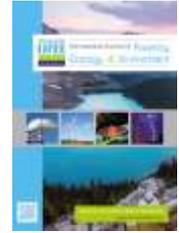


Published with Open Access at **Journal BiNET**

Vol. 01, Issue 01: 10-20

International Journal of Forestry, Ecology and EnvironmentJournal Home: www.journalbinet.com/ijfee-journal.html

Diversity of underutilized fruits and their uses in Karnaphuli range, Rangamati, Bangladesh

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Article received: 30.01.2020; Revised: 17.02.2020; Published online: 15 April 2020.

ABSTRACT

Underutilized fruits were important sources of food for humankind, before the dawn of civilization. These fruits play a vital role in the supplement of nutrition of marginal people. To determine the diversity of underutilized fruits both cultivated and wild, a field survey was conducted from May 2015 to May 2016 using a semi-structured questionnaire in the Karnaphuli range of Kaptai reserve forest, Rangamati, Bangladesh. A total of 40 households (more than 50% population) in two enclaves of the locality were surveyed. Plant species were preserved in herbarium sheet and were brought to the laboratory for identification consulting monograph and Taxonomist. The local inhabitants used a total of thirty one species underutilized fruits from twenty four genera and seventeen families. Of these, eighty percent was grown in wild and only nine percent of fruits were cultivated. Most of the fruits come from Euphorbiaceae (12%) followed by Rutaceae (9%), Moraceae (9%), Myrtaceae (9%), Anacardiaceae (9%), Oxalidaceae (6%), Flacourtiaceae (6%) and Ebenaceae (6%). Considering the conservation status, 9% vulnerable (VU), 3% endangered (EN), 3% not evaluated (NE) and 83% fruits were least concern (LC). Among the species, Diospyros rammiflora of Ebenaceae was endangered (EN), Haematocarpus validus of Menispermaceae, Mangifera sylvatica of Anacardiaceae, Xerospermum laevigatum of Sapindaceae family were vulnerable (VU) and rarely found in wild. These fruits are taken as fruits, vegetables, preparing pickles and also used for ethnomedicinal purposes. Preferences ranking indicates that Tamarindus indica is the common and favorite fruits among the local inhabitants. They also indicate that earliest step should be taken to conserve these threatened species. Such information is essential for the conservation of those underutilized fruits (especially those grown in the wild) to safeguard them for future generations and to avoid their genetic erosion.

Key Words: Underutilized fruits, Diversity, Conservation, Karnaphuli range and Bangladesh

Cite Article: Abdullah, M. R., Haque, M. E., Sarwar, A. K. M. G., Ashrafuzzaman, M. and Rahman, M. M. (2020). Underutilized fruits and their diversity in Karnaphuli range, Rangamati, Bangladesh. International Journal of Forestry, Ecology and Environment, 01(01), 10-20.

Crossref: <https://doi.org/10.18801/ijfee.010120.1>



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I. Introduction

Forest is one of the main sources of the indigenous fruits in Bangladesh, where major forest areas now confined within the Chittagong Hill Tracts (CHT). Among the 45 smaller groups of indigenous people of the country, 13 ethnic groups have been dwelling in CHT, which is rich in natural biological resources. This area is the repository of many medicinal (Snigdha et al., 2008; Animesh et al., 2010), fiber, ornamental, fodder, vegetable, and fruit plant though some ethnic fruits are threatened and endemic with undeveloped potential uses (Arora, 2014). Khan (1974) was the pioneer who reported 43 species of edible fruits cultivated in Bangladesh followed by Das (1982) mentioned 60 solely wild grown fruits; Rashid et al. (1987) reported 40 cultivated fruits; Begum (2004) reported 55 species of cultivated fruits; Roy (2007) recorded 120 both cultivated and wild species; Hossian et al. (2011) mentioned about 70 various kinds of fruits; Rahim et al. (2011) identified and characterized 46 underutilized fruit species from different homesteads of Bangladesh and he also mentioned 67 minor fruit yielding plants of Bangladesh that are growing in the Germplasm Centre at Bangladesh Agriculture University. Finally, Pasha and Uddin (2019) reported 255 species of minor edible fruit yielding plants in Bangladesh.

Though we have reached near to self-sufficiency in food grain production, still the fruit consumption per head per day was about 77g against the minimum requirement of 115g per head per day, which indicates that their production could meet only 67% of her requirements (Bhuiyan, 2012). Minor fruit occupies 3.01% of the area and 8.38% of production compared to the total fruit production of Bangladesh (BBS, 2011). The native minor fruit production was abundant in earlier days, but recently the country spent about Tk. 8,000–10,000 million for the import of fruits from other countries (Hossain and Uddin, 2005). Underutilized fruits are well adapted to the local climate, are highly nutritious and contribute to poverty drop and household food safety of rural people and play an important role in herbal medicine. Huge numbers of tribal people are also dependent on underutilized fruit and vegetables (Rahim et al., 2009; Das and Prakash, 2011).

Karnaphuli range is one of the richest botanical areas which represents tropical rain forest mainly of an evergreen type of vegetation. Underutilized fruits are important constituents of biodiversity (Hegazy et al., 2013). The majority of local tribe communities live close to or within the forestry. Due to over exploration and jhum cultivation, forest cover losses along with forest fruits. Previously 34 plant species are under severe threat of extinction from Bangladesh (Gain, 2002). The loss of such species has serious implications on rural life and not only deprives people of essential vitamins and vital insurance against malnutrition, but also medicinal attributes and employment opportunities (Rahman, 2003). A very little study was so far carried out solely on the status of underutilized fruit diversity in the Karnaphuli range under the Kaptai reserve forest in Bangladesh. So, it's necessary to develop suitable plans and fruit production systems for fruit diversification. Therefore, it is very important to have a clear understanding of the present status of underutilized fruit diversity. The present study was taken to generate baseline information of underutilized fruits in the Karnaphuli range with their availability in nature and uses by the local inhabitant.

II. Materials and Methods

Site description

The study was conducted in two villages namely Kalabunia para and Chakua para of Karnaphuli range within the Kaptai Reserve Forest (KRF) area of Kaptai Upazila, Rangmati district, Bangladesh, under Chittagong Hill Tracts South Forest Division. The reserve forest lies between 22°26" N to 22°38" N Latitude and 92°80' E to 92°17' E longitude which is about 60 km away from Chittagong city (Annon, 1970).

Selection of key informants and households

For this study, key informants (KI) were defined as knowledgeable persons about underutilized fruits (UFs) and local conditions. After selecting two villages of KR, 12 KI (six from each village) were selected by using a snowball method to collect preliminary data and for questionnaire development following the method of Bernard (2002). Three villagers were randomly asked to call five knowledgeable persons in the village. Then, semi-structured were prepared to interview the KI and household (HH), respectively. A simple stratification of HHs respondents was conducted by age (≤ 40

and >40) and wealth (poor, medium and rich), which were commonly used in assessing the local knowledge and underutilized fruits selection (Cotton, 1996).

Data Collection

Questionnaire survey and key informant interview: Semi-structured questionnaires and botanical monographs were prepared, pretested and administered to HHs and KIs, respectively. All interviewees were met on a 'one-to-one' basis and asked the same standard (open and closed-ended) questions using the local language (Marma) based on their consent, including expansions or clarifications as needed.

Field observation and focused group discussion: Repeated field observations were conducted in the study sites by walking transects where most of the UFs are grown/cultivated. A total of 10 botanical exploration tours were made during 2015-2016. The areas were visited every month and the forest was reached by walking on foot following the existing forest trails. The purpose of the field observation was to obtain actual information of presence, growth habit, habitat characteristics and identification of underutilized fruits species mentioned during the interviews. A focused group discussion of KI was conducted at each study site to verify the data and identification of UFs.

Preference ranking: Preference ranking of selected UFs was conducted using taste and availability for each study village to assess the perception of the community. The most preferred underutilized fruits in each study villages were selected by KIs, and ranking (4-most preferred, 3-commonly preferred, 2-preferred but not so common, and 1-occasionally used) was conducted by all respondents, who followed the method of Jain et al. (2011). Similarly, ranking of conservation demand for selected underutilized fruit plants was conducted to assess the conservation status of most preferred species following the method of Jain et al. (2011) (4-for the species whose conservation is highly demanded, 3-conservation urgently demanded, 2-conservation required but not so urgent, and 1-conservation not required at present). Finally, such ranking of the species was summed up, and the average ranking was employed at the site level.

Plant identification: All encountered plants were identified and recorded by their vernacular names. Later, these were converted to their botanical names using the Encyclopedia of Flora and Fauna of Bangladesh and experience. Plant specimens were collected and taken to the Bangladesh National Herbarium for the identification of plants that were not identified in the field. List of underutilized fruits were prepared with their up-to-date nomenclature (Rahim et al., 2011; Pasha and Uddin, 2013; www.theplantlist.org).

III. Results and Discussion

Species diversity of underutilized fruits in the surveyed area

A total of 31 species (29 trees and 2 climbers) belonging to twenty four genera and seventeen families of underutilized plants used as a fruit by the people around the Karnaphuli range was identified and recorded (Table 02). It's certainly not presumed here that the list of species from this study is a complete one for the Karnaphuli range, as, due to the constraints of time and resources, the study did not cover every part of the forest. This is a substantial number and comparable to the documented from Tripura (Sankaran et al., 2006). Considering the number of species the Karnaphuli range is one the most diverse with underutilized fruits within a single place. The most dominant family was Euphorbiaceae, representing 12.90% of all species collected followed by Anacardiaceae, Moraceae, Myrtaceae and Rutaceae (each of 9.68%), Ebenaceae, Flacourtiaceae, and Oxalidaceae (6.45% of each) and rest of the families represent only 3.23% each (Table 01). Abdullah et al. (2017) recorded 35 minor fruits from the Kaptai Reserve forest. Rahim et al. (2011) recorded 46 underutilized fruits from different parts of Bangladesh.

Twenty-one of the recorded underutilized fruits are used as medicinal purposes by the local people for curing of different diseases, i.e. treating dysentery, diarrhea, cough, fever, headache, abdominal pain mouth ulcer, chicken pox and so on. Eight of them are taken solely as fruits and two of them used for preparing pickles such as Chalta and Laktan. Both the ripen and unripe fruits are most common edible parts. The bulk of the species identified (67%) were indigenous and only 23% were exotic (Table 02)

that is also a fact reflecting the localized nature of the indigenous knowledge about these medicinal plant species. The results of the study proved the diversity of underutilized fruits and varieties of uses of vegetation by of Marma tribes in the Karnaphuli range as well as indigenous communities worldwide (Kuhnlein et al., 2009; Rathore, 2009). In the study area, the collected minor fruits mostly grow in wild (80%), only 10% cultivated by local inhabitant and forest department and rest 10% grown by both (Figure 01). The minor fruits consumed by local inhabitants without considering the conservation point of view Abdullah et al. (2017). They collect without following any scientific way or kind of any conservation measure.

Table 01. Families and corresponding number of species of fruit plants identified

Family	No of species	% proportion (N = 31)
Anacardiaceae	3	9.68
Arecaceae	1	3.23
Burseraceae	1	3.23
Caesalpinaceae	1	3.23
Clusiaceae	1	3.23
Dilleniaceae	1	3.23
Ebenaceae	2	6.45
Elaeocarpaceae	1	3.23
Euphorbiaceae	4	12.90
Flacourtiaceae	2	6.45
Menispermaceae	1	3.23
Moraceae	3	9.68
Myrtaceae	3	9.68
Oxalidaceae	2	6.45
Rhamnaceae	1	3.23
Rutaceae	3	9.68
Sapindaceae	1	3.23

Conservation status

Considering the conservation status of the collected underutilized fruit, most of them are the least concern (83%). About 10 percent of the collected fruits were vulnerable and only 3 % were endangered and rest are not under any evaluation (Figure 02). Among these fruits, *Diospyros rammiflora* (EN) of Ebenaceae family is in endangered condition (Ara et al., 2013). Besides this, *Mangifera sylvatica* of Anacardiaceae (Rahman, 2013), *Xerospermum laevigatum* of Sapindaceae (Ara et al., 2013) are vulnerable. Though *Haematocarpus validus* enlisted as least concern (Ahmed et al., 2009) in our study and local inhabitant mentioned that it is rarely collected from wild (Rahim et al., 2015). This ethnic fruit plant grows in the remote areas of Chittagong Hill Tracts (CHT) and it is endemic in these natural habitats. Its population suffers from serious environmental problems such as deforestation, soil degradation, loss of biodiversity, landslides etc. So, its conservation status is highly threatened (Rahim et al., 2015).

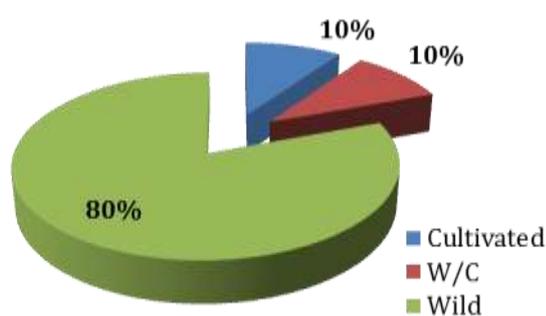


Figure 01. Percentages of fruit collected from wild and cultivated

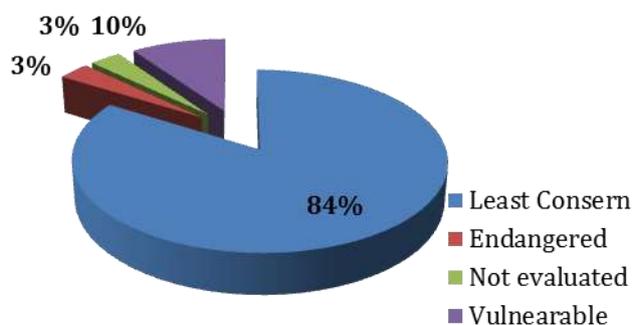


Figure 02. Conservation status of recorded underutilized fruits

Table 02. Underutilized fruits recorded in the around two villages within Karnaphuli range, Rangmati

Local Name	Scientific name	Family	Habit	Indigenous (In)/Exotic(E)	Edible parts	Conservation Status	Uses
Bel (B), Wer-e-si-apang (M)	<i>Aegle marmelos</i> (L.) Corrêa	Rutaceae	Tree	In	Fruit pulp and unripe fruit	LC ²	Ripe fruit is taken during summer to keep the body and mind cool (Faruque and Uddin, 2014).
Kaju Badam (B), Senabadam	<i>Anacardium occidentale</i> Linn.	Anacardiaceae	Tree	Ex	Ripe fruits and nuts	LC ²	Ripe fruit and nuts as a raw and fruit juice is taken internally to treat diarrhea (Bown, 1995)
Khudijam (B)	<i>Antidesma ghaesembilla</i> Gaertn.	Euphorbiaceae	Tree	In	Ripe fruit	LC ²	Ripe fruit occasionally and treat for headaches and fevers (Gardener et al., 2000)
Chapalish (B)	<i>Artocarpus chama</i> Roxb	Moraceae	Tree	In	Ripe fruit	NE ²	Ripe fruit use as a fruit. (Rahim et al., 2011)
Dewa (B), Khau (M)	<i>Artocarpus lacucha</i> Buch.-Ham.	Moraceae	Tree	In	Ripe fruit and pulp	LC ²	Ripe fruit use a fruit and fruit pulp used as tonic for the liver (Rahim et al., 2011)
Bilimbi (B)	<i>Averrhoa bilimbi</i> L.	Oxalidaceae	Tree	Ex	Ripe and unripe fruit	LC ²	Used as raw fruits and sometimes as cooked as vegetables. Flowers is used for coughs (Subhadrabandhu, 2001)
Kamranga (B)	<i>Averrhoa carambola</i> L.	Oxalidaceae	Tree	Ex	Unripe and ripe fruits	LC ²	Used raw as fruits. Crushed leaves for curing chickenpox (Farooqi, 2015).
Latkon (B), Kusumgula (C)	<i>Baccaurea ramiflora</i> Lour.	Euphorbiaceae	Tree	In	Ripe fruit	LC ²	Used as raw in ripen condition. Juice took orally for complaints of constipation (Khan, 2008)
Bet (B), Thengkhu (M)	<i>Calamus viminalis</i> Willd.	Arecaceae	Climber	In	Ripe fruits	LC ²	Ripe fruit occasionally eaten
Chilla (B)	<i>Casearia tomentosa</i> Roxb.	Flacourtiaceae	Tree	In	Ripe fruit	LC ²	Ripe fruit occasionally eaten
Jambura (B), Dopaasha (M)	<i>Citrus grandis</i> (L.) Osbeck	Rutaceae	Tree	In	Ripe fruits	LC ²	Ripe fruits edible and used in fever.
Jamir (B), Tha rock pad (M)	<i>Citrus jambhiri</i> Lush.	Rutaceae	Tree	In	ripe fruits	LC ²	Ripe fruit occasionally eaten
Krananing (M), Chalta (B)	<i>Dillenia indica</i> Linn.	Dilleniaceae	Tree	In	Unripe and ripe fruits	LC ²	Fruit are used to prepare pickle and used for abdominal pains (Rahim et al., 2011)
Bilati gab (B),	<i>Diospyros peregrina</i> (Gaertn.) Gürke	Ebenaceae	Tree	Ex	Ripe fruit	EN ¹	Fruits are edible. Used for treating mouth ulcer.
Uri Gab(B), Tafun (M)	<i>Diospyros rammiflora</i>	Ebenaceae	Tree	In	Ripe fruit	LC ²	Ripe fruit rarely eaten.
Jalpai (B)	<i>Elaeocarpus floribundus</i> Blume	Elaeocarpaceae	Tree	In	Unripe and ripe fruits	LC ²	Unripe and ripe fruits use as fruit or made into pickles. Fruits used in dysentery and diarrhoea.

Local Name	Scientific name	Family	Habit	Indigenous (In)/Exotic(E)	Edible parts	Conservation Status	Uses
Desidumur (B), Sarak (M)	<i>Ficus racemosa</i> Linn.	Moraceae	Tree	In	Unripe and ripe fruits	LC ²	Ripe fruit as fruits and unripe fruits used in diarrhoea, dysentery,
Lukluki (B), Nerechi (M)	<i>Flacourtia jangomas</i> (Lour.) Raeusch.	Flacourtiaceae	Tree	In	Ripe fruit	LC ²	Ripe fruit as fruit and used in affections of the liver.
Kaophal(B), Tahgala (M)	<i>Garcinia cowa</i> Roxb.	Clusiaceae	Tree	In	Ripe fruits	LC ²	Ripe fruit as fruit and Sun-dried slices of the fruit are used in dysentery.
Raktogota (B), Agnigola (M)	<i>Haematocarpus validus</i> (Miers.) Bakh. f. ex Forman)	Menispermaceae	Climber	In	Ripe fruits	VU ³	Ripe fruits eaten as such and used as a curative measure of anemia (Rahim et al., 2015)
Uri am(B), Gosara (M)	<i>Mangifera sylvatica</i> Roxb.	Anacardiaceae	Tree	In	Unripe and ripe fruits	VU ⁴	Ripe fruit as a fruit and immature fruits eaten by children
Amloki (B), AonlaSoisha (M)	<i>Phyllanthus emblica</i> L.	Euphorbiaceae	Tree	In	Unripe and ripe fruits	LC ²	Ripe and unripe fruit as a fruits and used in jaundice, bacillary dysentery.
Orboroi (B), Dendalum (M)	<i>Phyllanthus acidus</i>	Euphorbiaceae	Tree	Ex	Ripe fruits	LC ²	Ripe fruit eaten as such.
Gutgutia (B), Shu dui shi (M)	<i>Protium serratum</i> (Wall. ex Colebr.) Engl.	Burseraceae	Tree	In	Ripe fruit	LC ²	Ripe sour fruits are edible and used for mouth ulcer.
Amra(B), Thaura (M)	<i>Spondias pinnata</i> (Linn. f.) Kurz.	Anacardiaceae	Tree	In	Unripe fruit	LC ²	Unripe fruits as a fruit and used in dysentery.
Kalojam (B), Musbrisi (M)	<i>Syzygium cumini</i> (L.) Skeels	Myrtaceae	Tree	In	Ripe fruit	LC ²	Ripe fruits are widely used; often after treating in salt water; used for diabetes (Shilpa et al., 2015).
Ban jam(B), Sabri (M)	<i>Syzygium fruticosum</i> DC	Myrtaceae	Tree	In	Ripe fruit	LC ²	Ripe fruit occasionally eaten.
Gulapjam(B)	<i>Syzygium jambos</i> (Linn.) Alston.	Myrtaceae	Tree	Ex	Ripe fruit	LC ²	Ripe fruit eaten and used in liver complaints.
Tentul(B), Haomong (M)	<i>Tamarindus indica</i> Linn.	Caesalpiniaceae	Tree	Ex	Unripe and ripe fruits	LC ²	Unripe and ripe fruits are eaten as such or made into pickles and used for cooling and carminative.
Bonlichu (B)	<i>Xerospermum laevigatum</i> Radlk.	Sapindaceae	Tree	In	Ripe and mature fruit	VU ¹	Ripe fruits occasionally eaten.
Ban boroi (B), Si mothuai (M)	<i>Ziziphus oenoplia</i> Mill.	Rhamnaceae	Tree	In	Ripe and mature fruit	LC ²	Ripe fruit collected and consumed by children; fruit used for stomach pain (Mahapatra and Panda, 2012).

B-Bangla, M-Marma language ¹Ara et al., 2013; ²Ahmed et al., 2008; ³Rahim et al., 2011; ⁴Rahman, 2013

Preference ranking

Most of the fruits are very popular among the tribal community. Ban litchi, Uriam, and Banboroi were very much popular among tribal children. Some of the fruits are taken occasionally i.e. Banlitchu, Chilla, Banjam and one of them rarely took i.e. Uri gab. Considering the preference ranking of the studied underutilized fruit species in Karnaphulli forest range, the top 10 scorers were *Tamarindus indica* (114), *Baccaurea ramiflora* (107), *Diospyros peregrine* (105), *Dillenia indica* (104), *Flacourtia jangomas* (104), *Citrus grandis* (99), *Aegle marmelos* (98), *Averrhoa bilimbi* (97), *Elaeocarpus floribundus* (97), and *Syzygium cumini* (97). Preference ranking indicates that *Tamarindus indica* is the common and favorite fruit among the local inhabitants (Table 03). Mannan et al. (2000) observed velvet apple was more widespread among the minor fruits.

Table 03. Preference ranking according to taste and availability

Local name	Scientific name	Total score	Raking order
Tentul	<i>Tamarindus indica</i>	114	1
Lotkon	<i>Baccaurea ramiflora</i>	107	2
Bilati gab	<i>Diospyros peregrine</i>	105	3
Chalta	<i>Dillenia indica</i>	104	4
Lukluki	<i>Flacourtia jangomas</i>	104	5
Jambura	<i>Citrus grandis</i>	99	6
Bel	<i>Aegle marmelos</i>	98	7
Bilimbi	<i>Averrhoa bilimbi</i>	97	8
Jalpai	<i>Elaeocarpus floribundus</i>	97	9
Kalojam	<i>Syzygium cumini</i>	97	10

Conservation need

According to the respondent of the local tribe, *Mangifera sylvatica* ranked the top position of the chart (Table 04) followed by *Haematocarpus validus*, *Diospyros rammiflora*, *Garcinia cowa*, *Flacourtia jangomas*, *Xerospermum laevigatum*, *Protium serratum*, *Artocarpus lacucha*, *Calamus viminalis* and *Casearia tomentosa* (Plate 01) which indicates that the species conservation is highly demanded. Most of these species were also listed as different categories of threats mentioned by other researchers such as Ahmed et al. (2009); Ara et al. (2013) and Abdullah et al. (2016). Management of species in the wild habitats also desired high awareness and conservation education among users and collectors.

Table 04. Conservation needs assessment of local people

Local Name	Scientific name	Total Score	Ranked order
Uri am	<i>Mangifera sylvatica</i>	120	1
Raktogota	<i>Haematocarpus validus</i>	117	2
Uri Gab	<i>Diospyros rammiflora</i>	113	3
Kaophal	<i>Garcinia cowa</i>	99	4
Lukluki	<i>Flacourtia jangomas</i>	98	5
Bonlichu	<i>Xerospermum laevigatum</i>	98	6
Gutgutia	<i>Protium serratum</i>	97	7
Dewa	<i>Artocarpus lacucha</i>	95	8
Bet	<i>Calamus viminalis</i>	91	9
Chilla	<i>Casearia tomentosa</i>	91	10

IV. Conclusion

Study indicates that the Karnaphuli forest range is one of the richest areas for the minor/underutilized fruit collected from a single range along with some threatened species. Underutilized fruits used by indigenous people are closely linked to the cultural traditions and have an important role to play in supporting social diversity of ethnic people of Bangladesh. But deforestation, habitat destruction and more land under mono-cropping plantation causes threats and accelerate the disappearing from natural habitats. These underutilized fruits are mostly indigenous to Bangladesh but did not receive any attention in previous. A strategy to promote commercial production to boost the local economy would depend not only on increasing the volume of production but with initiating processing and

value addition for raw fruit. A database on availability of different species of wild fruiting species and their uses should be compiled to aid such development of poor tribal areas.



Diospyros rammiflora



Haematocarpus validus



Protium serratum



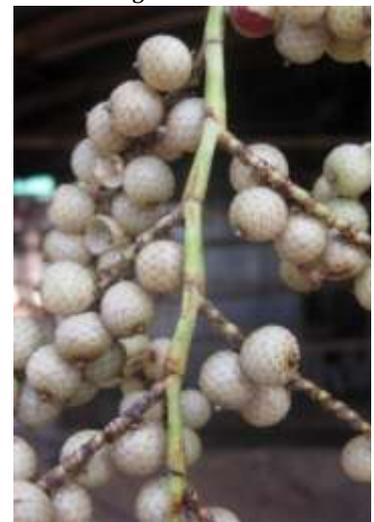
Xerospermum laevigatum



Casearia tomentosa



Flacourtia jangomas



Calamus viminalis

Plate 01. Picture of some rare underutilized fruits

Acknowledgement

This work was supported in part by a grant from the HEQEP CP-3021, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, Bangladesh.

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HOW TO CITE THIS ARTICLE?**MLA**

Abdullah, M. R. et al. "Underutilized fruits and their diversity in Karnaphuli range, Rangamati, Bangladesh". *International Journal of Forestry, Ecology and Environment*, 01(01), (2020):10-20.

APA

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Vancouver

Abdullah, MR, Haque, ME, Sarwar, AKMG, Ashrafuzzaman, M and Rahman, MM. Underutilized fruits and their diversity in Karnaphuli range, Rangamati, Bangladesh. *International Journal of Forestry, Ecology and Environment*, 2020 April 01(01): 10-20.

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