and fish intoxication can be done by bark apart from extracting yellow dye (Maikhuri *et al.*, 1994).

Pinus gerardiana (Chilgoza)

It is locally called chilgoza is near endemic and endangered to the Himalayan region, as it has the ability to grow under extreme rough site it is also known as the Champion of rocky mountains (Malik *et al.*, 2012) contains 50% fat, 30% protein and 10% carbohydrate. It is rich in unsaturated fatty acids i.e., 51% and 37% linoleic and oleic acid respectively besides chiro-inositol, pinitol and various glycosyl- inositols contribute to antioxidant potential of the nut (Destailats *et al.*, 2010).

Rubus ellipticus (Himalayan yellow raspberry)

It belongs to the family Rosaceae and found from MSL up to 2800 m, fruits can be eaten fresh or jam, jelly can be prepared from it (Maikhuri *et al.*, 1994). It is 1-3 m thorny shrub flowers in March-April and fruits borne on nipple shaped thalamus are aggregate, etaerio of drupes, harvests in April-May and because of the heating potency of the inner bark it is used in Tibetan medicine and used in kidney tonic and an anti-diuretic (Pandey and Bhatt, 2016).

Baccaurea ramiflora (Burmese grapes)

It belongs to the family Euphorbiaceae, due to the presence of high content of vitamin C, protein and iron fruits are important as noval food additive (Peter, 2007). Fruits contain 5.5 % and 178 mg of protein and vitamin C 100 g⁻¹ of pulp respectively along with 169 mg Ca, 137 mg K, 177 mg P and 100 mg Fe 100 g⁻¹ of fruit pulp (Kermasha *et al.*, 1987). Wine rich in natural antioxidants, including phenols, flavonoids, flavonols and proanthocyanidins, can be made from the fruits having health benefits if consumed in limited amount (Goyal *et al.*, 2013).

Dillenia indica (Elephant apple)

The fruits are rich in nutrients (Gopalan *et al.*, 1971) and various products such as clear beverage and RTS beverage and squash can be made from it and sold commercial (Saikia and Saikia, 2002). The greenish-yellow ripe fruits are edible, whereas unripe ones can be processed

into pickle and chutney (De, 2017). Protection against various diseases get on increased consumption of fruits and vegetables which includes certain forms of cancer, diabetes, Alzheimer's disease and cardiovascular disease etc. as per epidemiological studies (Ames *et al.*, 1993), and the protective effects are due to the presence of antioxidants, like ascorbic acid, á-tocophero & â-carotene (Kalt and Kushad, 2000). The anti-leukemic activity in the fruit's methanol extract (Kumar *et al.*, 2009), and anti-cancer activity is well established (Gopal *et al.*, 2005) due to the presence of good quantity of betulinic acid.

Docynia indica (Assam apple)

Fruit contains 600% Zn, 76.67% Cu, 0.51% Mg, 0.73% K, 0.78% N, 0.13% P minerals (Deka and Rymbai, 2014), and 80.31-85.14% moisture, 14.8-17.5 mg vit. C, 1.81-2.76 mg protein, 21.92 mg total sugar content, 140 mg K, 20.60 mg Mg 100 g⁻¹ of the pulp and 1657-1731 µg ml⁻¹ (Khomdram and Devi, 2010). Antioxidant, antibacterial effects and potential as food preservative of extracts from the fruits is reported (Shende *et al.*, 2016), in NE India, it is used as a natural remedy to treat digestive problems and infectious diseases, have hypoglycemic and hypolipidemic effects (Vivek *et al.*, 2017).

Eugenia jambos

Nearly all of its parts is used for different purposes and it's wood is resistance to termites and water (Khan *et al.*, 2020). Due to the presence of tannin brown coloured dye can be collected from the bark which is used for tanning leather, preserving fishing nets etc. (Chaudhary and Handique, 2012), and the essential oil extracted from the leaves is used as fragrant in soaps and to manufacture perfumes mixed with other chemicals substances (Wealth of Indian, 2002). It provides energy of 251 kJ (60 kcal) 100 g⁻¹ of edible fruit and contains water 83.13 g, carbohydrates 15.56 g, protein 0.72 g, fat 0.23 g, 79 mg K, 19 mg Ca, 17 mg P, 15 mg Mg, 14 mg Na, 0.19 mg Fe, vitamin A 3IU, 14.3 mg vitamin C, 0.260 mg vitamin B3, 0.160 mg vitamin B5, 0.038 mg vitamin B6, viamin B2 0.012 mg and vitamin B1 0.006 mg (Anonymous, 2010). It exhibited hypoglycemic action similar or sometimes even better when compared oral hypoglycemic drugs (Sahana *et al.*, 2010), and it has been used in India and Europe as a frontline antidiabetic medication before the discovery of insulin (Baliga *et al.*, 2013). On fermenting the fruits by *S. cerevisiae* var. Bayanus it produces wine with good anthocyanin content of 60 mg 100 ml⁻¹ and 6% ethanol (Chowdhury and Ray, 2007).

Garcinia lanceaefolia

Plant blooms in Feb.-March and harvested in April-June, fruits are rich in vitamin C 42.3 mg 100 ml⁻¹ juice, 6.8% TSS, 2.34% acidity, externally it is similar to tomato and due to juice sacs internally to the citrus when fully ripe, also it can be planted in the banana, citrus and arecanut orchard as a subsidiary crop (De, 2017). It is an endemic medicinal plant of Assam which belongs to the Clusiaceae family which has antibacterial, antifungal, antioxidant and cytotoxic effects as it is a rich source of bioactive compounds such

as xanthenes, biflavonoids, benzophenones, benzoquinones and triterpenes (Patil, 2005). Antibacterial activity is against both gram +ve, gram -ve organisms and several multidrug resistance organisms (Chowdhury and Handique, 2012).

Diploknema Butyracea (Indian butter tree)

It belongs to the family sapotaceae, fruit is a sweet berry thus jaggary can be made or eaten fresh and flower nectar can be used during famine due to its nutritional and medicinal properties (Joshi *et al.*, 2018). Seed extracts contain alkaloid, tannin, glycosides, fixed oils, fats, flavonoids, sterols, phenols, terpenoids and saponins (Tyagi and Tyagi, 2015). Cheura ghee can be extracted which is used for cooking as vegetable oil (42-47%) and lightening lamps (Joshi *et al.*, 2018). Antioxidant, free-radical scavenging properties are present due to the presence of flavonoids (Winkel-Shirley, 2002), antibacterial due to saponin and it can lower blood pressure due to glycosides presence (Lu *et al.*, 2004).

Phyllanthus acidus (star gooseberry)

It belongs to Euphorbiaceae family which yields twice i.e., 1st in April-May and 2nd in August-September in South India, whereas in other parts with the scattered fruiting the main crops yields in January (De, 2017). Fruits are rich in ascorbic acid (36.7 mg 100 g⁻¹), 0.01 mg and 0.05 mg thiamine and riboflavin is present in traces 100 g⁻¹ (Shilali, 2005).

Flacaurtia Jangomas (Indian coffee plum)

It belongs to the family salicaceae, when ripe fruits are dark red or purple and jams and preserves can be made from it (Singh *et al.*, 1994), when unripe slightly jellies can be made, fruits have high culinary value in Kerala, India (Tee *et al.*, 1997). Fruits are known as the vitiated doshas and toxic conditions alleviator in Indian system of medicine. It is used in treatment of diarrhea, dysentery, piles, toothache, bleeding gum and diabetes etc. (Kirthikar *et al.*, 1993).

Elaegnus latifolia* Syn: *E. pyriformis (Soh-shang)

Elaegnus has two species i.e., *E. latifolia* and *E. pyriformis* belonging to the Elaeagnaceae family, flowers in Sept.-December and harvest in March-April, is rich in vitamin A, C, E, flavonoids, essential fatty acids and has the ability to halt, reverse or reduce the cancer incidence (De, 2017). Plant with nitrogen fixing bacteria has symbiotic relationship (Maikhuri *et al.*, 1994), thus it can be grown even under acidic nutritionally poor soil, fruits contain 8.8 to 11.2% , 1.96- 4.03%, 3.1-3.3, 4.8-7.2 and 2.23 to 5.71 , TSS, acidity, pH, ascorbic acid, TSS: acidity ratio in different genotypes of Soh-shang fruits respectively (Patel *et al.*, 2008).

Prunus nepalensis (Meghalaya cherry)

It belongs to the Rosaceae family, depending upon altitude flowers in November-March and harvest in July-early october in Meghalaya (De, 2017). It is rich in nutrients and natural food colour can be extracted from it for food industrial use besides on the basis of size it is of two types

i.e., bigger and smaller size fruit, bigger size fruits contain higher content of 358.86 mg anthocyanin, 74.71 % pulp recovery, 20.15 % TSS, 2.76 mg beta-carotene, 58.38 mg ascorbic acid, 115 mg P, 1362.5 mg S, 9.6 mg Fe, 0.56 mg Cu, 2.42 mg Zn and 7.7 mg 100 g⁻¹ as compared to smaller size fruits which have high K content of 530 mg 100 g⁻¹. Fruit's juice and pulp are used to prepare RTS and cherry wine as it gives purple colour (Rymbai *et al.*, 2016).

Averrhoa carambola (Star fruit)

It is a fibreless juicy fruit belong to the family Oxalidaceae, smells like oxalic acid and presence of calcium oxalate crystals in the flesh results in fruit tartness which forms oxalic acid on dissolving in saliva (De, 2017). Fruit contains natural antioxidants viz., epicatechin, gallic acid, L-ascorbic acid (Guanghou and Leong, 2004), 35.7 g calories, 0.38 g protein, 9.38 g carbohydrate, 0.8 g fat, 0.8-0.9 g dietary fibre, 15.5-21 mg P, 2.35 mg K, 4.4-6.0 mg Ca, 0.32-1.65 mg Fe, 0.003-0.552 mg carotene, 9.6 mg oxalic acid, 4.37 mg tartaric acid, 1.32 mg citric acid, 0.03-0.038 mg of thiamine, 0.019-0.03 mg of riboflavin, 0.294-0.38 mg niacin, 3 mg tryptophan, 2 mg methionine, 26 mg lysine in 100 g of fruit (Chang *et al.*, 2002).

Passiflora edulis (Passion fruit)

It belongs to the family Passifloraceae, and is of two types i.e., yellow (*P. edulis* var. *flavicarpa* Degenerer) and purple (*P. edulis* Sims) form (Montanher *et al.*, 2007). In Meghalaya, under mid hill conditions purple type fruits in March-May and yellow type in August-September, rich in provitamin A (Kaur *et al.*, 2018), vit. C, 31.31% juice, 14.7% TSS, 4.42% acidity, is eaten raw or can be used in ice creams, jam and drinks to add aroma apart from that squash and nectars can be made from the fruits at home (De, 2017).

Ficus carica (Fig) (Anjir)

Fruits are rich in nutrients like vitamin A, Ca, Fe, protein, consists of 84% and 16% pulp and skin respectively which can be eaten fresh, dried, canned or preserved. Latex obtained from it can coagulate the milk and leaves work as diuretic and anthelmintic etc. (Kaur *et al.*, 2018).

Strategies for the development and popularization of wild and underutilized crops

Joint forest management programmes : Here the forest departments work with the people of rural areas who use the resources of forest, for regenerating the forest lands which are degraded (Sundar, 2000), it may be done with the objective to supplement and enrich the biodiversity by growing edible horticultural crops and such programs should spread the indigenous tree knowledge for sustainable use of species that local people know (Kaur *et al.*, 2018).

Involvement of school going children in the process of 'bringing out trees from the wild' to prepare next generation cultivators of indigenous trees apart from reinforcing parental participation in knowledge –intensive domestication of fruit trees, marketing process and capacity building (Akinnifesi *et al.*, 2008).

The wild and underutilized crops are hardy in nature and they can grow under adverse conditions, they can be planted on marginal and wastelands to fulfill the ever increasing food demand (Mayes *et al.*, 2012), as they are adapted to low input agriculture (Jena *et al.*, 2018).

National programmes: One of the reasons why list of industrial priorities are not made is, it is very unlikely to focus on any single crop for industrial purpose without recognised national programme on underutilized crops unless there is major loss in export earnings or if there is any replacement product needed (Williams, 2002).

To conserve the neglected and underutilized fruit crops for future benefits live samples should be identified, collected and plant arboretum should be established to promote studies, research and multiplication (Dahanayake, 2016).

Planning of the crops should be in accordance with the agro climatic suitability of the region (Kaur *et al.*, 2018).

Documentation of traditional knowledge: As these crops are generally grown in traditional way, the traditional societies have much knowledge about the use which has been hardly recorded in a proper way (Dahanayake, 2016). Thus, proper measures should be taken to preserve the knowledge for further development.

Protecting the IPR of farmer breeders, community custodians, researchers by consecrating the policies to ensure that large scale commercial growers will not exploit benefits from Indigenous fruit trees domestication besides creating awareness and profile raising of IFTs contribution in developmental intervention programmes and policy debates. Long term investment, policies appraisal governing land and tree tenure in many countries to facilitate cross border trades, harmonization of exploitation, transportation, germplasm exchange and reducing institutional constraints to tree planting and enact policies (Akinnifesi *et al.*, 2008).

Focus on only few domesticated fruit crops has resulted in the extinction of various wild species and many species with great commercial potential if given attention and rich in nutrients are at the verge of extinction and few are classified as endangered. Thus, it is the need of the hour to give proper attention to such wild species and domesticate before they extinct. Domestication and diversification can provide nutritional and food security as the wild and underutilized fruit trees are hardy in nature and doesn't need much attention, thus even if the main crop fails it will give harvest. Farmers involvement in the process will speed up the rate of domestication plus there is need to give proper monetary fund for these crops at the time of budget allocation to carry out research for improvement. Sometimes, people don't eat them thinking fruits from wild might contain toxin which is not always true, and such toxin may also be present in major domesticated fruit crops like, in case of litchi presence of toxin called methylene cyclopropylglycine (MCPG) which induced hypoglycaemia by blocking the fatty acid oxidation pathway, unable to

correct the glucose level leading to the death of many undernourished children. Thus, there is need to spread awareness about safety and nutritional aspects of the wild and underutilized fruits to popularize it among the people.

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