

## Nutritional and therapeutic attributes of neglected and underutilized fruit crops in Sri Lanka and their potential applications in value addition

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### ABSTRACT

Sri Lanka endowed a rich biodiversity, making it a significant source of plant species used as food sources. Fruits serving as both desserts and refreshments. Major and minor fruits contribute vitamins to the Sri Lankan diet, but underutilized fruit crops, lacking developed cultivation protocols and commercial production, remained as unexplored resources. Soursop (*Annona muricata*), Lavalu (*Pouteria campechiana*), Madam (*Syzygium cumini*), Nam-nan (*Cynometra cauliflora*), Mangosteen (*Garcinia mangosteen*), Beli (*Aegle marmelos*), Kamarankha (*Averrhoa carambola*), Jambu (*Syzygium jambos*), Sapodilla (*Achras sapata*), Veralu (*Elaeocarpus serratus*) are some underutilized fruit crops available in Sri Lanka. This review article highlights the nutritional, medicinal, and value-added potential of selected minor fruits in Sri Lanka.

**Keywords:** Medicinal properties, nutritional value, underutilized fruits, value addition

### INTRODUCTION

Sri Lanka is one of the biologically diverse hotspot in Asia, serving a home to more than 100 species of fruits. There are numerous underutilized wild fruit species that are used by the locals to suit their dietary needs (Tripathi, 2021). However, only a limited number of species are considered major fruits, including Banana, Mango, Pineapple, Passion Fruits and Avocado, which are cultivated on a commercial scale (Premathilake and Wathugala, 2013). Neglected or underutilized fruit crops are domesticated plant species that have been historically valued for their food or medicinal properties (Dahanayake, 2015). Neglected and underutilized agricultural species hold an enormous promise for combating malnutrition, poverty, and global hidden hunger (Ali and Bhattacharjee, 2023). Indeed, underutilized fruits are not only a source of food, vitamins, and minerals, but also a source of income due to their nutritional and medicinal capabilities. Fruits are high in vitamins and minerals. Aside from their nutritional worth, some fruits offer therapeutic properties due to presence of flavonoids, quinolizidine, alkaloids, stilbenes, tannins, steroids, coumarin, and saponins, quinolizidine, triterpenoids, glycosides, and fatty

acids. They are having a variety of pharmacological effects, including anti-inflammatory, analgesic, antidiabetic, antipyretic, antioxidant, hypoglycemic, hepatoprotective, and anticancer, dysentery, cholera, wounds, and sores (Tripathi, 2021). This review will present the nutritional and medicinal properties of selected minor crops in Sri Lanka, along with their potential for value-added products.

*Beli* (*Aegle marmelos*), *Woodapple* (*Ferronia Limonia*), *Mangosteen* (*Garcinia mangosteen*), *Nelli* (*Embelica officinalis*), *Sapodilla* (*Achras sapata*), *Star fruit* (*Averrhoa carambola*), *Lovi* (*Flacourtial inermis*), *Amberalla* (*Spondias dulcis*), *Ambul Dodam* (*Citrus aurantium*), *Heen Naran* (*Citrus crenatifolia*), *Pani Dodam* (*Citrus sinensis* (L.)), *Veralu* (*Elaeocarpus serratus*), *Ugurassa* (*Flacourtia indica*), *Katu anodha* (*Annona muricata*), *Rose apple* (*Syzygium jambos*), *Bilin* (*Averrhoa bilimbi*), *Tamarind* (*Tamarindus indica*), *Damina* (*Limonia acidissima*), *Madan* (*Syzygium caryophyllatum*), *Damba* (*Syzygium rotundifolium*), *Kon* (*Schleichera oleosa*), *Karanda* (*Carissa carandas*), *Nam-nan* (*Cynometra cauliflora*), *Jambola* (*Syzygium cumini*) are some important underutilized fruit species available in Sri Lanka (Fig. 1).

These species lack developed scientific agronomic packages, organized supply and marketing channels, processing techniques as well as export share (Premathilake and Wathugala, 2013). Over time, significance of these fruit species has diminished due to factors such as limited supply, constraints like poor shelf life, insufficient consumer awareness, and their nutritional and medicinal value going unrecognized (Dahanayake, 2015). One of a major reasons for their limited popularity include the lack of knowledge regarding their nutritional and medicinal value. Inadequate scientific research, particularly on their potential for medical applications, has also contributed to their lack of attraction. Furthermore, insufficient value addition as well as rising demand for imported fruits contributed to this decline in popularity (Premathilake and Wathugala, 2013).

“Value addition” would be the greatest approach not only to ensure year-round availability of underutilized fruit species but also enhanced their popularity and will help to eliminate the surplus waste. Exporting processed and semi-processed products ensures profits and economic benefits. Most important thing is the prioritizing in-depth researches on nutritional quality and anti-nutritional elements, processing, value addition, product development, and successful marketing methods. Additionally, close linkages between growers, merchants, processors, and consumers are needed to be developed to have an efficient value chain and stimulate the use of these potentially neglected crops (Ali & Bhattacharjee, 2023).

In order to overcome the major constraints regarding underutilized crops in Sri Lanka, a well-organized surveys must be launched to build a database on the origin, distribution, habitat, agroclimatic requirements, and scientific application of potential underutilized crops. Then, suitable plant types with desirable characteristics should be generated. Further introducing underutilized crops into existing agricultural systems can be also done.

### **Important underutilized fruit species in Sri Lanka**

#### **Soursop (*Annona muricata*)**

Soursop belongs to the Annonaceae family and is commonly known to Soursop in English, locally referred to as “*Katu anoda*” in Sri Lanka. It is a

climacteric fruit with a short shelf life (Badrie and Schauss, 2010). The tree is an evergreen slender, reaches a height of around 8-10 meters. The tree produces dark green oval to conical/heart shaped fruits in the unripen stage, which gradually turn light green as they ripen (Sanusi and Abu Bakar, 2018). Typically, many fruitlets fuse together to form a single soursop fruit. The fruit has whitish flesh that is juicy, with dark brown seeds and the number depends on the size of the fruit. Outer skin has a leathery appearance with short spines. The average weight of a fruit is around 4 kg. The primary propagule is the seed which can be stored for several months before planting. However, vegetative propagation have not been tried in Sri Lanka or with low percentage of success.

The well ripe (WR) stage fruit contains a significant amount of moisture (80.52% w/w), crude fat content (3.28% w/w), crude protein content (2.98% w/w), Brix value (11.5 degrees Brix), titratable acidity (1.02% w/w), pH (3.7), and a low amount of ash content (78% w/w). (Wijerama *et al.*, 2023). Additionally, soursop is rich in Vitamins B<sub>1</sub>, B<sub>2</sub>, and Ascorbic acid (Badrie and Schauss, 2010). Antioxidant compounds such as ascorbic acid,  $\beta$ -carotene,  $\alpha$ -carotene, and different xanthophylls have been detected in soursop and may have contributed to the antioxidant activity of the fruit extract (Wijerama *et al.*, 2023). *A. muricata* is often referred to as a miracle fruit and is widely used in traditional medicine around the world to treat various conditions such as abscesses, bronchitis, diabetics, intestinal colic, palpitations, gallbladder problems, diarrhoea, dysentery, inflammation, liver disorders, fungal infections, asthma, blood cleansing, cancer, arthritis, malaria, intestinal parasites etc (Sejal and Jayvadan, 2016).

#### **Lavalu (*Pouteria campechiana*)**

Lavalu belongs to the Sapotaceae family and is one of the underutilized fruits of Sri Lanka, while it is commonly referred to as Canistel in most parts of the world (Lim, 2013). It is an evergreen tree that can be found in tropical and sub-tropical areas around the world and it is well adapted to a wide range of soil conditions. *P. campechiana* is an erect medium-sized tree that reaches a height of 8-20 m. Every part of the tree having whitish gummy latex. The fruit is a berry with obovoid to variable shapes,

measuring 7-12.5 cm in length and 4-7.5 cm in width and it has a golden yellow coloured skin (Lim, 2013).

The edible part of the plant is the fruit pulp, which resembles the texture of a hard-boiled egg yolk, giving rise to the name “Egg Fruit” (Lim, 2013 and Sethuraman *et al.*, 2020). Sethuraman *et al.* (2020) indicated that the fruit pulp of *P. campechiana* contains 52.96% moisture, 40.19% carbohydrate, 1.16% protein, 4.97% fat, 2.12% fiber, and 0.71% ash content. Ripe fruits also contain 2.7% fructose, 3.3% glucose, 15.6% sucrose and 6mg/100g of vitamin C. Due to its lower sugar content, it is potentially suitable for the people with obesity and type II diabetics (Sethuraman *et al.*, 2020). Moreover, *Pouteria campechiana* has many medicinal uses, such as preventing heart failures, cardiac arrhythmia, intestinal disorders, allergies and cancers (Mehraj *et al.*, 2015).

#### **Madam (*Syzigium cumini*)**

*Syzigium cumini*, locally known as “Madam” is an evergreen drought tolerant tropical tree belongs to the family Myrtaceae. It is commonly referred to as “Jamun” around the world (Madani *et al.*, 2021). Other synonyms for this crop include Portuguese plum, black plum, Malabar plum (Rehaman, 2021). The tree can grow up to a height of 30 meters with a girth of 3-4 m (Jadhav *et al.*, 2009). In Sri Lanka, these trees are mostly found in rural forest areas as wild trees bearing purple coloured berries that mainly serve as a food source for birds and mammals. The fruit of *S. cumini* is a berry with deep purple coloured fleshy pulp. The pulp is astringent and sour in taste, and it contains a hard seed embedded within it (Benherlal and Arumughan, 2007). The fruit is perishable and typically have a short postharvest shelf life at room temperature. Fresh fruit pulp is rich in carbohydrates, proteins and minerals. It contains 80% moisture, 0.81% protein, 12.7% Sugar (Swami *et al.*, 2012). The fruit is an excellent source of antioxidants, iron, and vitamin C (Rizvi *et al.*, 2022).

*S. cumini* plays a significant role in primary healthcare and traditional systems such as Ayurveda, Unani and Sidha. It is used as a treatment for diabetes mellitus, ulcers, inflammations,

stomach pains, chronic diarrhea (Jadhav *et al.*, 2009 and Swami *et al.*, 2012). Additionally, it possesses antimicrobial, anti-inflammatory, anticancer, gastroprotective, anti-viral activities and can be used to boost up immune system (Rehaman, 2021).

#### **Nam-nan (*Cynometra cauliflora*)**

Nam-nan is a member of family Fabaceae and one potential underutilized fruit crop in Sri Lanka. It is a widely spread evergreen small tree that can grow up to a height of 15m. This tree typically bears greenish yellow or brown kidney-shaped pods (fruits) on its trunk, which have a rough surface with wrinkles (Tajudin *et al.*, 2012). Nam-nan can be found in village areas as a homegrown tree and it produces fruits with a savory taste that can be consumed either as a raw fruit or as a salad (Khoo *et al.*, 2016). It is rich in vitamin A and vitamin C (Duraisamy *et al.*, 2020). According to Lim (2012), the edible fruits are used in traditional medicine to treat skin diseases and loss of appetite.

#### **Mangosteen (*Garcinia mangosteen*)**

Mangosteen belongs to Clusiaceae family (Ketsa and Paull, 2011). It is locally known as “*Mangus*” in Sri Lanka. Mangosteen plants can be found in Sri Lanka as garden plants or small cultivations in both the mid and wet low-country districts. This plant has a slow growth habit and a long juvenile stage of 8-12 years to develop fruits, thus seedlings should be kept at the nursery for at least two years. It is considered to be one of the most popular tropical fruits with a strong economic potential (Wickramasingha *et al.*, 2021).

Pedraza-Chaverri *et al.* (2008) described mangosteen as an evergreen tropical tree that exhibits very slow growth in an erect habit, reaching heights of 6-25m. The fruit is externally smooth and round shaped, with a dark purple to reddish purple in colour. Inside the fruit, there are 4 to 8 triangular, white juicy arils, that form the edible portion of the fruit. The flesh has slightly to distinctly acid flavour. Rizaldy *et al.* (2022) stated that edible portion of 100g contains 80.94 g of moisture, 0.41 g of protein, 0.58 g of fat, 17.94 g of carbohydrates, minerals 73 mg (calcium, phosphorous, potassium) and ascorbic acid (2.9 mg). Aril has pleasant taste but contain low nutrient content (Ketsa and Paull, 2011). They also reported minor amount of vitamin B<sub>1</sub>, B<sub>2</sub>, niacin and vitamin C in the edible portion.

Rizaldy *et al.* (2022) stated in their review that the main abundant bioactive compound in mangosteen is xanthone. Kurniawati *et al.* (2014) suggested that the xanthone found in the rind of mangosteen has antidiabetic effect. Furthermore, the pericarp is utilized for various medicinal purposes such as overcoming abdominal pain, dysentery, eczema, cystitis, chronic ulcers and diarrhea (Al-Massarani *et al.*, 2013). Mangosteen has been found to exhibit a range of pharmacological effects including anti-diabetic, anti-obesity, antimalarial, anti-parasitic, antioxidant, anti-acne, anti -aging, anti-bacterial and anti-inflammatory properties (Rizaldy *et al.*, 2022).

### **Beli (*Aegle marmelos*)**

‘Beli’ or ‘Bael’ belongs to the Family Rutaceae. The fruit is native to Southeast Asia (Jayawardene, 2019) and it can be found in most parts of home gardens in Sri Lanka. Bael is an arid fruit crop with high nutritional content, hardness, high processing quality, and extensive adaptability across the tropics and subtropics (Kundu & Ghosh, 2017). Bael trees are commonly observed in Hindu temple gardens in Sri Lanka. The tree can grow up to 18 meters in height and bears fruits with a smooth woody skin that measures 5-15 cm in diameter. It is regarded as a hardy tree that can flourish in both marshy alkaline soil and strong acid soil with pH ranging from 5 to 10 (Kundu & Ghosh, 2017).

Inside the fruit, a thick, glue-like aromatic pulp, which is yellow and fibrous, contains embedded seeds. The taste resembles marmalade. The Bael fruit is rich in Vitamins B<sup>1</sup>, B<sup>2</sup>, and Proteins (Jayawardena, 2013). Maity *et al.* (2009) stated that bael may play a vital role in future medicine systems. Bael is used as a treatment for cancer, and cardiovascular diseases and has many medicinal properties, including being astringent, antidiarrheal, antipyretic and anti-inflammatory property (Maity *et al.*, 2009). Bael fruit also shows numerous potential health benefits, such as radioprotective effects, antibacterial, gastroprotective, antiviral, antidiabetic, anti-ulcerative colitis, as well as cardioprotective effects (Venkothodika *et al.*, 2020). Fruit drink of bael is an excellent “restorer of vigor” for those engaged in outdoor activities (Jayawardene, 2019). The fruit shell can be boiled in water and consumed to provide a cooling effect for the body.

### **Kamarankha or Star fruit (*Averrhoa carambola*)**

Kamarankha, are called as “Star Fruit” in English and is one important underutilized fruit in Sri Lanka belongs to the family Oxalidaceae (Dasgupta *et al.*, 2013). Star fruit originated from Ceylon and the Moluccas. It is a small tree that grows up to 6 m in height, mainly in tropical and sub-tropical areas (Manda *et al.*, 2012). It bears green to greenish-yellow, fleshy fruits that are about 6 cm long. The fruits are distinct with five longitudinal angular lobes. The fruits are green at the unripe stage and turn yellow or orange when ripe (Dasgupta *et al.*, 2013). The fruit has a slightly tart, sweet and acidic taste (Muthu *et al.*, 2016).

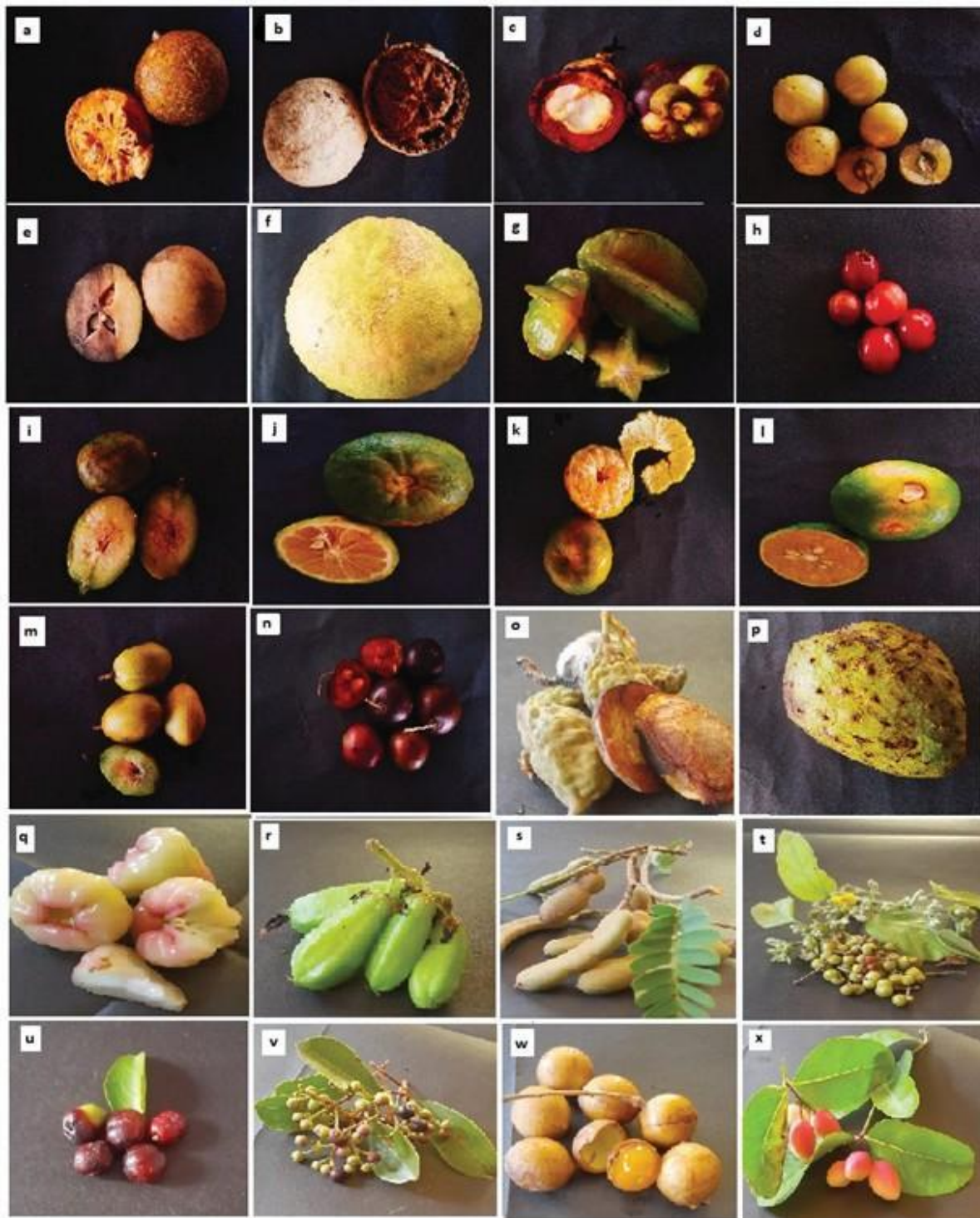
In their review, Manda *et al.* (2012) cited out that star fruits contain a package of nutrients. In 100g of fruit, there is 38g of protein, 9.38g of carbohydrates, 0.9g of fiber, 0.08g of fat and Ascorbic acid (15.4/100ml). Patil *et al.* (2010) conducted an analysis of star fruit at various stages of ripening and found that fully ripe fruit contains 0.85% protein, 1.32% reducing sugar, 2.25% total sugar, 18% ascorbic acid, 5.11% pectin and 0.17% amino acids. They also noted that the chemical composition of edible star fruit differs with the maturity stage.

Star fruits can be eaten as raw fruits and can also be used in the preparation of juices, salads, jams, wine and pickles (Patil *et al.*, 2010 and Muthu *et al.*, 2016). Lakmal *et al.* (2021) listed several beneficial medicinal effects of star fruit including anti-inflammatory, anti-infective, antitumor, antioxidant, hypotensive, hypocholesterolemic and immune boosting effects. They also mentioned that

star fruits are commonly used in Ayurvedic medicine to treat skin disorders, fever, cough, diarrhea, chronic headache etc.

### **Jambu or Rose apple (*Syzygium jambos*)**

Jambu is known as Rose Apple belongs to the family Myrtaceae (Subbulakshmi *et al.*, 2021). It has a dense crown with wide spreading branches. The fruit is a berry and has a fleshy pericarp that is 10-15mm thick. The epicarp of the fruit is reddish and thin. The fruit has succulent whitish flesh (Ochieng *et al.*, 2022). Subbulakshmi *et al.*, (2021) stated that the fruits are sometimes yellowish in colour, except for the Malaysian variety, which is reddish slightly pear shaped and crowned by a 4



**a.** Beli - *Aegle marmelos*, **b.** Woodapple – *Ferronia limonia*, **c.** Mangosteen - *Garcinia mangosteen*, **d.** Nelli – *Embelica officinalis*, **e.** Sapodilla - *Achras sapata*, **f.** Jambola - *Syzygium cumini*, **g.** Star fruit - *Averrhoa carambola*, **h.** Lovi – *Flacourtia inermis*, **i.** Amberalla- *Spondias dulcis*, **j.** Ambul Dodam- *Citrus aurantium*, **k.** Heen Naran- *Citrus crenatifolia*, **l.** Pani Dodam- *Citrus sinensis* (L.), **m.** Veralu – *Elaeocarpus serratus*, **n.** Ugurassa – *Flacourtia indica*, **o.** Nam-nan - *Cynometracauliflora*, **p.** Katu anodha – *Annona muricata*, **q.** Rose apple – *Zyzygium jambos*, **r.** Bilin – *Averrhoa bilimbi*, **s.** Tamarind – *Tamarindus indica*, **t.** Damina- *Limonia acidissima*, **u.** Madan- *Syzygium caryophyllatum*, **v.** Damba – *Syzygium rotundifolium*, **w.** Kon- *Schleichera oleosa*, **x.** Karanda - *Carissa carandas*,

**Table 1: Processed products that can be prepared from the selected minor fruits**

Minor Fruit	Value Added Products	Sources
<b>Soursop</b>	Juices, juice blends, fresh pulp bottled, frozen pulp, concentrates, nectar, ice cream, sherbets, syrups, jams, jellies, yoghurt, powder, dehydrated products, candies, canning, flakes, fruit bars, champola	Badrie and Schauss, 2010; Sanusi and Abu Bakar, 2018
<b>Lavalu</b>	Custards, ice cream, milkshakes/eggfruit nog, pancakes, cupcakes, jam, marmalade, pie butter	Lim, (2013)Sethuraman <i>et al.</i> (2020)
<b>Madam</b>	Juices, seed powders, jellies, jam, squash, hips, wine, vinegar, pickles, syrups, sauces, brandy	Rehaman, 2021; Babak Madani <i>et al.</i> (2021); Swami <i>et al.</i> (2012)
<b>Nam-nan</b>	Jam, pickles, salads, fried products	Duraisamy <i>et al.</i> (2020)Lim, (2012)
<b>Mangosteen</b>	Paste, leather, candy, juice, dried arils, pericarp powder, freeze dried mangosteen, wine, vinegar, ice cream, yoghurt, cosmetics	Ketsa and Paull, (2011)
<b>Beli</b>	Juices-RTS, jam, toffee, preserve, panjiri, squash, dehydrated products, Powder, Slab	Singh and Chaurasiya, (2014) Ullikashi <i>et al.</i> (2017)
<b>Starfruits</b>	Puddings, tarts, stews, pickles, jam, preserves, canned syrups, carambola juice, sherbets, jelly, salads, squash	Manda <i>et al.</i> 2012 ; Patil <i>et al.</i> (2010); Anuar and Salleh, (2019); Monalisa <i>et al.</i> (2014)
<b>Rose Apple</b>	Wine, jam, jelly, syrups, sauce, drinks, candy, rosewater	Subbulakshmi <i>et al.</i> (2021)
<b>Sapodilla</b>	Fruit bars, nectar, puree, juice, jams, butter, powder, candy, dried slices, halwa, milkshakes, Shrikhand	Madani <i>et al.</i> (2018); Jadhav <i>et al.</i> (2018)
<b>Veralu</b>	Juice, smoothies, ice cream, jelly pickles	Jayawardane, (2019)

lobed calyx. It is a non-climacteric tropical fruit with a rose fragrance, which is due to the presence of linalool (Mondal *et al.*, 2023). The fruit possess vitamins, fat, minerals and antioxidants as nutrients. Subbulakshmi *et al.* (2021) found that 100g of the fruit contains 84-93g of water, 0.6g of protein, 0.3g of total lipids, minute amounts of minerals (Ca, Mg, Fe, Zn, K etc.), 22.3mg of vitamin C, and minutes amount of Vitamin B<sub>1</sub>, B<sub>2</sub> and A. Scientific studies have found that rose apple has uses in traditional medicine, such as antimicrobial, anti-inflammatory, analgesic, antiviral, anticancer, and hepatoprotective activities, while the seeds are used in treatments for diabetes, diarrhoea and dysentery (Subbulakshmi *et al.*, 2021).

#### **Sapodilla or Sapota (*Achras sapata*)**

Sapota belongs to the Sapotaceae family (Bano and Ahmed, 2017 and Kulkarni *et al.*, 2007) and is locally known as Sapodilla in Sri Lanka. It is a medium to large sized tree that reach up to 20-30 meters bears brown coloured fruit that measures 5-10 cm in width, course textured when unripe, which gradually turns soft as it ripens (Bano and Ahmed, 2017). Sapota has an average moisture content of 75.2% , an average fruit weight of 52.19g, a brix value of 19.45, an average acidity of 0.16 , 0.5% protein, 19.5% carbohydrates, 0.49% fat, 2.5% fiber and average total sugar content of 48.5% with reducing sugar accounting for 16.3% (Jadhav *et al.*, 2018).

A decoction of young fruits help relieve diarrhea, while an infusion of young fruits and flowers together is used to treat pulmonary complaints. Additionally, seeds have a diuretic action that helps expel stones from the kidney and bladder (Kulkarni *et al.*, 2007). A paste of seeds is known to be used as an application for the stings and bites of venomous animals. Sapodilla has anti-inflammatory, anti-arthritis, anti-fungal, anti-oxidant, anti-tumor anti-diabetic activities. Ripe fruits are used to treat diarrhoea, dysentery, haemorrhage, pulmonary problems, muscle spasms and breast cancers (Bano and Ahmed, 2017)

#### **Veralu or Ceylon olive (*Elaeocarpus serratus*)**

Ceylon olive belongs to the family Elaeocarpaceae which is known as Veralu in Sri Lanka (Ananda *et al.*, 2023). It is a medium sized tree with drupe shaped fruits which have an astringent taste (de Lima *et al.*, 2019). The results of physical, chemical and pharmacological study carried out by them showed that average total weight of 19.45 g where pulp is about 82.16% of it and seed represent 17.89%. 100g of edible portion have 84.62g of moisture content, 6.1 g of ash, 3.15 g of total sugar, 1.1g lipid 4.92g of protein, 17.5 g of crude protein and 5.93mg of vitamin C ( de Lima *et al.*, 2019). *Elaeocarpus serratus* can be utilized in traditional systems of medicine to treat arthritis, diabetic, analgesic activities, diarrhea. Further olive plants possess significant effect on melanogenesis inhibition and antioxidant properties, antibacterial activity and antifungal activity (Maheshwari *et al.*, 2022).

#### **Value addition of underutilized fruits**

Most of the time, the surplus of these underutilized and neglected fruits are subjected to loss, as they are not harvested and instead left under trees or become a food source for wild animals, without being optimally utilized. On the other hand, many of these minor fruits available only for a certain period of the year, due to their seasonal bearing habit. Furthermore, these fruits are not very popular among the native population due to the lack of awareness about their nutritional and medicinal traits, as well as lack of continuous supply. To address these issues related to underutilized fruits, “value addition of minor fruits” emerges as an

excellent option. The approach can potentially fulfill the off-season nutritional requirements of the local population by producing value added products that are available throughout the year, even during the off-season. This strategy can help to reduce post-harvest losses and increase the shelf life of these specific fruits. Despite some limitations, such as concerns about product quality, potential health issues, and nutrient loss during processing, the concept of “Value addition” can facilitate consistent supply against the demand. Moreover, it has the potential to enhance foreign exchange revenues and uplift livelihoods. Various value-added products that can be processed from selected minor crops in Sri Lanka has been presented in Table 1.

#### **CONCLUSION**

This review provides insights into selected underutilized fruit crops in Sri Lanka, focusing on their nutritional and therapeutic attributes and potential applications in value addition. In conclusion, these fruit crops have immense potential to gain popularity among the local community, primarily due to their nutritional and therapeutic qualities. To ensure year-round supply and demand, there is a need for value addition and commercialization of these fruits. Industrial workshops, promotional campaigns, and awareness programs involving both the government and private sector are essential to promote the local consumption of these minor fruits. Furthermore, additional studies are required to explore the nutritional and therapeutic properties of these fruits and to develop products through value addition.

#### **REFERENCES :**

- Al-Massarani, S.M., El Gamal, A. A., Al-Musayeib, N.M., Mothana, R.A., Basudan, O.A., Al-Rehaily, A.J., Farag, M., Assaf, M.H., El Tahir, K.H. and Maes, L. 2013. Phytochemical, antimicrobial and antiprotozoal evaluation of *Garcinia mangostana* pericarp and á-mangostin, its major xanthone derivative. *Molecules.*, **18** : (9) : 10599–10608.
- Ali, A. and Bhattacharjee, B. 2023. Nutrition security, constraints, and agro-diversification strategies of neglected and underutilized crops to fight global hidden hunger. *Frontiers in Nutrition*, **10** : (June) : 1–12.

- Ananda, N. V, Shekshavali, T. and Soundarya, M. 2023. A review on pharmacological activities of *Eleocarpus Serratus*. *Research Journal of Pharmacology and Pharmacodynamics*, **15** : (2) 66-68.
- Anuar, N. A. and Salleh, R. M. 2019. Development of fruit jam from *Averrhoa bilimbi* L. *Journal of Food Processing and Preservation*, **43**: (4)1-7.
- Babak Madani, Mirshekari, A., Yahia, E.M., Golding, J.B., Hajivand, S., Dastjerdy, A.M. 2021. Jamun (*Syzygium cumini* L. Skeels): A promising fruit for the future. *Horticultural Review*, **48**: 275-306.
- Badrie, N. and Schauss, A.G. 2010. Soursop (*Annona muricata* L.): Composition, nutritional value, medicinal uses, and toxicology. In: *Bioactive Foods in Promoting Health; Fruits and Vegetables*. Elsevier Inc, pp. 621-643.
- Bano, M. and Ahmed, B. 2017. *Manilkara zapota* ( L . ) P . Royen ( Sapodilla ): A Review. *International Journal of Advance Research, Ideas and Innovations in Technology*, **3**(6): 1364-1371.
- Benherlal, P. S. and Arumughan, C. 2007. Chemical composition and in vitro antioxidant studies on *Syzygium cumini* fruit, *Journal of the Science of Food and Agriculture*, **87**:(4): 2560-2569.
- Dahanayake, N. 2015. Some neglected and underutilized fruit- crops in Sri Lanka. *International Journal of Scientific and Research Publications*, **5**:(2)1-7.
- Dasgupta, P., Chakraborty, P. and Bala, N. N. 2013. *Averrhoa carambola*/ : An Updated Review. *International Journal of Pharma Research & Review*, **2**(7):54-63.
- De Lima, F.F., Breda, C. A., Lma Cardoso, A. C., Duarte, C.T. and Sanjinez-argandoña, E. J. 2019. Evaluation of nutritional composition, bioactive compounds and antimicrobial activity of *Elaeocarpus serratus* fruit extract. *African Journal of Food Science*, **13**(1): 30–37.
- Duraisamy, S. R. W., Bandara, G. M. W. R. and Nayomi, H. M. D. 2020. Development of a Jam from Nam-Nam (*Cynometra cauliflora*) Fruit. In : *Proceedings of International Conference on Dry Zone Agriculture*. Faculty of Agriculture, University of Jaffna, Sri Lanka, pp. 50.
- Jadhav, S.S., Swami, S.B. and Pujari, K.H. 2018. Study on physico-chemical properties of sapota (*Achras sapota* L.). *Trends in Technical and Scientific Research*, **3**(1): 23-29.
- Jadhav, V.M., Kamble, S.S. and Kadam, V. J. 2009. Herbal medicine: *Syzygium cumini*/ :A Review. *Journal of Pharmacy Research*, **2**(7):1212-1219.
- Jayawardane, I. 2019. Bael: The miracle Fruit. *Daily News*, June, 2019.
- Jayawardane, I. 2019. Secrets of Veralu. *Daily News*, November, 2019.
- Jayawardane, S. 2013. The delightful Beli Fruit. *Sunday Observer*, September , 2013.
- Ketsa, S. and Paull, R. E. 2011. Mangosteen (*Garcinia mangostana* L.). Woodhead Publishing Limited.
- Khoo, H. E., Azlan, A., Kong, K. W. and Ismail, A. 2016. Phytochemicals and medicinal properties of indigenous tropical fruits with potential for commercial development. *Evidence-Based Complementary and Alternative Medicine*, **2016**. 1–20.
- Kulkarni, A.P., Pllicegoudra, R. and Aradhya, S. 2007. Chemical Composition and Antioxidant Activity of Sapota (*Achras sapota* Linn.) Fruit. *Journal of Food Biochemistry*, **31**(3):399-414.
- Kundu, M. and Ghosh, S.N. 2017. Yield and quality improvement in bael (*Aegle marmelos* ) by plant growth regulators. *International Journal of Minor Fruits, Medicinal and Aromatic Plants*, **3**(1):5-8.
- Kurniawati, M., Mahdi, C. and Am, A. 2014. The effect of juice of mangosteen rind (*Garcinia Mangostana* L.) to blood sugar levels and histological of pancreatic rats with the induction of streptozotocin. *The Journal of Pure and Applied Chemistry Research*, **3** (1):1-6.
- Lakmal, K., Yasawardene, P., Jayarajah, U. and Senevirathne, S.L. 2021. Nutritional and



- medicinal properties of Star fruit (*Averrhoa carambola*): A review. *Food Science and Nutrition*, **9**(3):1810-1823.
- Lim, T. 2013. *Pouteria campechiana*, *Edible Medicinal and Non-Medicinal Plants*, Springer Science+Business Media, pp.133–137.
- Lim, T. K. 2012. *Cynometra cauliflora*, *Edible Medicinal and Non-Medicinal Plants*, Springer Science+Business Media, pp.614–616.
- Madani, B., Mirshekari, A., Yahila, E. M., Golding, J. B., Hajivand, S. and Dastjerdy, A. M. 2021. Jamun (*Syzygium cumini* L. Skeels): A promising fruit for the future. In *Horticultural Reviews*. Warrington I (ed.). John Wiley & Sons, pp. 275-305.
- Maheshwari, P., Faseela, V.A. and Shanmugasundaram, P. 2022. Traditional uses, phytochemical and pharmacological activity Of *Elaeocarpus Serratus*/ : A Global Perspective. *Journal of Pharmaceutical Negative Result.*, **13**(8):1837-1840.
- Maity, P., Hansda, D., Bandyopadhyay, U. and Kumar Mishra, D. 2009. Biological activities of crude extracts and chemical constituents of Bael, *Aegle marmelos* (L.) Corr. *Indian Journal of Experimental Biology*, **47**(11): 849-861.
- Manda, H., Vyas, K., Pandya, A. and Singhal, G. 2012. A Complete Review on : *Averrhoa carambola*. *World Journal on Pharmacy and Pharmaceutical Sciences*, **1**(1):17-33.
- Mehraj, H., Sikder, R. K., Mayda, U., Taufique, T. and Uddin, A. F. M. J. 2015. Plant physiology and fruit secondary metabolites of Canistel (*Pouteria campechiana*). *World Applied Sciences Journal.*, **33**(12):1908-1914.
- Monalisa, K., Islam, M. Z., Asif-Ul-Alam, S. M. and M. Hoque, M. 2014. Valorization and storage stability assessment of underutilized fruit carambola (*Averrhoa carambola*) in Bangladesh. *American Journal of Food Science and Technology*, **2**(4):134-138.
- Mondal, T., Chattopadhyay, S., Mandi, G., Alam, M., Bauri, F. K. and Kundu, S. 2023. Survey and Selection of Superior Rose Apple (*Syzygium jambos* L.) Genotypes from West Bengal. *Environment and Ecology*, **41** (June):1247-1249.
- Muthu, N., Lee, S. Y., Phua, K. K. and Bhore, S. J. 2016. Open access review nutritional, medicinal and toxicological attributes of star fruits (*Averrhoa carambola* L.): A Review. *Bioinformation*, **12**(12):420-424.
- Ochieng, M. A., Ben Bakrim, W., Bitchagno, G. T. M., Mahmoud, M. F. and Sobeh, M. 2022. *Syzygium jambos* L. Alston: An Insight into its phytochemistry, traditional uses, and pharmacological properties. *Frontiers in Pharmacology*, **13**:1-15.
- Patil, A. G., Patil, D. A., Phatak, A. V. and Chandra, N. 2010. Physical and chemical characteristics of carambola (*Averrhoa carambola* L.) Fruit at three stages of maturity. *International Journal of Applied Biology and Pharmaceutical Technology*, **1**(2):624-629.
- Pedraza-Chaverri, J., Cardenas-Rodriguez, N., Orozco-Ibarra, M. and Perez-Rojas, J. M. 2008. Medicinal properties of mangosteen (*Garcinia mangostana*). *Food and Chemical Toxicology*, **46**(10):3227-3239.
- Premathilake, U.G. A.T. and Wathugala, D.L. 2013. A Review on Medicinal and Nutritional Properties of Some Important Underutilized Fruit Species in Sri Lanka. *Proceedings of International Symposium of Minor Fruits and Medicinal Plants for better lives*. University of Ruhuna, Sri Lanka, pp. 89–98.
- Rehaman, S. 2021. Therapeutic traits of jamun tree/ : *Syzygium cumini* (Linn.) to combat against covid-19. *International Journal of Botany Studies*, **6**(1):248-253.
- Rizaldy, D., Hartati, R., Nadhifa, T. and Fidrianny, I. 2022. Chemical Compounds and Pharmacological Activities of Mangosteen (*Garcinia mangostana* L.) - Updated Review. *Bio interface Research in Applied Chemistry*, **12**(2):2503-2516.
- Rizvi, M.K., Rabail, R., Munir, S., Inam-ur-raheem, M., Nasir Qayyum, M.M., Kieliszek, M., Hassoun, A. and Aadil, R.M. 2022. Astounding health benefits of jamun (*Syzygium cumini*) toward metabolic syndrome, *Molecules*, **27**(21):1-16.

- Sanusi, S. B. and Abu Bakar, M. F. 2018. Soursop - *Annona muricata*. In *Exotic Fruits Reference Guide*, Elsevier Inc.
- Sejal, P. and Jayvadan K, P. 2016. A review on a miracle fruits of *Annona muricata*. *Journal of Pharmacognosy and Phytochemistry*, **5**(1):137-148.
- Sethuraman, G., Mohd Nizar, N.M., Muhamad, F. N., Tengku, S. A. T., Suhairi, M., Jahanshiri, E., Gregory J, P. and Azam-Ali, S. 2020. Nutritional composition of canistel (*Pouteria campechiana*). *International Journal of Food Science and Nutrition*, **5**(6):53-57.
- Singh, A.K. and Chaurasiya, A.K. 2014. Post Harvest Management and value addition in Bael (*Aegle marmelos* Corr.). *International Journal of Interdisciplinary and Multidisciplinary Studies*, **1**(9):65-77.
- Subbulakshmi, K., Satish, S. and Shabaraya, A. R. 2021. Rose Apple Fruit/ : a Pharmacological Review. *World Journal Pharmacy and Pharmaceutical Science*, **10**(4):842-849.
- Swami, S. B., Thakor, N. S. J., Patil, M. M. and Haldankar, P. M. 2012. Jamun (*Syzygium cumini* ( L .): A Review of Its Food and Medicinal Uses. *Food and Nutrition Sciences*, **3**(8):1100-1117.
- Tajudin, T. S. A., Mat, N., Siti-aishah, A. B., Yusran, A. A. M., Alwi, A. and Ali, A. M. 2012. Cytotoxicity, antiproliferative effects, and apoptosis induction of methanolic extract of *Cynometra cauliflora* Linn whole fruit on human Promyelocytic Leukemia HL-60 Cells. *Evidence-Based Complementary and Alternative Medicine*, **2012**:1-6.
- Tripathi, P. C. 2021. Medicinal and theraptic properties of minor fruits - A Review. *International Journal of Minor Fruits, Medicinal and Aromatic Plants*, **7**(2):1-28.
- Ullikashi, K. Y., Kammar, M. R. and Lokapure, S. R. 2017. Development of value added products from bael fruit (*Aegle marmelos*), *International Journal of Current Microbiology and Applied Sciences*, **6**(7): 2652-2659.
- Wickramasingha, N. D. N., Arunakumara, K. K. I. and Warusawitharana, A. 2021. Effect of growth regulators on growth enhancement of Mangosteen (*Garcinia mangostana*) seedlings. In *Abstract: International Symposium on Agriculture and Environment 2021 University of Ruhuna, Sri Lanka*, pp.92.
- Wijerama, H. J. K. S. S., Shanika, M. K. A., Wedamulla, N. E. amd Wijesinghe, W. A. J. P. 2023. Evaluation of the antioxidant potential of soursop (*Annona muricata* L .) fruit at different maturity stages. *The Journal of Agricultural Sciences- Sri Lanka*, **18**(3): 424-431.
- Venthodika, A., Chhikara, N., Mann, S., Kumar Garg, M., Sajad, A. S. and Panghal, A. 2020. Bioactive compounds of *Aegle marmelos* L., medicinal values and its food applications: A critical review. *Phytotherapy Research*, **35**(4):1887-1907.