DOI : 10.5958/0974-0112.2019.00098.7

Indian J. Hort. 76(4), December 2019: 611-617

Physico-chemical characterization of wild and semi wild Indian gooseberry from Mizoram, North-East India

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ABSTRACT

An extensive survey was made to identify and collect the elite genotypes of Indian gooseberry at different altitude in its natural population and find out the promising genotypes having good fruit quality from different regions of the Mizoram, North-Eastern region of India, during 2015-17. The mature fruits were analyzed for a number of traits like fruit weight, fruit length, fruit diameter, fruit volume, specific gravity, pulp weight, pulp-stone ratio, pulp percentage, stone weight, moisture content, TSS, acidity, ascorbic acid, total sugars, reducing sugar, non-reducing sugar, sugar : acid ratio and TSS : acid ratio. Significant to highly significant differences were observed with respect to fruit weight (5.42 - 9.04 g); fruit length (18.98 - 24.08 mm); fruit diameter (19.46 -20.02 mm); volume (4,58 - 8.79 cc); specific gravity (1.029 - 1.167 g/cc); pulp weight (7.26 -3.92 g); pulp-stone ratio (1.63 - 6.98); pulp percentage (60.27 - 84.81 %); stone length (9.27 -12.80 mm); stone weight (0.58 -2.94g); moisture content (78.70 - 87.57%); TSS (9.48 -14.93 °B); acidity (1.35- 2.69%); ascorbic acid (418.27 - 894.15 mg/100 g); total sugars (5.59 -13.08%); reducing sugar (1.29 - 9.37%); non-reducing sugars (1.29 - 6.16%); sugar : acid ratio (2.71 -10.93) and TSS : acid ratio (3.89 - 11.87). Among all the germplasms, HAMP-MZU-AS-2, HAMP-MZU-AS-3 and HAMP-MZU-AS-29 showed the overall superiority in all the parameters. Hence, HAMP-MZU-AS-2, HAMP-MZU-AS-3 and HAMP-MZU-AS-29 can be considered as elite germplasm for use in various purposes.

Key words: *Emblica officinalis,* genetic diversity.

INTRODUCTION

Indian gooseberry (*Emblica officinalis* Gaertn), commonly known as *aonla* is one of the sub-tropical fruit crop, well known for its nutraceutical and therapeutic properties. Next to Barbados cherry (*Malpighiae marginata*), it is the richest source of vitamin 'C' among fruits. The fruit is also a fair source of minerals, carbohydrates, and vitamins like carotene, thiamine and riboflavin. Owing to its hardy nature, regular and profuse bearing, ability to produce remunerative yield in various kinds of wastelands, and suitability for various value added products, *aonla* is becoming an important fruit crop across the country (Kowar *et al*., 8; Pathak and Pathak 12).

Knowledge of genetic parameters is very useful for predicting genetic progress in breeding programme and for developing efficient breeding strategies. Knowledge of the magnitude of genetic variation among fruit characters and their heritability is very much important in a highly out crossing species. Unfortunately, information on genetic parameters for fruit quality traits is very limited. In order to enrich the information and acquaint the breeder to interpret phenotypic values in terms of potential genetic gain, there is a need to study genetic parameters of traits related to fruit quality. Although, newly developed molecular markers are valuable in gene based diversity studies, however the procedures used for the molecular markers analysis have disadvantage of high cost. In contrast, morphological traits could feasibly be used for parental selection and germplasm classification in plant breeding programs.

The success of an improvement programme depends mostly on the identification and selection of superior parents for hybridization (Prakash *et al*., 13). Therefore, exploitation of existing variability, identification of superior genotypes and their conservation are important in context of the present day scenario of rapid extinction of such useful unexploited fruit. Due to unawareness of the knowledge of biodiversity among local people, some germplasms are almost near extinct and very little attention has been given for the characterization, evaluation and conservation of available accessions.

However, so far no systematic studies have been undertaken to screen out superior genotypes in terms of physico-chemical properties of the *aonla* fruits in this biodiversity hot spot area of India. The aim of the present study was to investigate the morphological

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diversity of *aonla* genotypes as an initial step aiming to characterization and preservation of these precious fruit trees for future breeding programe. The result of the present study will lead in selection of the most promising *aonla* germplasms based on quality and yield characteristics.

MATERIALS AND METHODS

In the present study, survey of *Aonla* orchards and collection of fruits from six districts of Mizoram *i.e* Aizawl, Lunglei, Serchhip, Mamit, Champhai and Kolasib comprising of 30 different villages of Mizoram was conducted during the fruiting season of 2016-2017. The germplasm were collected from a latitude range of 22°53'01"- 24°19'37" N, longitude 92°29'33"-93°20'09"E and elevation 78-1466 m amsl. The collected specimens were immediately brought to the Post-harvest Laboratory, Dept. of HAMP, Mizoram University for analysis of physio-chemical characters.

For measuring the physical parameters of the fruits, 20 randomly selected fruits were taken from each replication. The data on physical parameters were recorded as per standard procedures with the help of electronic balance. The fruit volume was measured by dipping the fruits in the water through water displacement method and expressed in cc. The specific gravity was measured by dividing the fruit weight by the fruit volume and was expressed in g/cc. Quality parameters like juice, TSS, acidity, ascorbic acid, reducing, non-reducing and total sugars were estimated following standard procedures. The standard method (AOAC, 1) was followed to determine the titratable acidity, reducing, non-reducing and total sugars of fruit. Visual titration method (Freed, 3) was followed for the estimation of ascorbic acid content of the fruit pulp and the result was expressed in mg per 100 g. The data obtained from different observations were subjected to Fisher's method of analysis of variance (ANOVA) following completely randomized design. Significance and non-significance of the variance due to different treatments were determined by calculating the respective 'F' value and comparing with the appropriate value of 'F' at 5 % probability level (Panse and Sukhatme, 10).

RESULTS AND DISCUSSION

The analysis of variance of 30 *aonla* germplasms identified from different locations of Mizoram in this investigation revealed significant to highly significant variation among the germplasms in various physico-chemical parameters of the fruits.

The fruit weight was ranged between 5.42- 9.04 g (Fig. 1). Among all the germplasms, the highest fruit weight was recorded in MZU-HAMP-AS-3 (9.04 g), while, the lowest was recorded in MZU-HAMP-AS-5 (5.42 g). Our study is in close conformity with the findings of Hazarika *et al*., (4) and Sharma, (14) who also reported variation in fruit weight of *aonla* in the range of 3.24-10.18 g and 4.90-21.00 g

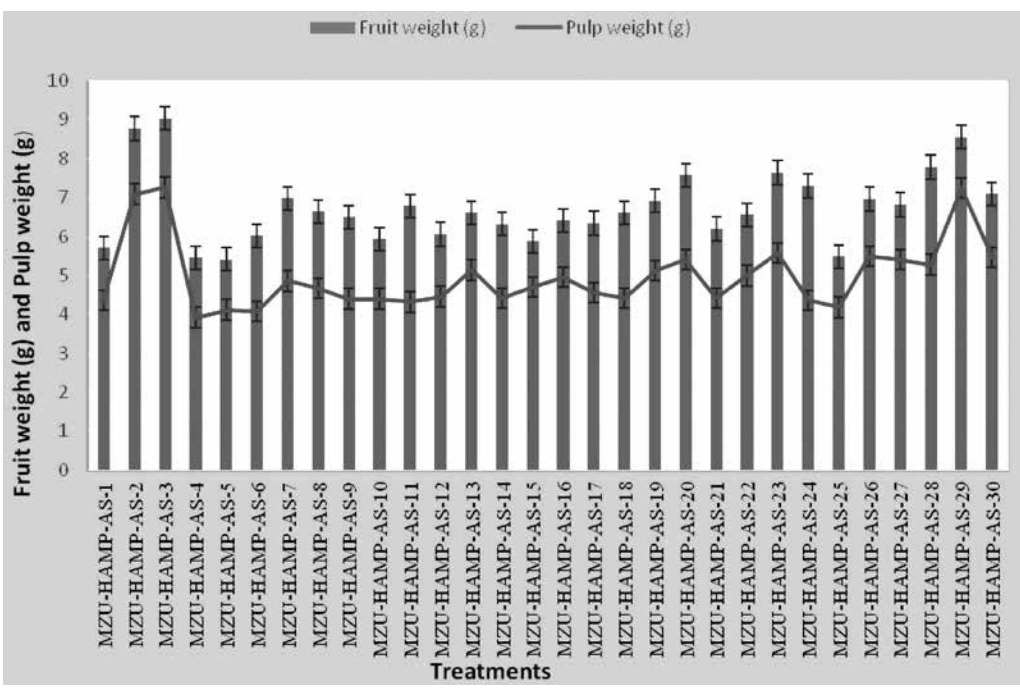

Fig. 1. Fruit weight and pulp weight among different *aonla* germplasm.

respectively. The accessions ranged between 18.98-24.08 mm in respect to fruit length. The maximum was recorded in MZU-HAMP-AS-2 (24.08 mm), followed by MZU-HAMP-AS-3 (23.42 mm), and MZU-HAMP-AS-29 (23.40 mm), while the lowest was in MZU-HAMP-AS-1 (18.98 mm). This variation in fruit length might be due to different genetical constitution of the individual genotypes. More or less similar kinds of variability in fruit physical characteristics were observed in *aonla* genotypes from the Garo hills of Meghalaya (Chandra *et al*., 2) from north east India (Singh *et al*., 15) and from Assam (Hazarika *et al*., 4). Maximum fruit diameter was recorded in MZU-HAMP-AS-3 (24.88 mm), followed by MZU-HAMP-AS-2 (24.48 mm). Similarly, MZU-HAMP-AS-1 (19.46 mm), recorded the lowest value followed by MZU-HAMP-AS-25 (20.02 mm), MZU-HAMP-AS-12 (20.10 mm), and MZU-HAMP-AS-4 (20.12 mm). Our study is in close conformity with the findings of (Singh *et al*. 15) who reported the fruit diameter of *aonla* in the range of 1.27-2.57 cm. Among all the germplasms, the highest fruit volume was recorded in MZU-HAMP-AS-3 (8.79 cc) followed by MZU-HAMP-AS-2 (8.39 cc), and MZU-HAMP-AS-29 (8.28 cc), while, the lowest was recorded in MZU-HAMP-AS-4(4.58 cc). Our results are in the line with the findings of Chandra *et al*., (2); Singh *et al*. (15); Hazarika *et al*., (4); Singh and Singh, (16). The maximum specific gravity (1.167g/cc) was recorded in MZU-HAMP-AS-4, which was followed by MZU-HAMP-AS-5 (1.137 g/cc), while, the lowest was recorded in MZU-HAMP-AS-3 (1.029 g/cc). The variation in specific gravity of the fruits among different *aonla* germplasms was also reported by Chandra *et al*., (2); Hazarika *et al*., (4); Singh and Singh, (16). Among all the germplasms, the highest pulp weight was recorded in MZU-HAMP-AS-3 (7.26 g), followed by HAMP-AS-29 (7.24 g) and MZU-HAMP-AS-2 (7.09 g) (Fig. 1). The significantly lowest pulp weight was observed in MZU-HAMP-AS-4 (3.92 g). Our study is in close conformity with the findings of Hazarika *et al*., (4) and Sharma, (13), who also obtained significant variation in pulp weight among *aonla* accessions. Pulp percentage of the genotypes ranged between 60.29 to 81.60 per cent and among all the germplasms, MZU-HAMP-AS-2 (81.60 %), recorded the highest pulp percentage. The lowest pulp percentage was recorded in MZU-HAMP-AS-24 (60.29 %), followed by MZU-HAMP-AS-18 (66.79%). The pulp percentage of *aonla* was reported in the range of 80.10-95.74 per cent (Sharma, 14). The highest stone length was observed in MZU-HAMP-AS-3 (13.30 mm) followed by MZU-HAMP-AS-2 (13.09 mm), while, the lowest was recorded in HAMP-AS-21 (9.27 mm). The stone length of *aonla* was reported in the range of 9.23-14.75 mm (Sharma, 14). In the present study, there was no significant difference among the germplasms with respect to pulp peel ratio, however, among the germplasms, MZU-HAMP-PS-3 (3.12) and MZU-HAMP-PS-23 (1.12), recorded the highest and lowest value of pulp peel ratio respectively. Similarly, maximum stone diameter was observed in MZU-HAMP-AS-3 (11.30 mm), followed by MZU-HAMP-AS-2 (11.09 mm). Stone diameter of *aonla* ranged between 7.50-11.00 mm and 9.27-12.34 mm respectively (Hazarika *et al*., 4; Sharma, 14). Different *aonla* germplasms indicated significant difference in stone weight (Table 1). Among the different germpalsms, the highest stone weight was observed in MZU-HAMP-AS-24 (2.94 g). Germplasm MZU-HAMP-AS-27 recorded the lowest stone weight of 0.58 g. It was followed by MZU-HAMP-AS-15 (0.82 g), and MZU-HAMP-AS-26 (0.94 g). The variation in stone weight among different germplasms may be due to different genetical constitution of the individual genotypes. Our result is in the line with the findings of Chandra *et al*., (3); Hazarika *et al*., (4); Singh and Singh, (16) from North-east India. There was no significant difference among the germplasms with respect to pulp stone ratio (Table 1).

The chemical parameters of different *aonla* fruits are presented in Table 2. Among all the germplasms, MZU-HAMP-AS-29 recorded the significantly highest moisture content (87.57 %). It was followed by MZU-HAMP-AS-3 (87.00%), and MZU-HAMP-AS-2 (85.47%). Germplasm MZU-HAMP-AS-11 recorded the lowest moisture content of the fruits (78.70%). More or less similar kinds of variability in moisture content (78.51-84.29%) was also observed by Hazarika *et al*., (4) from Assam. Similarly, germplasm MZU-HAMP-AS-2 (14.93 °B), recorded the maximum TSS followed by MZU-HAMP-AS-29 (14.13 °B), MZU-HAMP-AS-3 (13.63 °B), and MZU-HAMP-AS-20 (14.20 °B), while the lowest was recorded in MZU-HAMP-AS-7 (9.48 °B). The variation in TSS may be due to different genetical constitution of the individual genotypes. Fruits growing in arid region with limited water tended to more accumulation of dry matter and lower moisture may result in higher TSS in fruits (Meghwal and Azam, 9). The breeders during selection of superior genotypes should emphasize total soluble solids content of the fruit. Our study is in the close conformity with the findings of Chandra *et al*., (2); Singh *et al*. (15); Hazarika *et al*., (4); Singh and Singh, (16). Ascorbic acid is also one of the most important criteria, which also determine the quality of fruits. Among all germplasms, the highest value of ascorbic acid was recorded in MZU-HAMP-AS-29 (894.15 mg/100 g),

Table 1. Fruit physical parameters among different germplasms.

Germplasm	Location	Fruit length (mm)	Fruit diameter (mm)	Fruit volume (cc)	Specific gravity (g/cc)	Pulp percentage	Stone length (mm)	Stone diameter (mm)	Stone weight (g)	Pulp: Stone ratio
MZU-HAMP-AS-1	Mualkhang	18.98	19.46	5.21	1.098	76.82	10.41	8.11	0.96	5.34
MZU-HAMP-AS-2	Bilkhawthlir	24.08	24.48	8.39	1.046	81.60	13.09	11.09	1.95	4.25
MZU-HAMP-AS-3	Sairang	23.42	24.88	8.79	1.029	80.41	13.30	11.30	1.92	4.13
MZU-HAMP-AS-4	N. Vanlaiphai	19.00	20.12	4.58	1.167	71.72	10.76	8.54	1.54	2.63
MZU-HAMP-AS-5	Khawlailung	19.18	0.36	4.69	1.137	76.10	10.89	8.63	1.30	3.38
MZU-HAMP-AS-6	Mamit	20.08	21.02	5.61	1.062	67.77	11.24	9.04	1.94	2.10
MZU-HAMP-AS-7	Hortoki	21.44	21.60	6.29	1.103	69.39	11.55	9.20	2.12	2.53
MZU-HAMP-AS-8	Khawzawl	21.14	21.04	6.23	1.039	70.56	11.25	9.16	1.96	2.42
MZU-HAMP-AS-9	Champhai	20.82	20.94	5.82	1.105	67.72	11.20	9.05	2.10	2.12
MZU-HAMP-AS-10	Tlungvel	20.08	20.66	5.39	1.090	74.56	11.05	8.98	1.54	3.34
MZU-HAMP-AS-11	Thingsulthliah	19.28	19.88	6.15	1.088	63.77	10.63	8.53	2.46	1.79
MZU-HAMP-AS-12	Seling	20.82	20.10	5.63	1.069	73.61	10.05	8.05	1.60	2.84
MZU-HAMP-AS-13	Sesawng	21.02	21.30	5.87	1.109	77.78	11.39	9.19	1.48	7.87
MZU-HAMP-AS-14	Khawruhlian	19.50	20.50	5.49	1.103	69.98	10.25	8.25	1.90	2.38
MZU-HAMP-AS-15	Khanpui	19.88	21.28	5.47	1.130	80.32	11.38	9.11	0.82	6.73
MZU-HAMP-AS-16	Darlawn	20.30	20.62	6.07	1.058	77.38	11.03	8.81	1.12	5.16
MZU-HAMP-AS-17	Sunhluchhip	20.24	20.36	5.98	1.062	71.97	10.89	8.80	1.78	2.62
MZU-HAMP-AS-18	Hlimen	21.02	21.06	5.97	1.109	66.79	11.26	9.05	2.20	2.04
MZU-HAMP-AS-19	Lunglei	21.50	21.86	6.63	1.044	73.85	11.69	9.31	1.80	3.00
MZU-HAMP-AS-20	Thenzawl	22.22	21.54	7.02	1.080	71.49	11.52	9.32	2.18	2.71
MZU-HAMP-AS-21	Sialsuk	20.78	20.40	5.61	1.105	71.36	9.27	7.24	1.78	2.59
MZU-HAMP-AS-22	Hmuifang	21.10	21.52	5.89	1.114	76.12	11.51	9.38	1.56	3.34
MZU-HAMP-AS-23	Aibawk	22.70	23.00	6.99	1.093	73.03	12.30	10.23	2.06	2.77
MZU-HAMP-AS-24	Falkawn	22.10	20.46	6.79	1.076	60.29	10.94	8.91	2.94	1.63
MZU-HAMP-AS-25	Reiek	19.54	20.02	5.18	1.058	76.41	10.71	8.84	1.30	3.29
MZU-HAMP-AS-26	Rawpuichhip	22.04	22.28	6.50	1.071	79.26	11.91	9.75	0.94	6.45
MZU-HAMP-AS-27	Dampui	21.46	21.86	6.27	1.088	79.21	11.69	9.60	0.58	4.01
MZU-HAMP-AS-28	Tuidam	22.54	21.74	7.34	1.060	68.13	11.63	9.50	2.50	2.24
MZU-HAMP-AS-29	Kolasib	23.40	23.94	8.28	1.034	84.81	12.80	10.80	1.32	5.99
MZU-HAMP-AS-30	Serchhip	22.68	22.78	6.65	1.068	76.96	12.18	9.95	0.84	6.98
S.Em (±)		0.49	0.46	0.31	0.008	3.96	0.25	0.27	0.29	-
$CD_{0.05}$		0.82	0.76	0.52	0.013	6.57	0.41	0.45	0.49	NS

followed by MZU-HAMP-AS-2 (889.41 mg/100g), MZU-HAMP-AS-9 (863.74 mg/100 g), and MZU-HAMP-AS-3 (847.20 mg/100 g), while, the lowest (418.27 mg/100 g) was recorded in MZU-HAMP-AS-1 (Fig. 2). Our study is in close conformity with the findings Singh *et al*. (15) and Hazarika *et al*., (4) who also obtained significant variation in ascorbic acid of the fruits among different *aonla* accessions. In our study, MZU-HAMP-AS-29 (1.19%), recorded the lowest titratable acidity followed by MZU-HAMP-AS-3(1.35%), while, the highest was recorded in MZU-HAMP-AS-14 (2.69%). This is a fact in many fruits that, when TSS is increasing acidity is definitely decreased. This may be major factor for minimum acid content in MZU-HAMP-AS-29 and MZU-HAMP-AS-3. The variation among genotypes for acidity might be due to higher TSS and genetic make of plant (Prakash *et al*., 13) which has also proved

Table 2. Chemical characteristics of the fruits among different germplasms.

Germplasm	Moisture (%)	TSS (°B)	Acidity (%)	Total Sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)	Sugar: acid ratio	TSS : acid ratio
MZU-HAMP-AS-1	79.17	10.85	1.79	6.53	5.51	1.29	3.65	6.07
MZU-HAMP-AS-2	85.47	14.93	1.41	12.78	9.37	3.87	9.12	10.63
MZU-HAMP-AS-3	87.00	13.63	1.35	13.08	9.11	4.42	9.65	10.06
MZU-HAMP-AS-4	81.60	10.81	2.07	5.59	2.72	3.00	2.71	5.24
MZU-HAMP-AS-5	82.27	13.15	2.43	8.01	5.88	2.42	3.29	5.43
MZU-HAMP-AS-6	82.63	10.88	1.56	6.74	4.76	2.21	4.42	7.02
MZU-HAMP-AS-7	82.50	9.48	1.88	8.90	4.98	4.16	4.73	5.04
MZU-HAMP-AS-8	82.70	11.11	1.94	11.42	6.68	5.07	5.89	5.75
MZU-HAMP-AS-9	83.57	10.81	1.38	11.33	8.35	3.40	8.80	8.46
MZU-HAMP-AS-10	82.70	12.01	1.84	12.29	6.75	5.88	6.75	6.58
MZU-HAMP-AS-11	78.70	9.85	2.54	7.41	5.46	2.23	2.92	3.89
MZU-HAMP-AS-12	82.27	10.45	2.33	10.35	5.73	4.91	4.45	4.49
MZU-HAMP-AS-13	84.63	11.88	1.88	11.79	6.55	5.57	6.29	6.32
MZU-HAMP-AS-14	81.83	10.65	2.69	11.58	7.60	4.36	4.33	3.96
MZU-HAMP-AS-15	79.37	12.27	2.65	9.54	6.23	3.62	3.60	4.63
MZU-HAMP-AS-16	84.60	9.91	1.44	7.79	5.20	2.85	5.42	6.93
MZU-HAMP-AS-17	82.20	12.05	2.35	7.23	5.51	2.00	3.08	5.13
MZU-HAMP-AS-18	82.43	10.81	1.44	12.01	8.96	3.50	8.33	7.50
MZU-HAMP-AS-19	83.37	10.55	2.09	12.04	7.60	4.81	5.77	5.06
MZU-HAMP-AS-20	83.03	14.20	1.92	9.45	5.52	4.21	4.93	7.40
MZU-HAMP-AS-21	82.73	9.91	1.92	8.51	4.65	4.09	4.39	5.20
MZU-HAMP-AS-22	82.83	10.58	1.90	12.62	7.78	5.23	6.73	5.58
MZU-HAMP-AS-23	81.00	11.21	2.65	11.62	5.74	6.16	4.42	4.23
MZU-HAMP-AS-24	81.10	11.88	2.54	9.54	5.95	3.89	3.76	4.70
MZU-HAMP-AS-25	83.67	10.28	2.28	9.17	6.39	3.10	4.06	4.52
MZU-HAMP-AS-26	84.47	12.70	1.96	11.68	7.17	4.86	5.86	6.49
MZU-HAMP-AS-27	83.37	13.11	2.16	9.84	5.77	4.36	4.57	6.07
MZU-HAMP-AS-28	83.37	10.81	1.60	8.57	5.98	2.89	5.37	6.79
MZU-HAMP-AS-29	87.57	14.15	1.19	12.85	8.26	5.00	10.93	11.87
MZU-HAMP-AS-30	83.93	10.91	1.92	12.01	6.51	5.83	6.27	5.69
S.Em (±)	1.72	1.02	0.12	1.37	0.64	-	0.84	0.72
$CD_{0.05}$	2.88	1.70	0.20	2.30	1.08	NS	1.40	1.20

in our study. Similarly, highest total sugars was recorded in MZU-HAMP-AS-3(13.08%), followed by MZU-HAMP-AS-29(12.85 %), MZU-HAMP-AS-2 (12.78 %), while, the lowest was recorded in MZU-HAMP-AS-4(5.59 %). The variation in total sugars among the accessions may be due to different genetical constitution of the individual genotypes. Our study is in close conformity with the findings of Hazarika *et al*. (4), Patel et al. (11) Singh *et al*. (15). Among all the germplasms, the highest reducing sugar of fruits was recorded in MZU-HAMP-AS-2(9.37%), followed by MZU-HAMP-AS-3(9.11%), while, lowest was recorded in MZU-HAMP-AS-4 (2.72 %). Variation in reducing sugars among different genotypes was also reported by a number of researchers (Hazarika *et al*., 4; Hazarika *et al*. 5; Hazarika *et al*. 7; Hazarika *et al*. 6). There was no significant difference among the germplasms with respect to non-reducing sugars. The variation among the different germplasms in sugar: acid ratio

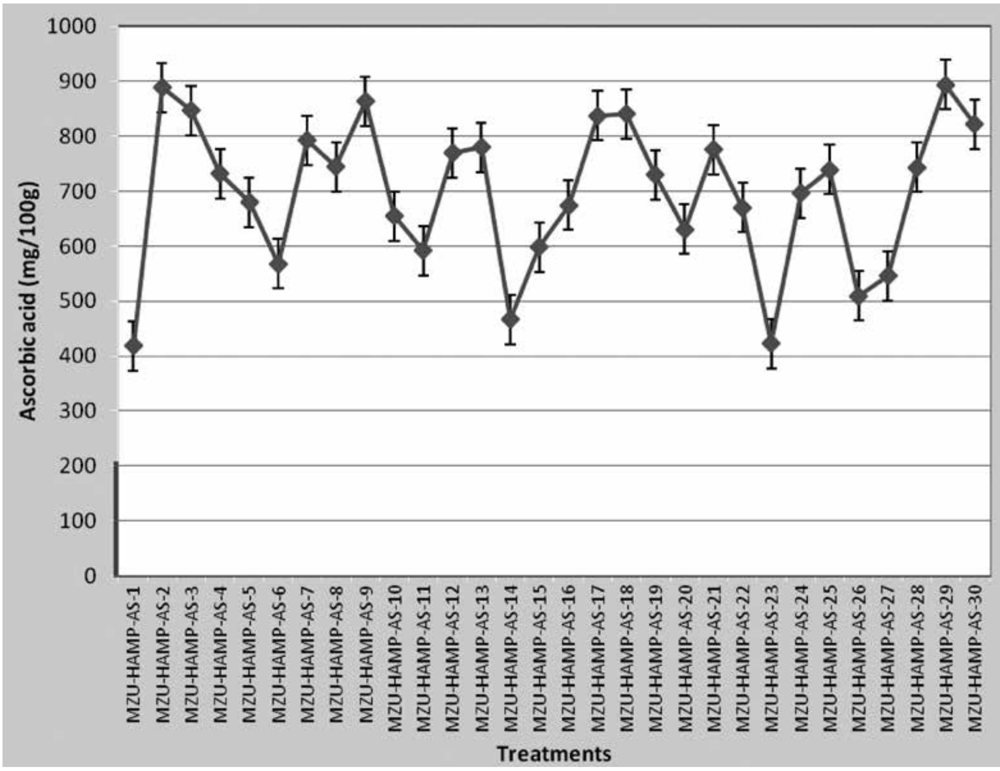

Fig. 2. Ascorbic acid content in fruits among different *aonla* germplasm.

was also found significant (Table 2). Among all the germplasms, MZU-HAMP-AS-29 recorded highest sugar: acid ratio (10.93) but it was found statistically *at par* with MZU-HAMP-AS-3(9.65), while, the lowest was recorded in MZU-HAMP-AS-4(2.71). Our study is in close conformity with the findings of Hazarika *et al*., (5), who also obtained significant variation in sugar: acid ratio among different accessions. In the present study, the highest TSS: acid ratio was recorded in MZU-HAMP-AS-29 (11.87), which was significantly higher than all other germplasms, while the lowest was recorded in MZU-HAMP-AS-11 (3.89). The variation in TSS: acid ratio among different *aonla* germplasms have been reported by Singh *et al*. 15 and Singh and Singh, 16).

Preference of consumers always depends on physical parameters of fruits like fruit weight, fruit diameter, pulp content and pulp: stone ratio of any fruit. In *aonla*, more fruit weight, bigger size, more pulp content and pulp: stone ratio, greater is the acceptability by the consumer. Similarly, consumers also prefer the fruit with small stone. Likewise, among the biochemical constituents of the fruits, consumers always prefer the fruits with high juice content, ascorbic acid, low acidity and high sugar: acid ratio. Similarly, for development of a new variety, breeders also choose germplasms with these desirable qualities. From the summary of the present investigation, it has observed that, among all the germplasms of *aonla* collected from different locations of Mizoram, North east India, HAMP-MZU-AS-2, HAMP-MZU-AS-3 and HAMP-MZU-AS-29 having all the desirable physical and chemical parameters from the consumer as well as breeders. Therefore, from the present investigation, it can be concluded that HAMP-MZU-AS-2, HAMP-MZU-AS-3 and HAMP-MZU-AS-29 can be considered as elite *aonla* germplasm for use in various purposes.

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Received : October 2018; Revised : .November 2019; Accepted : November 2019