

**SHORT COMMUNICATION**

**Unveiling of physico-chemical changes of some underutilized fruits at different stages of maturity**

**Atsungpong Longchar, Animesh Sarkar\*, Nitisha Chettri, Ujjwal Singh and C.S. Maiti**

*Department of Horticulture, School of Agricultural Sciences, Nagaland University, Medziphema, Nagaland 797106, India*

*\* Email: asarkar@nagalanduniversity.ac.in*

*Receipt: 27.02.25*

*Revised: 31.03.25*

*Acceptance: 01.04.25*

**DOI:** 10.53552/ijmfmap.11.1.2025.301-304

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**ABSTRACT**

*A study on physico-chemical properties of some underutilized fruits grown in Nagaland was conducted in School of Agricultural Sciences, Nagaland University in 2023 to evaluate the morphological and biochemical changes from fruit set to maturity. Three different locations furnished the fruits for study of Averrhoa carambola, Eleagnus latifolia, and Phyllanthus acidus. Averrhoa carambola fruit had the diameter of  $5.0 \pm 0.62$  cm,  $8.47 \pm 0.81$  cm in length and  $68.69 \pm 15.41$  g in weight at 75 days after fruit set (DAFS). There was a discernible biochemical synthesis trend in Averrhoa carambola fruit in TSS ( $5.27 \pm 0.64$  °Brix to  $6.77 \pm 0.36$  °Brix), total sugar ( $6.10 \pm 0.33$  to  $7.96 \pm 0.09\%$ ) and vit-C ( $12.64 \pm 7.20$  to  $22.68 \pm 10.04$  mg/100 g pulp) from 15 DAFS to 75 DAFS, respectively. The significant variation of Eleagnus latifolia were found in fruit weight ( $3.70 \pm 0.62$  to  $11.27 \pm 0.76$  g), fruit length ( $2.80 \pm 0.36$  to  $3.77 \pm 0.48$  cm) and fruit diameter ( $1.59 \pm 0.20$  to  $2.40 \pm 0.09$  cm) from 15 days after fruit set to 75 DAFS respectively. A progression of biochemical synthesis in the fruit of Eleagnus latifolia was noticed in TSS ( $5.70 \pm 0.46$  °Brix to  $9.87 \pm 0.52$  °Brix), total sugar ( $4.39 \pm 0.04\%$  to  $6.59 \pm 0.36\%$ ) and vit-C ( $14.08 \pm 1.32$  to  $9.19 \pm 0.99$  mg/100 g pulp) from 15 DAFS to 75 DAFS. Phyllanthus acidus showed a fruit weight of  $4.67 \pm 0.74$  g, length of  $1.60 \pm 0.01$  cm and diameter of  $2.22 \pm 0.03$  cm at 60 DAFS. The biochemical composition of Phyllanthus acidus was noticed in TSS ( $6.40 \pm 0.57$  °Brix), total sugar ( $5.87 \pm 0.26\%$ ), and Vit-C ( $22.20 \pm 1.22$  mg/100 g pulp) at 60 DAFS.*

**Keywords:** Morphology, physico-chemical properties, underutilized fruits

Indigenous and minor horticultural crops available in the region are not being exploited properly, but they have the potential to alleviate poverty, food, and nutritional security through processing, value addition, and diverse use. These fruits and vegetables are rich in vitamins and minerals as well. Besides, they are rich in secondary metabolites and medicinal properties which could be exploited in industrial and medicinal sectors (Deka and Rymbai, 2014). A survey in Nagaland was initiated and identified several underutilized fruits, including Averrhoa carambola, Elaeagnus latifolia, and Phyllanthus acidus, which are important in local diets and traditional medicine (Sarkar et al., 2023). These fruits, though abundant locally, are underrecognized and lacked in scientific study concerning their physiological, agronomic, and ecological characteristics. The study aims to address this gap by examining the morphological and biochemical characteristics of

*Averrhoa carambola*, *Eleagnus latifolia*, and *Phyllanthus acidus*.

The study was conducted in Chumoukedima district of Nagaland. The region falls under the geographical coordinates of 25°6' and 27° 4' North latitude and 93° 20' and 95° 15' East longitude covering a humid subtropical climate with a typical average temperature of 25.06°C and receives about 150-250 cm of annual precipitation. Soil in exploration area is predominantly acidic inceptisols, with fine clay, clay loamy, and fine loamy clay textures, and a pH ranging from 4.5 to 6.0. The season of flowering and harvesting times were determined through local interactions with village elders, farmers, and growers. For fruit morphological characters, weight, diameter, and length were measured by weighing of five random fruits on an electronic balance and using a vernier calliper to determine average measurements. Biochemical analysis was executed preparing a juice extract by removing seeds, crushing the pulp with a mortar and pestle, and filtering it through a muslin cloth. Total soluble solids (TSS) were determined with the help of hand refractometer calibrated in °Brix at 20 °C with necessary correction factor. Total sugar was determined using Fehling's reagents with methylene blue as an indicator, while reducing sugar was calculated through a similar titration process, with the endpoint indicated by a deep brick-red colour (A.O.A.C, 1995). Titratable acidity was measured by titrating the extracted juice against N/10 NaOH using phenolphthalein as an indicator and ascorbic acid using 2, 6-dichlorophenol indophenols dye titration method following the standard procedure of A.O.A.C (1995).

#### ***Averrhoa carambola* L.**

It is locally known as Charkhona in Ao and Karmal in Hindi. The fruit was collected from the location of surrounding Chumoukedima district, Nagaland. The

fruit grows well all over the north east region of India (De, 2017). *Averrhoa carambola* is an evergreen tree which flowers during the months of July-August, October-November, and January-February and is ready to harvest in September-October, December-January, and March-April in Chumoukedima region of Nagaland. *Averrhoa carambola* are generally oblong and 5-angled, weighing about 68.69±15.41 g at 75 DAFS, having a diameter of 5.00±0.62 cm, and a length of 8.47±0.81 cm on average per fruit (Table 1). The colour of the fruit when harvested is usually yellow in colour with yellow-coloured flesh. The fruit of *Averrhoa carambola* at 75 DAFS had the highest TSS of 6.77±0.36 °Brix, titratable acidity of 0.51±0.06%, total sugar of 7.96±0.09%, reducing sugar of 6.39±0.07% (Table 1). Pongener *et al.* (2022) also reported similar findings of titratable acidity (0.576%), total sugar (6.10±0.33% to 7.96±0.09%) and reducing sugar (5.20±0.26% to 6.39±0.07%). The vitamin C content was the highest at 75 DAFS (22.68±10.04 mg/100 g pulp), which was in consonance with Pawar *et al.* (2014) for vit-C (15.6 to 32.8 mg/100 g).

#### ***Eleagnus latifolia***

The fruit is vernacularly known as Metsüsera (Ao) and Pedüchüdi (Angami). *Eleagnus latifolia* L. is a large evergreen spreading type woody shrub which flowers in the month of December to January and is harvested when the fruits turn deep red or orange during the month of March to April. The fruits of *Elaeagnus latifolia* are oblong in shape with orange to red flesh and skin colour, weighing about 11.27±0.76 g, diameter of 2.40±0.09 cm, and a length of 3.77±0.48 cm at 75 DAFS (Table 2). The fruit of *Eleagnus latifolia* showed a TSS of 9.87 °Brix at 75 DAFS, while 5.70 °Brix was noticed at 15 days after fruit set (DAFS). The notable changes occurred in titratable acidity (1.47±0.10%), total sugar (6.59 ±0.36%), reducing sugar (4.75

$\pm 0.26\%$ ) and vitamin C ( $9.19 \pm 0.99$  mg/100 g) during harvesting stages of fruits (Table 2). The vitamin C content was also at par with Devachandra *et al.* (2018) where they reported vitamin C content of 11.49 mg/100g. The finding of total sugar was at par with Sarkar *et al.* (2023) who reported total sugar and reducing sugar of 6.89% and 4.44%, respectively in silver berry.

### ***Phyllanthus acidus*(L.)**

Star gooseberry was collected from home gardens at Medziphema Town, Seithekima C and Pherima village of Nagaland. The star gooseberry is a deciduous tree. It is small to medium tree which grows about 2-9 m. It was also noted that it flowered twice any time of the year and fruits and flowers appeared simultaneously. The fruits of star gooseberry are oblate in shape, light green to yellow in skin colour, with white to light yellow colour in flesh. The weight of the fruit is around  $4.67 \pm 0.74$  g, with a diameter of  $2.22 \pm 0.03$  cm and length of  $1.60 \pm 0.01$  cm at harvesting stage (60 DAFS) (Table 3). *Phyllanthus acidus* had shown TSS of 6.40 °Brix, titratable acidity of  $1.31 \pm 0.08\%$ , total sugar of  $5.87 \pm 0.26\%$ , reducing sugar of  $4.08 \pm 0.42\%$ , non-reducing sugar of 1.70 % and vitamin C content of  $22.20 \pm 1.22$  mg/100 g pulp at 60 DAFS (Table 3). Sarkar *et al.* (2023) also reported TSS of  $6.66 \pm 0.17^\circ$  Brix, titratable acidity of  $1.82 \pm 0.10\%$ , total sugar of  $5.33 \pm 0.23\%$ , reducing sugar of  $3.77 \pm 0.04\%$  and vitamin-C content of  $24.00 \pm 1.20$  mg/100 g pulp in *Phyllanthus acidus* fruits.

### **CONFLICT OF INTEREST STATEMENT**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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**Table 1. Study on physicochemical properties of carambola (*Averrhoa carambola*) at different stages of maturity**

DAFS (Days after fruit set)	Fruit weight (g)	Fruit diameter (cm)	Fruit length (cm)	TSS (°Brix)	Titrateable acidity (%)	Total sugar (%)	Reducing sugar (%)	Vitamin-C (mg/100g pulp)
15 DAFS	1.31±0.22	1.50±0.36	2.70±0.13	5.27±0.64	0.22±0.05	6.10±0.33	5.20±0.26	12.64±7.20
30 DAFS	7.33±0.93	2.44±0.14	4.72±0.16	4.70±0.46	0.32±0.09	6.53±0.63	5.55±0.53	16.67±7.09
45 DAFS	25.57±4.78	4.17±0.95	7.60±0.78	5.50±0.53	0.35±0.07	6.80±0.20	6.07±0.27	17.44±8.83
60 DAFS	61.22±17.15	4.67±0.64	8.40±0.79	6.03±0.49	0.46±0.05	7.39±0.36	6.16±0.39	18.60±6.96
75 DAFS	68.69±15.41	5.00±0.62	8.47±0.81	6.77±0.36	0.51±0.06	7.96±0.09	6.39±0.07	22.68±10.04

**Table 2. Study on physicochemical properties of silver berry (*Eleagnus latifolia*) at different stages of maturity**

DAFS (Days after fruit set)	Fruit weight (g)	Fruit diameter (cm)	Fruit length (cm)	TSS (°Brix)	Titrateable acidity (%)	Total sugar (%)	Reducing sugar (%)	Vitamin C (mg/100g pulp)
15 DAFS	3.70±0.62	1.59±0.20	2.80±0.36	5.70 ±0.46	0.12 ±0.09	4.39 ±0.04	3.89 ±0.02	14.08 ±1.32
30 DAFS	5.80±1.93	1.94±0.25	3.35±0.70	8.13 ±0.42	0.38 ±0.12	4.77±0.16	4.11 ±0.10	12.64 ±6.96
45 DAFS	9.70±0.56	2.11±0.09	3.50±0.48	8.67 ±0.58	1.08 ±0.13	5.16 ±0.09	4.34 ±0.42	15.51 ±6.21
60 DAFS	11.10±0.72	2.32±0.07	3.67±0.56	6.00±0.56	1.20±0.16	5.53±0.30	4.63±0.37	12.80±3.48
75 DAFS	11.27±0.76	2.40±0.09	3.77±0.48	9.87 ±0.52	1.47 ±0.10	6.59 ±0.36	4.75 ±0.26	9.19 ±0.99

**Table 3. Study on physicochemical properties of star gooseberry (*Phyllanthus acidus*) at different stages of maturity**

DAFS (Days after fruit set)	Fruit weight (g)	Fruit diameter (cm)	Fruit length (cm)	TSS (°Brix)	Titrateable acidity (%)	Total sugar (%)	Reducing sugar (%)	Vitamin C (mg/100g pulp)
15 DAFS	0.34±0.03	1.05±0.07	0.84±0.04	8.15±0.21	1.02±0.36	3.63±0.36	2.03±0.21	24.93±6.10
30 DAFS	1.09±0.16	1.35±0.07	1.05±0.04	7.90±1.27	1.18±0.37	4.21±0.02	2.52±0.08	25.86±7.32
45 DAFS	3.56±0.35	2.05±0.07	1.48±0.11	5.65±0.49	1.20±0.08	5.20±0.12	3.04±0.06	28.65±1.22