

Conservation of minor fruit genetic resources at the Botanical Garden, Bangladesh Agricultural University

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ABSTRACT

Minor fruits (MFs), a good source of micronutrients, can contribute significantly to the nutritional requirement of the rural population and be an alternative source to combat hidden hunger caused by micronutrient deficiencies mainly vitamins and minerals. A detailed survey was conducted to update the checklist of the MF collections at Botanical Garden under the Department of Crop Botany, Bangladesh Agricultural University (BAUBG) and their conservation priority in national/international perspectives. A total of 108 MF species, belong to 67 genera and 38 families, were collected and conserved at the BAUBG. Moraceae and Myrtaceae were the most dominant families with 8 taxa each followed by Rutaceae with 7 taxa, Arecaceae, Phyllanthaceae and Sapotaceae with 6 taxa each. Among the genera, Syzygium is the largest genus having 7 species followed by Citrus, Ficus and Garcinia with 5 species in each. Trees make up the largest proportion of MFs followed by shrubs, herbs and climbers. Although MFs are major sources of micronutrients, 97 taxa were also used in the treatment of various diseases in ethnobotanical literature. This study also contributes to the conservation database of plant genetic resources of BAUBG and the country as well.

Keywords: Botanical garden, conservation, medicinal uses, underutilized fruits

INTRODUCTION

Minor fruits (MFs) are a group of fruits presently growing in a scattered and unattended way on roadsides, homestead land, wasteland, etc. (Roya and Bauri, 2019). These fruits are cultivated to a limited extent only, and with consumption and trade being more limited both geographically and quantitatively, although many are of considerable economic importance in their respective regional markets. In general, these are suitable for human consumption but relatively less palatable than other major fruits (Srivastava *et al.*, 2017); MF species act as life support species in extreme environmental conditions and threatened habitats and have the tolerance to survive under harsh climatic conditions. The MFs are sometimes the only source of protective food to meet the vitamins and minerals requirements, and integral part of traditional foods of the people living in (remote) villages and tribal areas (Krishna *et al.*, 2019). These fruits play a great role in improving the food and nutritional status of the local people due to their year-round availability (Pasha and Uddin, 2019). The MFs, synonymously

called underutilized fruits, remain underutilized because of underestimation of their potential uses, little known outside its growing area, non-availability of their complete botanical information, inadequate research on their commercial exploitation, lack of knowledge on their food and nutritional value, promotion, popularization of very few fruit crops, fast disappearance of the ecosystem, and habitat destruction (Dandin and Kumar, 2016). Nowadays, for achieving the Sustainable Development Goals (SDGs), especially Goal #2, which calls for the eradication of hunger and all forms of malnutrition; MFs have become the focus of attraction. Because they are found harbouring nutritionally rich compounds, climate-resilient, resistant to biotic & abiotic stresses, rich in medicinal & nutritive value, source of breeding materials for crop improvement (Ghosh, 2017; Krishna *et al.*, 2019). The MFs are rich in phytochemicals and micronutrients such as antioxidants, polyphenols, flavonoids, minerals and vitamins, which are essential for good health and nutrition, advancing physical and intellectual development. Many of the MFs possess social and/

or ritual values and importance; these also provide the source of feed and nutrition for birds and wild animals.

Hitherto, a total of 255 minor edible fruit yielding species belonging to 149 genera under 61 families, three families to the Liliopsida and 58 families to Magnoliopsida, have been reported from the Bangladesh territory (Pasha and Uddin, 2019). Among these, 48 species are cultivated for fruits, 35 species both cultivated and wild, and the remaining species are exclusively wild. Due to rapid population growth and other anthropogenic activities, alien species, and climate change events – high temperature, change in rainfall pattern, early or late monsoon, frequent floods and cyclones, etc., these valuable plant genetic resources are now declining at an alarming rate. As a result, some of these valuable MF species are now become (critically) endangered and on the verge of extinction. Since its inception in 1963, the Botanical Garden under the Department of Crop Botany, Bangladesh Agricultural University (BAUBG) has been conducting collection and conservation activities. Presently about 1,146 species, more than 20% of the total Bangladesh (Spermatophyte) flora, under 327 genera and 215 families are harboured at this garden (Sarwar, 2019; 2020). Over time, an enormous number of MFs are also conserved in this place. Hitherto, five hundred twenty-seven medicinal and aromatic plant species, many of them are MFs, belonging to one hundred one families have conserved here (Sarwar, 2020). The objective of the present research was to compile an updated checklist of the MF collections of the BAUBG and their conservation priority from national/international perspectives.

METHODOLOGY

A detailed survey on the MFs growing throughout BAUBG, located at 24°7'22" 463 N 90°44'2" 163 E, was carried out through frequent visits (Sarwar, 2020). During these visits, fresh flowering samples were collected; herbarium specimens were prepared as vouchers by drying the fresh samples properly. The dried specimens were mounted on the herbarium sheet and preserved in Prof. Dr Arshad Ali Herbarium at the Botanical Garden, Department of Crop Botany, Bangladesh Agricultural University. The collected fresh (or

dried) specimens were identified in the field or by comparing with herbarium specimens or published literature. The botanical names were updated following <<http://www.worldfloraonline.org>> (older <http://www.theplantlist.org>) and their conservation status (and uses) follows “Encyclopedia of Flora and Fauna of Bangladesh” (Ahmed *et al.*, 2008a, b, 2009a, b, c, d; Siddiqui *et al.*, 2007) and “Red Data Book of Vascular Plants of Bangladesh” (Khan *et al.*, 2001; Ara *et al.*, 2013). The local names and medicinal uses were documented critically from published literature (Uddin, 2006; Yusuf *et al.*, 2009; Uddin *et al.*, 2016) and online resources.

RESULTS AND DISCUSSION

A total of 108 species were listed and distributed under 38 families and 67 genera (Table 1; Figs 1-6). Out of these, 30 species are exotic and mostly cultivated; however, a few of them, for example, *Hibiscus sabdariffa*, *Opuntia dellenii*, *Pithecellobium dulce*, *Polyalthia suberosa*, *Tamarindus indica*, etc., have become naturalized and found in the wild also (Pasha and Uddin, 2019). Moreover, Pasha and Uddin (2019) had identified 44 MFs species, many of them encompassed the BAUBG collection, as promising crops for the future due to their taste, colour, wide use and popularity in consumption. Moraceae and Myrtaceae were the most dominant families with 8 taxa each followed by Rutaceae with 7 taxa, Arecaceae, Phyllanthaceae and Sapotaceae with 6 taxa each, and Annonaceae with 5 taxa. The remaining families are represented by 4 or fewer species each (Table 2). Among the genera, *Syzygium* is the largest genus having 7 species (6.48% of the total MFs). *Citrus*, *Ficus* and *Garcinia* come next with 5 species in each genus (4.63%) followed by *Annona*, *Antidesma*, *Ardisia*, *Diospyros*, *Elaeocarpus* and *Flacourtia* with 3 species (2.78%) in each genus (Table 3). These ten genera together account for more than one-third of the total number of MFs the BAUBG. The remaining 11 genera were documented by having 2 species each and 46 genera represented by only 1 species each (Table 1). Among these 108 species, tree species were dominant (85; 78.70%) followed by shrubs (15; 13.89%), herbs (5; 4.63%) and only 3 (2.78%) climber (Fig. 7). The number of recorded MFs (255

Table 1: Minor fruit plant species conserved at the Botanical Garden, Bangladesh Agricultural University. (Ex) Exotic; Clim. Climber; LC Least concern; NE Not evaluated; VU Vulnerable; NT Near threatened; EN Endangered; DD Data deficient; CD Conservation dependent

Sl. No.	Local Name	Botanical Name	Family	Habit	Status	Fig. No.
1.	Bael	<i>Aegle marmelos</i> (L.) Corr.	Rutaceae	Tree	LC	1A
2.	Kaju badam	<i>Anacardium occidentale</i> L. (Ex)	Anacardiaceae	Tree	LC	1B
3.	Pond apple	<i>Annona glabra</i> L. (Ex)	Annonaceae	Tree	NE	1C
4.	Nona-ata	<i>Annona reticulata</i> L. (Ex)	Annonaceae	Tree	LC	1D
5.	Sharifa	<i>Annona squamosa</i> L. (Ex)	Annonaceae	Tree	LC	1E
6.	Elena/Bignay	<i>Antidesma acidum</i> Retz.	Phyllanthaceae	Tree	LC	1F
7.	Choto Sialbuka	<i>Antidesma bunius</i> (L.) Spreng.	Phyllanthaceae	Tree	LC	1G
8.	Siyal Buka	<i>Antidesma montanum</i> Blume	Phyllanthaceae	Tree	LC	-
9.	Chauldhoa	<i>Ardisia humilis</i> Vahl	Primulaceae	Shrub	LC	1H
10.	Bonjami	<i>Ardisia sanguinolenta</i> Blume	Primulaceae	Shrub	LC	1I
11.	Bonjam	<i>Ardisia solanacea</i> (Poir.) Roxb.	Primulaceae	Shrub	LC	1J
12.	Supari	<i>Areca catechu</i> L.	Arecaceae	Tree	LC	1L
13.	Dewa	<i>Artocarpus lacucha</i> Buch.-Ham.	Moraceae	Tree	LC	1M
14.	Chapalish	<i>Artocarpus chama</i> Buch.-Ham.	Moraceae	Tree	NE	1K
15.	Bilimbi	<i>Averrhoa bilimbi</i> L. (Ex)	Oxalidaceae	Tree	LC	1N
16.	Kamranga	<i>Averrhoa carambola</i> L. (Ex)	Oxalidaceae	Tree	LC	1O
17.	Latkan	<i>Baccauria ramiflora</i> Lour.	Phyllanthaceae	Tree	LC	2A
18.	Tal	<i>Borassus flabellifer</i> L.	Arecaceae	Tree	LC	2B
19.	Betphal	<i>Calamus manillensis</i> L.	Arecaceae	Tree	-	2C
20.	Kumbhi	<i>Careya arborea</i> Roxb.	Lecythidaceae	Tree	VU	2D
21.	Karamcha	<i>Carissa carandas</i> L. (Ex)	Apocynaceae	Shrub	LC	2E
22.	Bon supari	<i>Caryota urens</i> L.	Arecaceae	Tree	LC	2F
23.	Khejur	<i>Chamaerops humilis</i> L. (Ex)	Arecaceae	Tree	LC	5C
24.	Star Apple	<i>Chrysophyllum roxburghii</i> G. Don (Ex)	Sapotaceae	Tree	LC	-
25.	Ada jamir	<i>Citrus assamensis</i> R.M. Dutta & Bhatt.	Rutaceae	Shrub	Rare	2G
26.	Satkora	<i>Citrus aurantium</i> L.	Rutaceae	Tree	LC	-
27.	Rough Lemon	<i>Citrus jambhiri</i> Lush	Rutaceae	Tree	-	-
28.	Batabi Lebu	<i>Citrus maxima</i> (Burm.) Merr.	Rutaceae	Tree	LC	2H
29.	Komla	<i>Citrus reticulata</i> Blanco	Rutaceae	Tree	LC	2I
30.	Chalta	<i>Dillenia indica</i> L.	Dilleniaceae	Tree	LC	2J
31.	Bon Chalta	<i>Dillenia pentagyna</i> Roxb.	Dilleniaceae	Tree	LC	2K
32.	Ashphal	<i>Dimocarpus longan</i> Lour.	Sapindaceae	Tree	NT	2L
33.	Beelati Gab	<i>Diospyros blancoi</i> A. DC (Ex)	Ebenaceae	Tree	LC	2M
34.	Deshi Gab	<i>Diospyros malabarica</i> (Desr.) Kostel	Ebenaceae	Tree	LC	2N
35.	Gulal/Katgula	<i>Diospyros racemosa</i> Roxb.	Ebenaceae	Tree	Rare	-
36.	Rudhrakha	<i>Elaeocarpus angustifolius</i> Blume	Elaeocarpaceae	Tree	EN	-
37.	Jalpai	<i>Elaeocarpus floribundus</i> Blume	Elaeocarpaceae	Tree	LC	2O
38.	Mala	<i>Elaeocarpus grandiflorus</i> Sm.	Elaeocarpaceae	Tree	LC	3A
39.	Loquat	<i>Eriobotrya japonica</i> (Thunb.) Lindl. (Ex)	Rosaceae	Tree	VU	3B
40.	Surinum cherry	<i>Eugenia uniflora</i> L. (Ex)	Myrtaceae	Shrub	-	3C
41.	Makhna	<i>Euryale ferox</i> Salisb.	Nymphaeaceae	Herb	NE	3D
42.	Hostikorni dumur	<i>Ficus auriculata</i> Lour.	Moraceae	Tree	LC	3E
43.	Fapa-dumur	<i>Ficus fistulosa</i> Reinw. ex Blume	Moraceae	Tree	Rare	3F
44.	Kak dumur	<i>Ficus hispida</i> L.f.	Moraceae	Tree	LC	3G
45.	Jog Dumur	<i>Ficus racemosa</i> L.	Moraceae	Tree	NE	3H
46.	Sadimadi dumur	<i>Ficus semicordata</i> Buch.-Ham. ex Sm.	Moraceae	Tree	Rare	3I

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Sl. No.	Local Name	Botanical Name	Family	Habit	Status	Fig. No.
47.	Baichi	<i>Flacourtia indica</i> (Burm. f.) Merr.	Salicaceae	Shrub	LC	3J
48.	Tomytomy	<i>Flacourtia inermis</i> Roxb.	Salicaceae	Shrub	LC	
49.	Paniala	<i>Flacourtia jangomas</i> (Lour.) Raeusch.	Salicaceae	Tree	LC	3K
50.	Kaufal	<i>Garcinia cowa</i> Roxb. ex DC.	Clusiaceae	Tree	LC	3L
51.	Mangosteen	<i>Garcinia mangostana</i> L.	Clusiaceae	Tree	-	
52.	Gutta-gam	<i>Garcinia morella</i> (Gaertn.) Desr.	Clusiaceae	Tree	LC	
53.	Thoikar	<i>Garcinia pedunculata</i> Roxb. ex Buch-Ham.	Clusiaceae	Tree	LC	3M
54.	Dephall	<i>Garcinia xanthochymus</i> Hook.f. ex Anders.	Clusiaceae	Tree	LC	3N
55.	Phalsa	<i>Grewia asiatica</i> L.	Malvaceae	Tree	LC	3O
56.	Raktagota	<i>Haematocarpus validus</i> (Miers) Bakh.f. ex Forman	Menispermaceae	Clim.	Very Rare	4A
57.	Lal mesta	<i>Hibiscus sabdariffa</i> L. (Ex)	Malvaceae	Shrub	NE	-
58.	Bonchalita	<i>Leea asiatica</i> (L.) Ridsdale	Leeaceae	Tree	Very Rare	-
59.	Chagal ladi	<i>Lepisanthes senegalensis</i> (Poir.) Leenh.	Sapindaceae	Shrub	LC	5O
60.	Kathbel	<i>Limonia acidissima</i> L.	Rutaceae	Tree	LC	4B
61.	Mahua	<i>Madhuca longifolia</i> (Koenig ex L.) MacBr.	Sapotaceae	Tree	NE	3C
62.	Maila-am	<i>Mangifera longipes</i> Griff.	Anacardiaceae	Tree	Rare	4D
63.	Uri Aam	<i>Mangifera sylvatica</i> Roxb.	Anacardiaceae	Tree	VU	4E
64.	Khirmi	<i>Manilkara hexandra</i> (Roxb.) Dubard	Sapotaceae	Tree	Rare	-
65.	Sofeda	<i>Manilkara zapota</i> (L.) P. van Royen (Ex)	Sapotaceae	Tree	LC	4F
66.	Datranga	<i>Melastoma malabathricum</i> L. (Ex)	Melastomataceae	shrub	LC	4G
67.	Mainakanta	<i>Meyna spinosa</i> Roxb. ex Link	Rubiaceae	Shrub	LC	4H
68.	Bakul	<i>Mimusops elengi</i> L.	Sapotaceae	Tree	LC	4I
69.	Sajna	<i>Moringa oleifera</i> L.	Moringaceae	Tree	LC	4J
70.	Tut	<i>Morus alba</i> L. (Ex)	Moraceae	Tree	LC	4K
71.	China cherry	<i>Muntingia calabura</i> L.	Muntingiaceae	Tree	-	4L
72.	Paddo, Komol	<i>Nelumbo nucifera</i> Gaertn.	Nelumbonaceae	Herb	LC	4M
73.	Phanimanasa	<i>Opuntia dellenii</i> Haw. (Ex)	Cactaceae	shrub	LC	4N
74.	Passion fruit	<i>Passiflora edulis</i> Sims. (Ex)	Passifloraceae	Clim.	LC	4O
75.	Jhumka lata	<i>Passiflora foetida</i> L. (Ex)	Passifloraceae	Clim.	LC	5A
76.	Avocado	<i>Persea americana</i> P. Mill. (Ex)	Lauraceae	Tree	CD	-
77.	Khudi Khejur	<i>Phoenix acaulis</i> Buch.-Ham. ex Roxb.	Arecaceae	Tree	VU	5B
78.	Orboroi	<i>Phyllanthus acidus</i> (L.) Skeels.	Phyllanthaceae	Tree	LC	5D
79.	Amloki	<i>Phyllanthus emblica</i> L.	Phyllanthaceae	Tree	LC	5E
80.	Khai babla	<i>Pithecellobium dulce</i> (Roxb.) Benth.(Ex)	Leguminosae	Tree	LC	-
81.	Murmuri	<i>Polyalthia suberosa</i> (Roxb.) Thw. (Ex)	Annonaceae	Tree	Rare	5F
82.	Mock strawberry	<i>Potentilla indica</i> (Jacks.) Th.Wolf	Rosaceae	Herb	LC	5G
83.	Gutgutya/Neur	<i>Protium serratum</i> (Wall. ex Coelbr.) Engl.	Burseraceae	Tree	LC	5H
84.	Alu Bukhara	<i>Prunus bokhariensis</i> Royle ex C.K. Schneid. (Ex)	Rosaceae	Shrub	LC	5I
85.	Buddha Narical	<i>Pterygota alata</i> (Roxb.) R.Br.	Malvaceae	Tree	LC	5J
86.	Dalim	<i>Punica granatum</i> L. (Ex)	Lythraceae	Tree	LC	5K
87.	Sawtooth blackberry	<i>Rubus argutus</i> Link.	Rosaceae	Tree	LC	-
88.	Santol fruit	<i>Sandoricum koetjape</i> (Burm.f.) Merr. (Ex)	Meliaceae	Tree	LC	5L
89.	Joyna	<i>Schleichera oleosa</i> (Lour.) Merr.	Sapindaceae	Tree	Rare	5M

Contd.

Sl. No.	Local Name	Botanical Name	Family	Habit	Status	Fig. No.
90.	Choila	<i>Sonneratia caseolaris</i> (L.) Engl.	Lythraceae	Tree	NE	5N
91.	Amra	<i>Spondias pinnata</i> (L.f.) Kurz	Anacardiaceae	Tree	LC	6A
92.	Beelati Amra	<i>Spondias purpurea</i> L. (Ex)	Anacardiaceae	Tree	LC	-
93.	Miracle Fruit	<i>Synsepalum dulcificum</i> (Schumach. & Thonn.) Daniell	Sapotaceae	Tree	Rare	6B
94.	Noli Jam	<i>Syzygium claviflorum</i> (Roxb.) Wall. ex A.M. Cowan & Cowan	Myrtaceae	Tree	LC	6C
95.	Kalo-Jam	<i>Syzygium cuminii</i> (L.) Skeels	Myrtaceae	Tree	LC	6D
96.	Khudi jam	<i>Syzygium cymosum</i> (Lam.) DC.	Myrtaceae	Tree	NE	6E
97.	Dhaki-jam	<i>Syzygium grande</i> (Wight) Walp.	Myrtaceae	Tree	LC	6F
98.	Golab-jam	<i>Syzygium jambos</i> (L.) Alston (Ex)	Myrtaceae	Tree	LC	6G
99.	Malay apple	<i>Syzygium malaccense</i> (L.) Merr. & Perry (Ex)	Myrtaceae	Tree	LC	6H
100.	Jamrul	<i>Syzygium samarangense</i> (Blume) Merr. & Perry (Ex)	Myrtaceae	Tree	LC	6I
101.	Tentul	<i>Tamarindus indica</i> L. (Ex)	Leguminosae	Tree	LC	6J
102.	Bohera	<i>Terminalia bellerica</i> (Gaertn.) Roxb.	Combretaceae	Tree	LC	6K
103.	Horitoki	<i>Terminalia chebula</i> Retz.	Combretaceae	Tree	VU	6L
104.	Kantasingra	<i>Trapa natans</i> var. <i>bispinosa</i> (Roxb.) Makino	Lythraceae	Herb	LC	6M
105.	Paniphall	<i>Trapa natans</i> L.	Lythraceae	Herb	LC	6N
106.	Bonlichu	<i>Xerospermum noronhianum</i> (Blume) Blume	Sapindaceae	Tree	Rare	-
107.	Jangli-kul	<i>Zizyphus glabrata</i> Heyne ex Roth	Rhamnaceae	Tree	EN	-
108.	Jangli Boro	<i>Zizyphus oenoplia</i> (L.) Mill.	Rhamnaceae	Shrub	Rare	6O

taxa) in Bangladesh territory is very smaller compared to the world record (27,400) (French, 2019); therefore, a comprehensive field survey, exploitation, conservation and (large-scale) cultivation, through cultivar development, of MF genetic resources is strongly recommended. Many MF species, also known as “Food for the Poor” (Dandin and Kumar, 2016), are very nutritious, climate-resilient, well adapted to marginal lands and with low-cost inputs, thus may be of great benefit for the survival of poor communities and sustainability of agricultural ecosystems (Saúco, 2008; Krishna *et al.*, 2019). The production (and trade) of MFs could play an important role not only in food and nutrition security but also as a source of income (Altendorf, 2018).

Although MFs are commonly used/consumed as sources of micronutrients and phytochemicals – vitamins and minerals, antioxidants, etc., most of these (97 taxa) also have multiple (Ethno-) medicinal uses (Table 4). Along with the treatment of some common diseases e.g., cold, fever, cough,

stomachache, asthma, scabies, skin diseases, etc., these MFs are also used for the treatment and/or lowering the risk of some of the deadliest diseases of the world e.g., cardiac problem, diarrhoea and dysentery, diabetes, respiratory tract infection, etc. (<https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death>). The underutilized MF crops have also vast potential for the production of value-added products, with high therapeutic, medicinal values and antioxidant properties, and free from the residue of toxic chemicals (Krishna *et al.*, 2019). Among these species, some MFs e.g., amloki, bael, amrul, bilimbi, horitoki, bohera, kathbel, tentul, ber, kalo-jam/jamun, pomegranate, kamranga, etc., are very common and most popular among the rural people for their medicinal values. Many other fruit species are utilized by the tribal people. Eight MF species were recognized as threatened and/or near-threatened *viz.* endangered 2, vulnerable 5 and near-threatened 1, according to IUCN Red List categories (<https://www.iucnredlist.org/>); thirteen

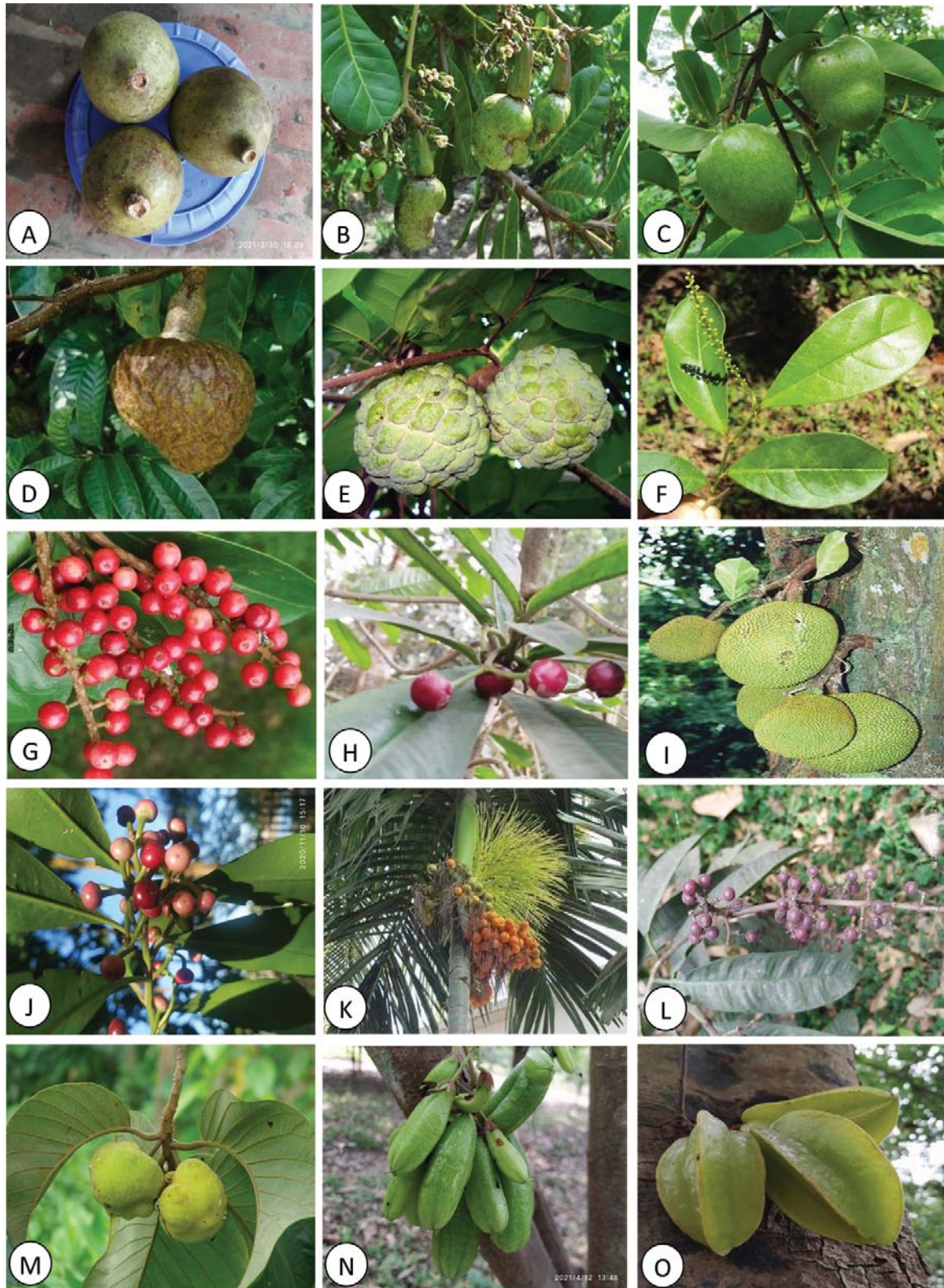


Figure 1: Photographs of minor fruit plants conserved at the Botanic Garden, Bangladesh Agricultural University. A. *Aegle marmelos*; B. *Anacardium occidentale*; C. *Annona glabra*; D. *Annona reticulata*; E. *Annona squamosa*; F. *Antidesma acidum*; G. *Antidesma buniuz*; H. *Ardisia humilis*; I. *Ardisia sanguinolenta*; J. *Ardisia solanacea*; K. *Areca catechu*; L. *Artocarpus chama*; M. *Artocarpus lacucha*; N. *Averrhoa bilimbi*; O. *Averrhoa carambola*.

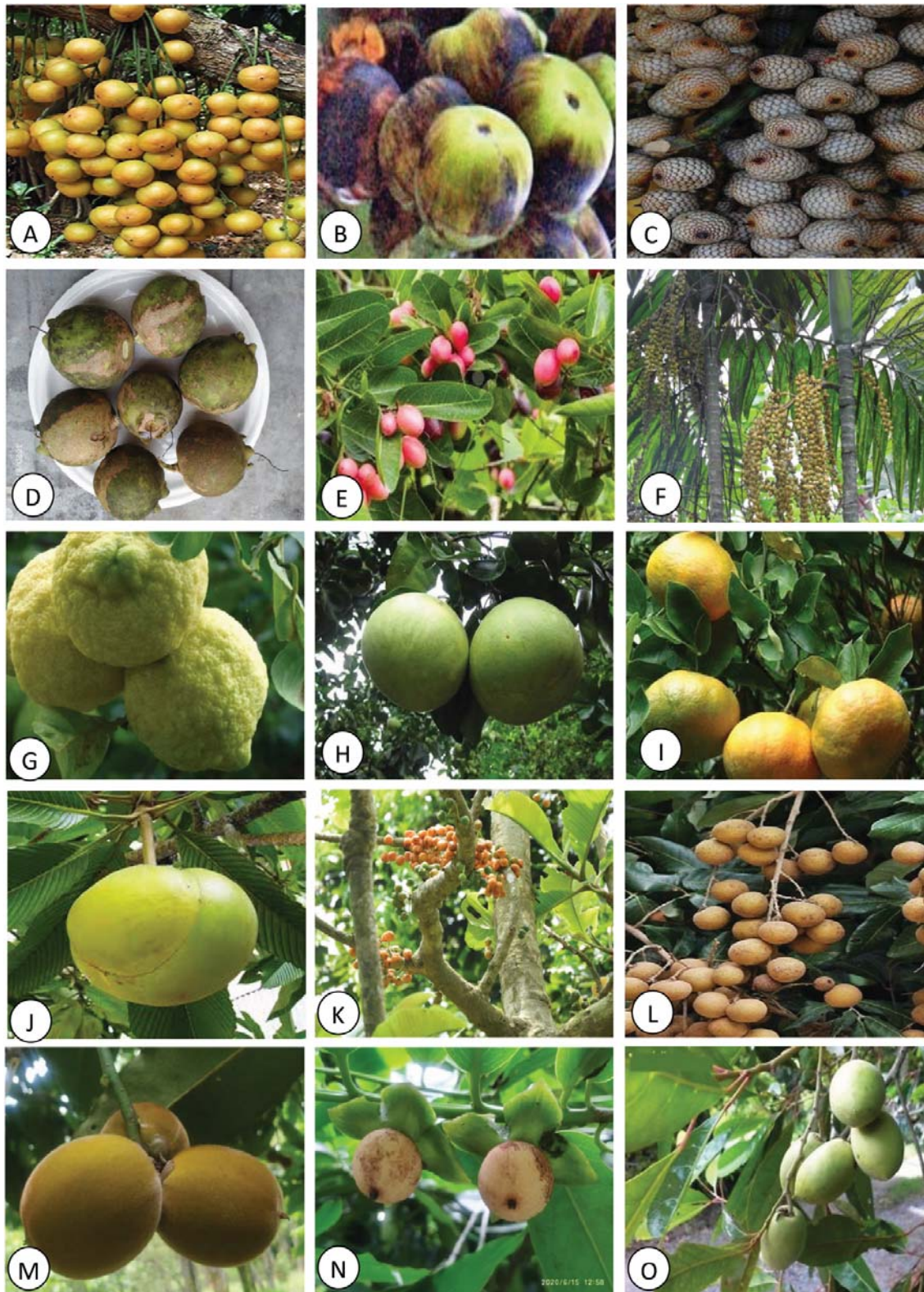


Figure 2: Photographs of minor fruit plants conserved at the Botanic Garden, Bangladesh Agricultural University. A. *Baccauria ramiflora*; B. *Borassus flabellifer*; C. *Calamus manillensis*; D. *Careya arborea*; E. *Carissaa carandas*; F. *Caryota urens*; G. *Citrus assamensis*; H. *Citrus maxima*; I. *Citrus reticulata*; J. *Dillenia indica*; K. *Dillenia pentagyna*; L. *Dimocarpus longan*; M. *Diospyros blancoi*; N. *Diospyros malabarica*; O. *Elaeocarpus floribundus*.

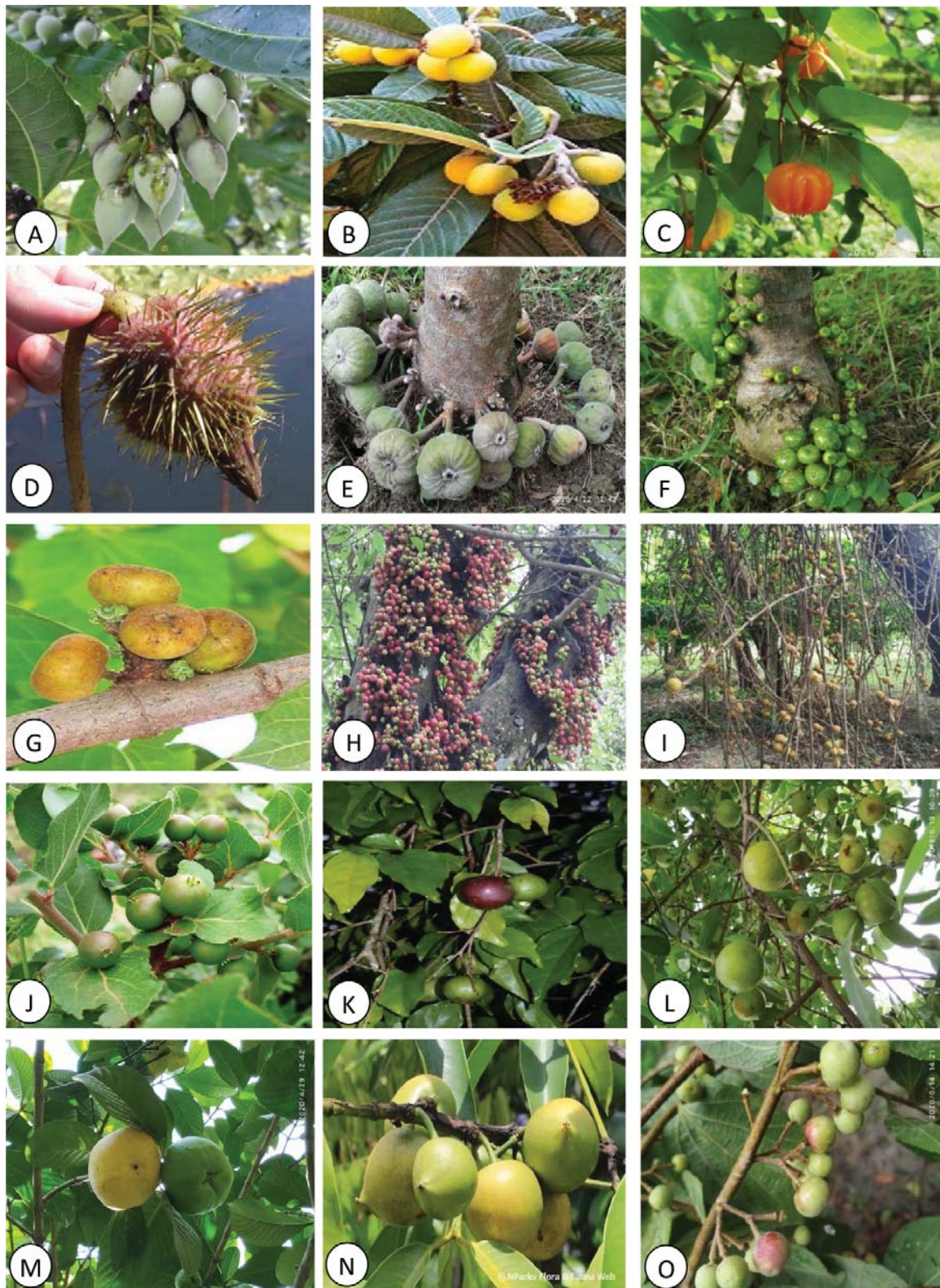


Figure 3: Photographs of minor fruit plants conserved at the Botanic Garden, Bangladesh Agricultural University. A. *Elaeocarpus grandiflorus*; B. *Eriobotrya japonica*; C. *Eugenia uniflora*; D. *Euryale ferox*; E. *Ficus auriculata*; F. *Ficus fistulosa*; G. *Ficus hispida*; H. *Ficus racemosa*; I. *Ficus semicordata*; J. *Flacourtia indica*; K. *Flacourtia jangomas*; L. *Garcinia cowa*; M. *Garcinia pedunculata*; N. *Garcinia xanthochymus*; O. *Grewia asiatica*.

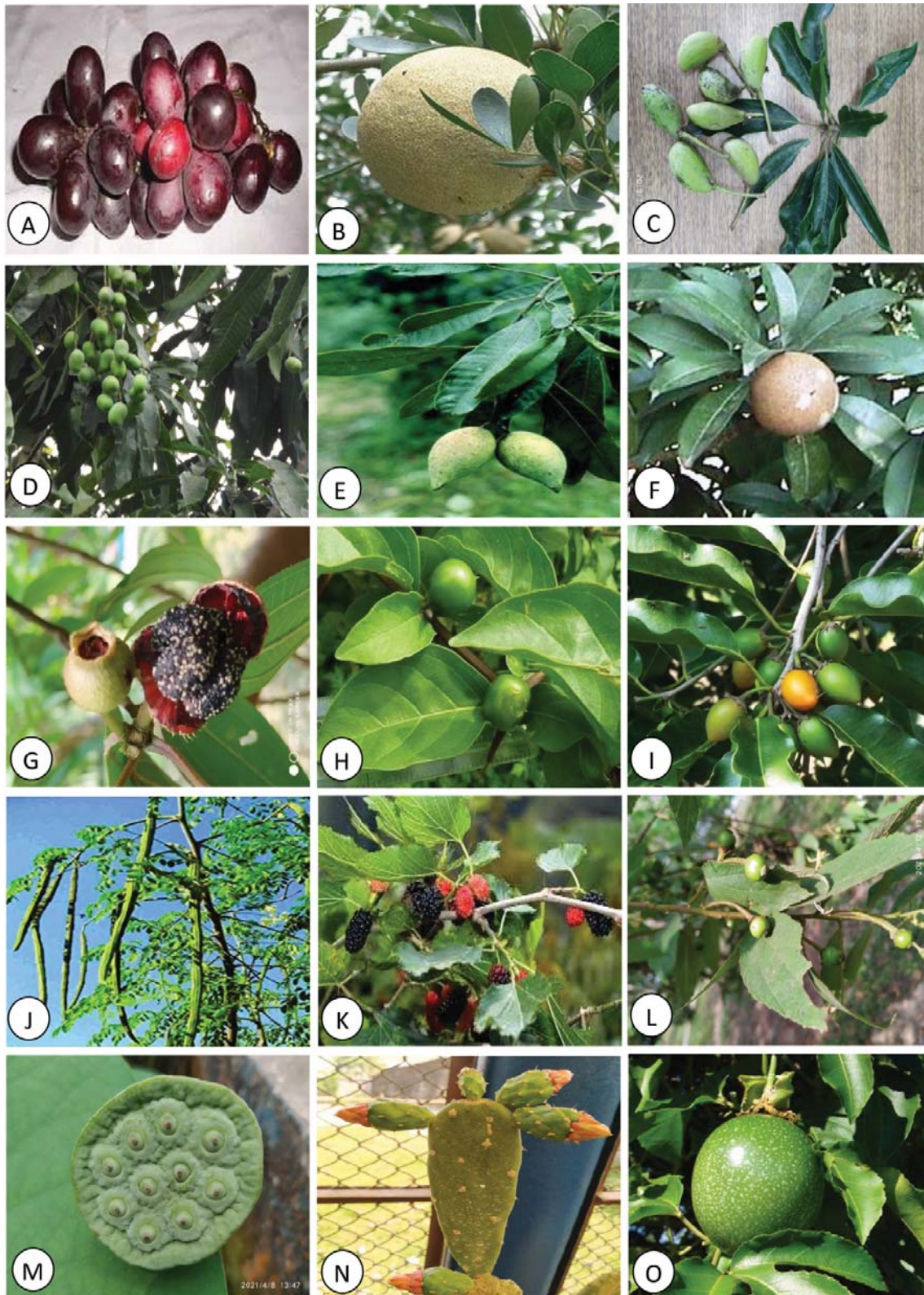


Figure 4: Photographs of minor fruit plants conserved at the Botanic Garden, Bangladesh Agricultural University. A. *Haematacarpus validus*; B. *Limonia acidissima*; C. *Madhuca longifolia*; D. *Mangifera longipes*; E. *Mangifera sylvatica*; F. *Manikara zapota*; G. *Melastoma malabathricum*; H. *Meyna spinosa*; I. *Mimusops elengi*; J. *Moringa oleifera*; K. *Morus alba*; L. *Muntingia calabura*; M. *Nelumbo nucifera*; N. *Opuntia dellenii*; (O) *Passiflora edulis*.

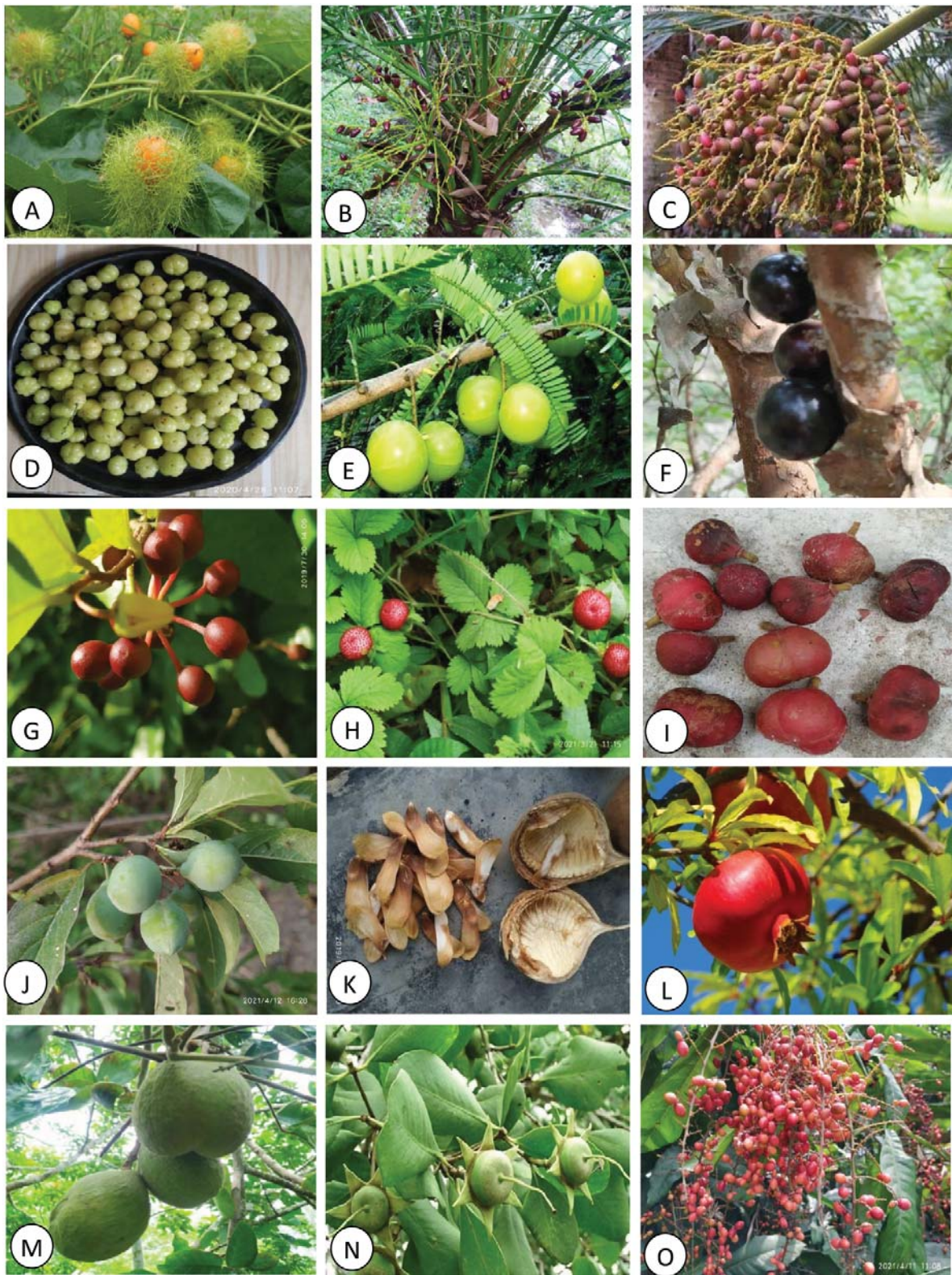


Figure 5: Photographs of minor fruit plants conserved at the Botanic Garden, Bangladesh Agricultural University. A. *Passiflora foetida*; B. *Phoenix acaulis*; C. *Chamaerops humilis*; D. *Phyllanthus acidus*; E. *Phyllanthus emblica*; F. *Plinia cauliflora*; G. *Polyalthia suberosa*; H. *Potentilla indica*; I. *Protium serratum*; J. *Prunus bokhariensis*; K. *Pterygota alata*; L. *Punica granatum*; M. *Sandoricum koetjape*; N. *Sonneratia caseolaris*; O. *Lepisanthes senegalensis*

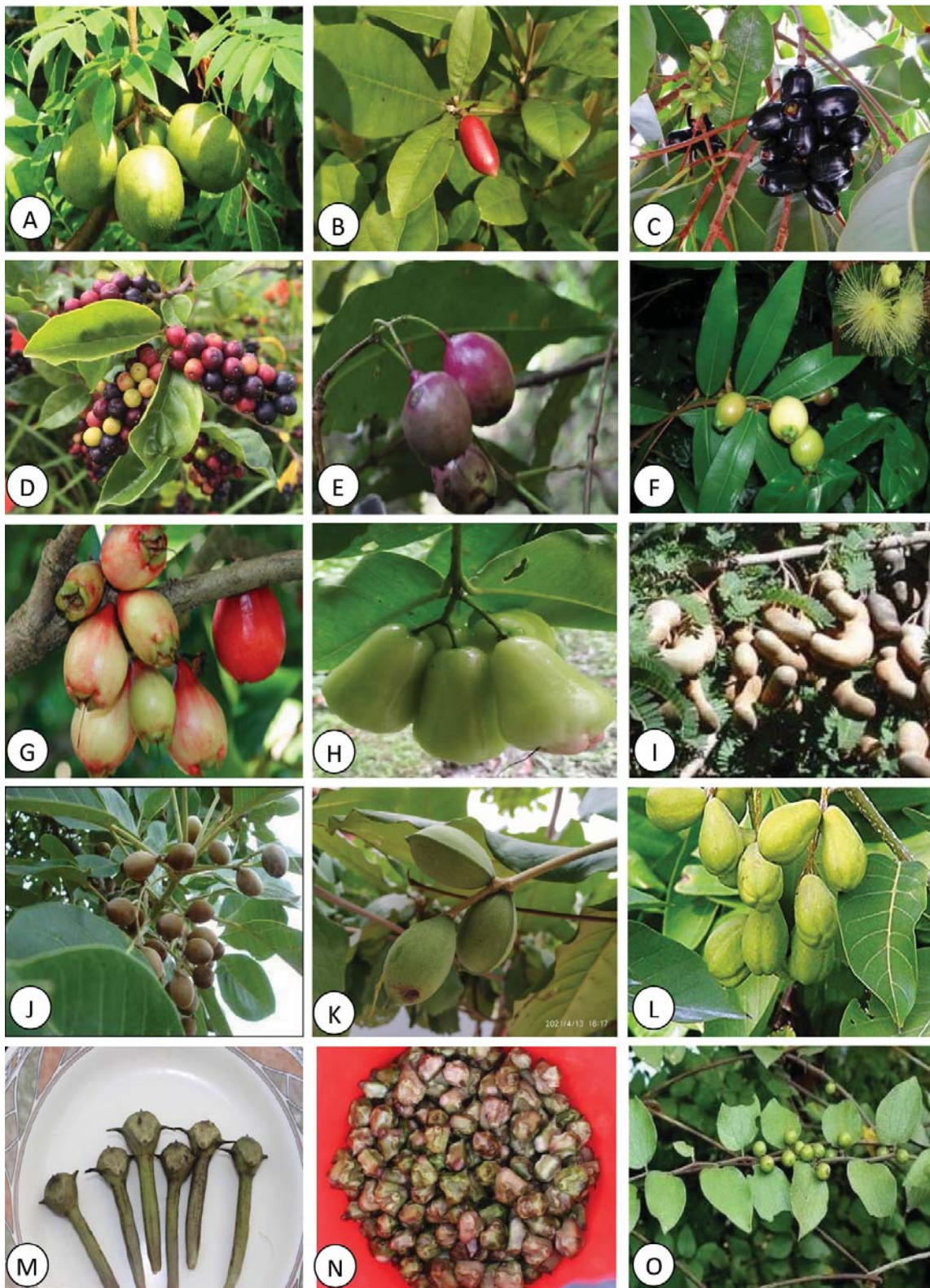


Figure 6: Photographs of minor fruit plants conserved at the Botanic Garden, Bangladesh Agricultural University. A. *Spondias pinnata*; B. *Synsepalum dulcificum*; C. *Syzygium cuminii*; D. *Syzygium cymosum*; E. *Syzygium firmum*; F. *Syzygium jambos*; G. *Syzygium malaccense*; H. *Syzygium samarangense*; I. *Tamarindus indica*; J. *Terminalia bellerica*; K. *Terminalia catappa*; L. *Terminalia chebula*; M. *Trapa natans* var. *bispinosa*; N. *Trapa natans*; O. *Zizyphus oenoplia*.

Table 2: Family-wise distribution of minor fruit taxa at the Botanical Garden, Bangladesh Agricultural University

Sl. No.	Family	Genera	Species	% of taxa in total
1	Anacardiaceae	3	5	4.63
2	Annonaceae	2	4	3.70
3	Apocynaceae	1	1	0.93
4	Arecaceae	6	6	5.56
5	Burseraceae	1	1	0.93
6	Cactaceae	1	1	0.93
7	Clusiaceae	1	5	4.63
8	Combretaceae	1	2	1.85
9	Dilleniaceae	1	2	1.85
10	Ebenaceae	1	3	2.78
11	Elaeocarpaceae	1	3	2.78
12	Lauraceae	1	1	0.93
13	Lecythydaceae	1	1	0.93
14	Leeaceae	1	1	0.93
15	Leguminosae	2	2	1.85
16	Lythraceae	3	4	3.70
17	Malvaceae	3	3	2.78
18	Melastomataceae	1	1	0.93
19	Meliaceae	1	1	0.93
20	Menispermaceae	1	1	0.93
21	Moraceae	3	8	7.40
23	Moringaceae	1	1	0.93
24	Muntingiaceae	1	1	0.93
25	Myrtaceae	2	8	7.41
26	Nelumbonaceae	1	1	0.93
27	Nymphaeaceae	1	1	0.93
28	Oxalidaceae	1	2	1.85
29	Passifloraceae	1	2	1.85
30	Phyllanthaceae	3	6	5.56
31	Primulaceae	1	3	2.78
32	Rhamnaceae	1	2	1.85
33	Rosaceae	4	4	3.70
34	Rubiaceae	1	1	0.93
35	Rutaceae	3	7	6.48
36	Salicaceae	1	3	2.78
37	Sapindaceae	4	4	3.70
38	Sapotaceae	5	6	5.56
Grand Total		67	108	100

species are rare/very rare in the wild. Another institute, the Germplasm Centre (of Fruit Tree Improvement Project), of Bangladesh Agricultural University is also maintaining the germplasms of 67 MFs of Bangladesh (Rahim *et al.*, 2011). Only about one-third of MFs (of Bangladesh) were under

cultivation (Pasha and Uddin, 2019), others are collected directly from the wild. The reckless collection and over-exploitation from the wild and illegal trade are some of the major drivers of biodiversity losses in the country (Sarwar, 2019). Awareness of the importance and utility of the

Table 3: Top ten species-rich genera of minor fruits at the Botanical Garden, Bangladesh Agricultural University

Genus	No. of species	% in total
<i>Syzygium</i>	7	6.48
<i>Citrus</i>	5	4.63
<i>Ficus</i>	5	4.63
<i>Garcinia</i>	5	4.63
<i>Annona</i>	3	2.78
<i>Antidesma</i>	3	2.78
<i>Ardisia</i>	3	2.78
<i>Diospyros</i>	3	2.78
<i>Elaeocarpus</i>	3	2.78
<i>Flacourtia</i>	3	2.78

underutilized fruit species should be enhanced to encourage and engage the local people/communities to participate in the conservation efforts. Recently, the Bangladesh Government enhanced the Protected Area (PA) management strategies by recognizing the benefits of collaboration with local communities in their management (DoE, 2015). The co-management, inclusion of local people/beneficiaries in management, of PAs coupled with alternative livelihood opportunities had given impacts biodiversity conservation. Moreover, most of the MF crops are perennial in nature, its cultivation has other benefits for example reduces environmental pollution, improves ecological balance, helps soil and water conservation and also enhances the beauty of the surroundings.

CONCLUSION

Out of the total 255 MF species of Bangladesh, only 108 species are collected and preserved at the BAUBG. The remaining species would be collected and conserved. The conserved MF species might be multiplied and distributed among the rural people and different habitat restoration programmes. The development of improved cultivars and new value-added products and/or by-products, and the expansion of the planting area of these MF species hold great potentials for improving nutrition and food security in Bangladesh and the world as well.

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Table 4: Medicinal uses of minor fruit plants at the Botanical Garden, Bangladesh Agricultural University

Sl. No.	Local Name	Parts used	Medicinal Uses
1.	Ada jamir	Fruits	Laxative, appetizer, stomachic, digestive, anthelmintic, dyspepsia, flatulence, helminthiasis, cold fevers, sore throats, sinusitis, bronchitis, asthma, antidepressant, rheumatism arthritis, obesity, an astringent, herpes, cuts, insect bites
2.	<i>Alu Bukhara</i>	Seed and young shoots	Toxic
3.	Amloki	Fruits, fresh bark	Jaundice, dyspepsia & coughs, cardiac problem, nasal congestion, retention of urine, diabetes, eye diseases & high cholesterol
4.	Amra	Unripe fruits	Diabetes, heart ailment & urinary troubles
5.	Amrul	Fruits and bark	Tuberculosis, mouth infection, stomach ache and abdominal ailments, cough, yellow urine, bad appetite, deep bone pains, diabetes, gonorrhoea, swollen stomach after childbirth, sore throat, bronchitis, constipation
6.	Ashphal	Fruits	Anti-depressant, neuroathenic neurosis and insomnia, reduce the risk of cancer, improve blood circulation, prevents anaemia, reduce the risk of cardiac arrest & strokes
7.	Avocado	Leaves, bark, fruit, seed	Dysentery, coughs, high blood pressure, liver problems, gout, diarrhoea, blood cholesterol, promote hair growth, smooth skin and treat skin conditions, aphrodisiac
8.	Bael	Ripe fruits	Fever, catarrh or the inflammation of the mucous membrane and asthma, melancholia or a depressed unhappy emotional state, scurvy, chronic diarrhoea & irritation of the alimentary tract
9.	Baichi	Ripe fruits, leaves, roots, bark	Snakebite, malaria, diarrhoea, pneumonia, intestinal worms, arthritis jaundice & enlarged spleens
10.	Bakul	Fruits, leaves and bark, flowers	Diarrhoea & dysentery, gum inflammation, toothache, gonorrhoea, snakebites, fever, headache
11.	Batabi Lebu	Leaves, fruits and seeds, flowers	Coughs, fevers, gastric disorders
12.	Beelati Amra	Fruits and leaves	Swollen glands & trauma, headache, constipation, dysentery & diarrhoea
13.	Beelati Gab	Fruits, leaves, bark	Cough & stomach ache, fever & also skin diseases
14.	Betphal		Stomach problems including ulcers, inflammation of the stomach lining, diarrhoea, intestinal gas, upset stomach
15.	Bilimbi	Fruits, flowers, leaves	Applied as a paste or itches, swelling of mumps & rheumatism & on skin eruptions, venereal diseases, coughs, beriberi & biliousness, fever, inflammation, rectal bleeding, internal haemorrhoids
16.	Bohera	Fruits	Diarrhoea and indigestion, chronic constipation, upper respiratory tract infections
17.	Bon chalta	Unripe fruits	Vata, khapa, anal fistula, wounds, diabetes, diabetic carbuncle, neuritis, pleurisy, pneumonia, burning sensation
18.	Bon Khejur	Ripe fruits, sap	Heart ailments, abdominal complaints, fever, vomiting and loss of consciousness, gonorrhoea
19.	Bon supari	Seed, root, bark, flower	Gastric ulcers, migraine headaches, snake-bite poisoning and rheumatic swellings, tooth ailments, boils, promoting hair growth
20.	Bonchalita	Tender shoots, leaves, roots, fruits	Guinea worms, snake-bite
21.	Bonjam	Roots, bark	Fever, dropsy, diarrhoea, rheumatism, concussion or bruises, indigestion
22.	Bonjami	Root, leaves, fruits, whole plant	Diarrhoea, cough, rheumatism or lumbago, colic, gonorrhoea, antileprotic, liver diseases, fever
23.	Bonlichu	Fruits, leaves	Stomach-ache
24.	Buddha Narical	Fruit, bark	Narcotic, haemorrhoids, dropsy, swelling oedema, gout, leprosy, pain
25.	Chagal ladi	Whole plant, seeds, flowers, roots	Epilepsy, mental illness, hemicranias, jaundice, hepatralgia, cough, gastropathy, hernia, haemorrhoids, helminthiasis, dyspepsia & skin diseases
26.	Chalta	Unripe fruits	Vata & kapha disorders, fatigue, abdominal pains, regulate the heat of the body & tone up the nervous system.
27.	Chauldhoa	Fruit, leaves	Cancer, heart diseases, liver poisoning, scabies
28.	Choila	Plant, leaves, ripe fruits	Haemostatic, sprains, swellings, worms, coughs, make poultices onto cuts and bruises, haematuria, smallpox
29.	Choto Sialbuka	Fruits, leaves	Heart diseases, high blood pressure, coughs, indigestion, syphilis, gonorrhoea
30.	Dalim	Ripe fruits	Diarrhoea, dysentery & intestinal parasites, nose bleeding, gum bleeding.
31.	Datranga	Leaves, shoots, barks, seeds,	Diarrhoea, dysentery, haemorrhoids, cuts and wounds, toothache, stomachache, antinociceptive, anti-inflammatory,

Sl. No.	Local Name	Parts used	Medicinal Uses
32.	Dephall	and roots	wound healing
33.	Deshi Gab	Ripe fruits	Anorexia, biliousness, dysentery, jaundice, malaria, pain, phlegm.
34.	Dewa	Ripe fruits	Heal sores & wounds, diarrhoea & dysentery, blood disease, gonorrhoea & leprosy, bilious fever, tumours
35.	Elena	Ripe fruits	Pimples, cuts and wounds, skin ailments, headache
36.	Fapa-dumur	Leaves, roots, ripe fruits	Dysentery & bile complaints, dropsy, muscular pains, pneumonia, sores
37.	Goda	Root, leaves	Diaphoretic, post-natal treatment, narcotic
38.	Golab-jam	Root, bark	Astringent, anthelmintic, gastrointestinal disorders
39.	Gutguya	Ripe fruits	Diarrhoea, dysentery and catarrh, diabetes, asthma, bronchitis and hoarseness, sore eyes, rheumatism, epilepsy
40.	Gutta-gam	Ripe fruits	Mouth ulcers
41.	Horitoki	Fruits	Dysentery, gastritis, anti-inflammatory
42.	Hostikorni dumur	Fruits, bark, leaves	Leprosy, anaemia, narcosis, fever, piles, heart diseases, diarrhoea, anorexia
43.	Jalpai	Stem latex, fruits	Cuts, wounds, cuts, wounds
44.	Jamrul (Thai)	Leaves, bark, fruits	Diarrhoea. Juice is very good for quenching thirst for diabetic patient
45.	Jangli boroi	Young leaves, shoots, flowers, fruits	Tuberculosis, mouth infections, stomach ache and abdominal ailments, red eyes, skin infections, cough, yellow urine, bad appetite, deep bone pains, diabetes
46.	Jhumka lata	Leaves, bark, ripe fruits	Wounds, mouthwash for sore throats, dysentery, inflammation of the uterus
47.	Jog dumur	Leaves, stem	Sleeping problems, itching, cough, anthelmintic, for intestinal nematodes and flatworms, colds, chest coughs, tuberculosis, worms, improve fertility in women, antispasmodic, snake bite
48.	Joyna	Ripe fruits	Diabetes, liver disorders, diarrhoea, inflammatory conditions, haemorrhoids, respiratory, urinary diseases
49.	Kaju-badam	Bark, seed, fruit	Itching, acne, burns, other skin troubles, rheumatism (external massage), hairdressing, hair growth, astringent, leprotic ruptures, skin inflammations, ulcers, malaria
50.	Kak dumur	Peduncle, cotyledons, bark, nut	Tooth abscesses, diarrhoea, snake bites, antifungal agent, cracked heels
51.	Kalo-Jam	Roots, bark, fruits	Fevers, antiperiodic, emetic, tonic, emetic, liver problems, ulcers, psoriasis, anaemia, piles, jaundice, vitiligo, hemorrhage, diabetes, convulsion, hepatitis, dysentery, biliousness, lactagogue, purgative
52.	Kamranga	Ripe fruits	Source of iron, diabetes, heart and liver troubles, quenching thirst for diabetic patients
53.	Kantasingra	Leaves, flowers, fruits	Antimicrobial activity against <i>E. coli</i> , <i>Salmonella typhi</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i>
54.	Karamcha	Fruit	Stomach problems, genitourinary system, liver, kidney, spleen, astringent, stomachic, diuretic, febrifuge, antiseptic
55.	Kathbel	Ripe & unripe fruits	Rich source of iron and vitamin C, antiscorbutic, anaemia
56.	Kaufal	Ripe fruits	Diarrhoea, dysentery, hiccup, sore throat, snakebite, biliousness, intestinal troubles of children
57.	Khaia Babla	Fruit, fruit rind, leaves, bark	Cramps, dysentery, headache, nausea, stomach ache, vomiting
58.	Khejur	Bark, pulp, leaves, seed	Astringent, gum ailments, toothache and bleeding, chronic diarrhoea, dysentery, constipation, tuberculosis, spontaneous abortion, gall bladder ailments, wounds, ulcers
59.	Khirmi	Ripe fruits, sap	Worms, heart ailments, fever, stomach pain, etc.
60.	Khudi jam	Fruits and bark, flowers	Dental ailments, wound and dysentery, disease of gums, blood diseases
61.	Komla	Ripe fruits	Antimalarial activity
62.	Kumbhi	Fruit and fruit rind	Dyspepsia, gastro-intestinal distension, cough with profuse phlegm, hiccup and vomiting, hernia, lumbago, mastitis, pain on swelling of the testes
63.	Lal mesta	Fruit, bark, leaves	Body swelling, cough and colds
64.	Latkan	Fruit, leaves	Laxative, increase urination, feet cracks, bilious, sores, wounds, sour throat, wounds healing, antimicrobial, emollient, antipyretic, diuretic, anti-helminthic, sedative, cough poultice on abscesses
65.	Loquat	Bark	Eye inflammation, sore eyes
		Fruits	Bronchitis, cough, feverish colds, allaying vomiting, thirst

Sl. No.	Local Name	Parts used	Medicinal Uses
66.	Mahua	Flowers, Ripe fruits	Bleeding gums and ulcers, diabetes, neurotic disorder, heart diseases, cough, ear troubles and bronchitis
67.	Mainakanta	Fruits, leaves	Phlegm & bile, diphtheria
68.	Makhna	Fruits, young stalks, rhizomes	Chronic diarrhoea, vaginal discharge, kidney weakness
69.	Mangosteem	Fruits	Abdominal pain, diarrhoea, dysentery, infected wound, suppuration, chronic ulcer
70.	Miracle fruit	Root, leaves, bark	Diabetic, blood cholesterol-lowering, anti-hyperuricaemia, antioxidant, anticonvulsant, anticancer, malaria, hyperthermia, prostate ailments, gonorrhoea, asthma, male infertility, weight loss
71.	Mock strawberry	Plant, leaves	Anticoagulant, antiseptic, deparative, febrifuge, diarrhoea, digestive upsets, gout, laryngitis, acute tonsillitis and as a gargle for sore throats
72.	Murmuri	Fresh root, bark	Abortifacient, abdominal pain, febrifuge analgesic, laxative
73.	Nona-ata	Ripe fruits	Worms, abscesses and ulcers, diarrhoea and dysentery.
74.	Orboroi	Fruits, leaves	Asthma, cure skin diseases, itching, fever, urticaria, treat bronchial catarrh, enrich the blood
75.	Paddo	Rhizomes, leaves, seeds	Hematemesis, epistaxis, hematuria, lowering blood sugar levels, diarrhoea, cholera, fever, hyperdipsia
76.	Paniala	Fruit, young shoots	Jaundice, enlarged spleens, diarrhoea and dysentery, malaria, snakebites
77.	Paniphal	Fruit	Elephantiasis, pestilent fevers, rheumatism, sores, sunburn, skin complaints
78.	Passion fruit	Fruit, flower	Mild sedative, bronchial asthma, insomnia, nervous gastrointestinal disorders, menopausal problems, rheumatism or gout, diuretic, inhibition of the cancer cell growth
79.	Phalsa	Fruits	Pustular eruptions, rheumatism
80.	Phanimanasa	Fruit, leaves	Anti-inflammatory, anti-oxidant, antidiabetic activity, immunomodulatory effect, anti-depressant, hypotensive, in acute liver injury, low-density lipoprotein peroxidation, anti-hyperlipidemia
81.	Pond apple	Bark, leaves	Flatworms, nematodes, sedative, cardiotoxic infusion, anticancer
82.	Raktagota	Fruits, leaves	Sore throat, inflamed tonsils, liver
83.	Rough lemon	Fruits, leaves	Arthritis, digestive disorders, analgesic, anti-inflammatory, antioxidant, anthelmintic, antibacterial, antifungal, hypolipidemic, antihypertensive, antidiabetic, hypoglycemic activity
84.	Rudhrakha	Fruit, seeds, bark	Poison antidote, mental diseases, epilepsy, asthma, hypertension, arthritis, liver diseases, blood pressure, heart ailments, stomach-ache, chest and shoulders pain, enlarged spleen
85.	Sadimadi dumur	Roots, bark, fruits	Headaches, fevers, menstrual disorders, gastric troubles, peptic ulcers, constipation
86.	Sajna	Leaves, roots, seed, bark, fruit, flowers, immature pods	Cardiac and circulatory stimulants, possess antitumor, antipyretic, antiepileptic, anti-inflammatory, antiulcer, diuretic, antispasmodic, antihypertensive, cholesterol-lowering, antioxidant, antidiabetic, hepatoprotective, antibacterial and antifungal activities
87.	Santol	Leaves, Bark, roots	Fever, diarrhoea, tonic after childbirth, ringworm, carminative, dysentery, anti-cancer activity, anti-spasmodic, carminative, antiseptic, astringent, stomachic
88.	Satkora	Fruit	Vasoconstriction, elevation of blood pressure, relaxation of bronchial muscle, gastrointestinal disorders, insomnia, headaches, cardiovascular diseases, cancer, antiseptic, antioxidant, antispasmodic, aromatic, astringent, carminative, digestive, sedative, stimulant, stomachic, tonic
89.	Sharifa	Root, leaves, seed	Analgesic, anti-inflammatory, anti-microbial, cytotoxic, anti-lipidemic, anti-ulcer, molluscicidal properties, genotoxic, vasorelaxant, anti-tumour, hepatoprotective, larvicidal, insecticidal, anthelmintic
90.	Siyal Buka	Fruit, leaves, roots and stem	Measles, chickenpox, malaria, headache, thrush in children, diuretic
91.	Sofeda	Ripe fruits	Diarrhoea, relieve pulmonary complaints, coughs, colds, expel bladder and kidney stones
92.	Star Apple	Fruits, roots, leaves	Inflammation in laryngitis and pneumonia, diabetes mellitus, to relieve angina, intestinal disturbance
93.	Supari	Seed	Hunger, abdominal discomfort, anaemia, leucoderma, leprosy, obesity
94.	Tal	Fruits, endosperm, latex	Biliousness, dysentery, gonorrhoea, liver disorders, ulcers, heartburn, enlarged spleen & liver
95.	Tentul	Ripe and unripe fruits	Stomach disorders, general body pain, jaundice, yellow fever, blood tonic, skin cleanser, antiseptic, scurvy, cough
96.	Thoikar	Ripe and unripe fruits	Carminative, unripe angina pectoris, abdominal tumour, haemorrhoids, to allay thirst, biliousness, constipation, heartburn; appetizer; gains weight
97.	Tut	Ripe fruits, root	Leukaemia, hyperuricemia & gout, diabetes

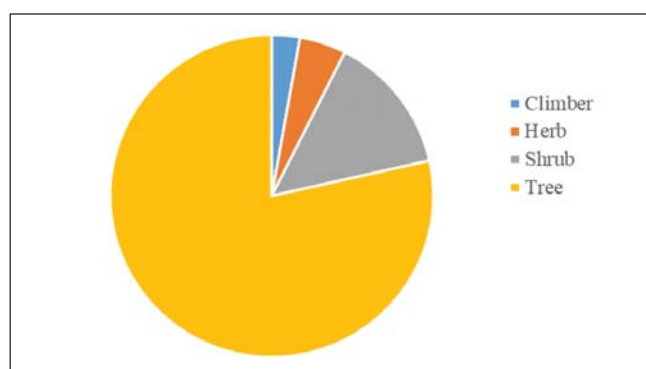


Fig. 7: Growth habit of minor fruits at Botanical Garden, Bangladesh Agricultural University

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