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Studies on variability in physico-chemical characters of *hatkora* (*Citrus macroptera* Mont.) collections of Mizoram

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ABSTRACT

A study was carried out to during 2010-2011 to identify the elite *hatkora* (*Citrus macroptera* Mont.) collections among its natural population from different districts of Mizoram. The ripe fruits of 15 selected collections were analyzed for physical parameters, *viz.*, fruit weight, diameter, length, volume, specific gravity, peel weight, pulp weight, pulp: peel ratio, peel thickness, pulp thickness, No. of segments, seed No., seed weight and quality parameters, *viz.*, juice, TSS, ascorbic acid, acidity, reducing, non-reducing and total sugars and sugar: acid ratio. The study reveals that there was significant variation among the collections in these particular traits. Individual fruit weight ranged from 332.00-654.44 g; fruit diameter 8.53-10.31 cm; fruit volume 283.33-584.67 cc; pulp weight 206.00-500.11 g; pulp: peel ratio 1.50-3.24 and seed number 9.33-23.6. Similarly, the chemical parameters also varied significantly among different collections. The juice content varied from 16.06-27.13%, ascorbic acid 36.47-49.77 mg/ 100 ml, acidity 6.20-8.85%, total sugars 5.31-7.33% and sugar: acid ratio 0.63-1.18. Wide range of variation in physico-chemical parameters of *hatkora* collections indicated the scope for individual plant selection based on these characters.

Key words: *Citrus macroptera* Mont., *hatkora*, variability, physico-chemical analysis, Mizoram.

INTRODUCTION

North-eastern region of India is endowed with favourable agro-climatic conditions for the growth of different citrus species and is considered as the natural home of many citrus species (Sheo Govind and Yadav, 12). A vast reservoir of citrus diversity exists in wild, semi-wild form and is found scattered without commercial cultivation (Hazarika, 5). Favourable climatic conditions aiding in easy hybridization among different species and genera has brought in about numerous forms in North-Eastern region (Hore *et al.*, 4; Singh *et al.*, 15). The total citrus production in NE region (2009-10) was 4.03 lakh tonnes from an area of 0.87 lakh ha with a productivity of 4.63 t/ha against the national productivity of 9.84 t/ha (Deka *et al.*, 2). *Hatkora* or *satkara* (*Citrus macropetra* Mont.) is one of the important and popular citrus species known for its medicinal as well as therapeutic values since ancient time. Fruit is smaller than grapefruit; contains low juice, bitter in taste. Because of its use in traditional medicines and presence of good amount of anti-oxidants, now a day this fruit is gaining worldwide popularity. A rich genetic diversity of *hatkora* exists in north-eastern region of India including bordering areas of Bangladesh, Meghalaya, Mizoram and Manipur (Singh and Singh, 14). The plant is grown semi-wild and juice obtained from fruit is used as medicine by local tribes of North East India (Ghosh, 3). Among the North Eastern states, in Mizoram, *hatkora* plants are found naturally in marginal lands, forest areas and homestead gardens without commercial cultivation. As majority of *hatkora* are of seedling origin, therefore they showed a tremendous variation in their morphology among its population. The knowledge of genetic variability is of great importance for crop improvement programme. Greater the variability in a population, greater the chance of effective selection for desirable types (Hazarika *et al.*, 4). Due to unawareness of the biodiversity, some species are almost near extinct. The rich gene pools incorporating extensive variability from basic ingredients are important for improvement programmes (Kumar, 8). Again, the success of an improvement programme depends mostly on the identification and selection of superior parents for hybridization (Jai Prakash *et al.*, 7). In the present investigation, efforts were made to find out variations in physico-chemical traits of some *hatkora* collections identified from different locations of Mizoram.

MATERIALS AND METHODS

The survey work to identify elite *hatkora* genotypes in their natural population was carried out in different districts of Mizoram during the fruiting season of 2010-2011. Matured fruits were collected from selected trees to study the physico-chemical characteristics. From

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each accession, five fruits were randomly selected for recording the data. The data on physical parameters like fruit weight, pulp weight, peel weight and seed weight were recorded with the help of an electronic balance. Quality parameters like moisture content, juice, TSS, acidity, ascorbic acid, reducing, non-reducing and total sugars were estimated following standard procedures. The juice content of the fruit was determined by extracting the juice with the help of extractor. The standard method (AOAC, 1) was followed to determine the titrable acidity of fruit juice. Ascorbic acid content was estimated as per the method of Sadasivam and Manickam (11). The reducing, non-reducing and total sugars were estimated by methods suggested by Ranganna (10). The data were statistically analyzed as per the method of Panse and Sukhatme (9).

RESULTS AND DISCUSSION

The analysis of variance of 15 *hatkora* collections identified in this investigation revealed significant differences in various physical parameters of the fruits (Table 1). Highest fruit weight (654.44 g) was observed in MZU-H-1, followed by MZU-H-4 (603.00 g) and MZU-H-15 (595.67 g) respectively. MZU-H-12 recorded the lowest fruit weight (332.00 g). Among the different collections, MZU-H-1 recorded maximum fruit length (8.87 cm). It was followed by MZU-H-15 (8.27 cm) and MZU-H-4 (8.17 cm) and the minimum (5.94 cm) was recorded in MZU- H- 12. This variation in fruit length might be due to different genetic make up of the genotypes. The accessions varied significantly with respect to fruit diameter also. Maximum diameter was recorded in MZU-H-1 (10.31 cm) which was significantly higher than most of the accessions, while the minimum was in MZU-H-12 (8.53 cm). The highest fruit volume was observed in MZU-H-1 (584.67 cc). It was followed by MZU-H-15 (573.33 cc) and the minimum was in MZU-H-12 (283.33 cc). Maximum specific gravity was recorded in MZU-H-6 (1.27 g/cc), followed by MZU-H-4 (1.19 g/cc) and the minimum was recorded in MZU-H-15 (1.04 g/cc). Collection MZU-H-5 recorded the highest peel weight (196.00 g), which was significantly higher than all the collections. The maximum pulp weight of 500.11 g was recorded in MZU-H-1 followed by MZU-H-4 (448.67 g) and MZU-H-15 (447.00 g) and the minimum of 206.00 g was recorded in MZU-H-12. The range of pulp: peel ratio varied from 1.50-3.24 among the genotypes. The highest ratio of 3.24 was recorded in MZU-H-1, which was followed by MZU-H-15 (3.01) and MZU-H-4 (2.91) and the lowest was in MZU-H-5 (1.50). Peel thickness also showed considerable variation among the collections and maximum of 2.37 cm was observed in MZU-H-1, which was significantly higher than most of the accessions. The lowest peel thickness was recorded in MZU-H-11 (1.10 cm). There is earlier report of considerable variation in peel thickness of *C. macroptera* (Singh and Singh, 14). Collection MZU-H-11 recorded the highest pulp thickness (8.57 cm) followed by MZU-H-13 (8.56 cm) and the lowest was recorded in MZU-H-10 (7.24 cm). The number of segments was maximum in MZU-H-4 (14.67) and it was lowest in MZU-H-1 (11.33). Similarly, the number of seeds per fruit was lowest in MZU-H-1(9.33) followed by MZU- H-15 (10.00) and MZU-H-4 (10.33) and highest was in MZU-H-3 (23.67). The lowest seed weight was noticed in MZU-H-1 (24.33 g) followed by MZU-H-4 (26.27 g), whereas it was highest in MZU-H-13 (51.57 g). For an ideal variety lower weight and small size of seed are the desirable characters.

These observations revealed a positive correlation among pulp weight, seed weight and fruit weight. The genotypes produced higher pulp weight may be due to higher fruit weight and less seed weight. This clearly indicated that, during selection of any genotype based on fruit, the breeder should give emphasis on fruit pulp content rather than fruit weight alone. This finding is in conformity with Hazarika *et al.* (4).

The data presented in Table 2 showed significant variation in chemical characters of fruits. The juice content was found maximum in MZU-H-1 (27.13%), followed by MZU-H-4 (23.67%) with minimum in MZU-H-2 (16.06%). This finding is in agreement with Singh *et al.* (15). In the present study, the TSS content of the fruits varied from 8.07-10.27%. Highest of 10.27% was recorded in MZU-H-1, followed by MZU-H-4 (9.76%), while lowest was in MZU-H-2 (8.07%). The variation in TSS may be due to genetic make up of plant. Singh and Singh (13) reported variation of TSS among different citrus accessions. Ascorbic acid content is also one of the most important criteria in determining the superiority of *hatkora* collection. MZU-H-1 showed highest ascorbic acid content (49.77 mg/100 g), followed by MZU-H-4 (48.63 mg/100 g). Among all the collection, MZU-H-7 (36.47 mg/100 g) recorded the lowest ascorbic acid. It is a fact that, if TSS increases, the ascorbic acid also increases because the precursor of ascorbic acid is glucose-6-phosphate (Jai Prakash *et al.*, 7). Titrable acidity of the fruits ranged between 6.20 to 8.85 percent. The highest acidity of 8.85 per cent was observed in MZU-H-5, while, lowest was in MZU- H-1 (6.20%). In many fruits TSS increased with decrease in acidity (Jai Prakash *et al.*, 7). Similarly, sugar content also varied significantly among the collections. Highest value of reducing sugar was recorded in MZU-H-1 (4.15%), followed by MZU-H-13 (4.08%) and the

Table 1. Variability in physical and morphological characteristics of fruits among *hatkora* collections.

Genotype	Fruit wt. (g)	Fruit length (cm)	Fruit dia. (cm)	Fruit vol. (cc)	Specific gravity (g/cc)	Peel wt. (g)	Pulp wt. (g)	Pulp: peel ratio	Peel thickness (cm)	Pulp thickness (cm)	No. of segments	No. of seeds	Seed weight (g)
MZU-H-1	654.44	8.87	10.31	584.67	1.12	154.33	500.11	3.24	2.37	7.94	11.33	9.33	24.33
MZU-H-2	432.62	7.67	9.67	409.67	1.06	128.67	303.95	2.36	1.27	8.40	12.00	16.00	33.93
MZU-H-3	426.64	7.32	9.40	407.33	1.05	167.00	259.64	1.55	1.61	7.79	13.00	23.67	32.24
MZU-H-4	603.17	8.17	9.14	506.67	1.19	154.33	448.67	2.91	1.70	7.44	14.67	10.33	26.27
MZU-H-5	490.15	7.67	9.16	430.00	1.14	196.00	294.00	1.50	1.50	7.66	13.67	11.00	42.33
MZU-H-6	386.67	7.33	9.33	303.34	1.27	108.33	278.34	2.57	2.06	7.27	14.33	16.67	42.43
MZU-H-7	470.00	6.67	9.40	435.00	1.08	168.33	301.67	1.79	1.53	7.87	13.33	10.67	32.53
MZU-H-8	383.24	7.57	9.00	342.00	1.12	124.00	259.24	2.09	1.67	7.33	12.33	20.00	40.70
MZU-H-9	353.25	7.77	8.77	313.33	1.13	94.67	258.58	2.73	1.23	7.54	13.33	22.33	34.17
MZU-H-10	360.02	6.77	8.67	306.67	1.17	94.00	266.00	2.82	1.43	7.24	14.33	11.00	41.67
MZU-H-11	416.67	7.83	9.67	379.00	1.10	130.00	286.67	2.20	1.10	8.57	13.67	12.33	32.23
MZU-H-12	332.00	5.94	8.53	283.33	1.17	126.00	206.00	1.63	1.27	7.26	12.67	16.00	42.67
MZU-H-13	457.69	7.73	10.09	410.00	1.12	145.00	312.69	2.16	1.53	8.56	13.67	11.33	51.57
MZU-H-14	451.62	7.77	9.69	417.00	1.08	136.67	314.95	2.30	1.57	8.12	11.67	15.67	32.13
MZU-H-15	595.67	8.27	10.10	573.33	1.04	148.67	447.00	3.01	1.57	8.53	12.00	10.00	31.30
$CD_{0.05}$	7.83	2.44	1.20	22.43	0.12	9.14	9.07	0.41	0.52	0.79	2.67	2.80	3.41

Table 2. Variability in chemical characteristics of fruits among different *hatkora* accessions

Genotype	Juice (%)	TSS (%)	Ascorbic acid (mg/100 g)	Acidity (%)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugars (%)	Sugar: acid ratio
MZU-H-1	27.13	10.27	49.77	6.20	4.15	3.18	7.33	1.18
MZU-H-2	16.06	8.07	41.37	7.33	4.02	2.15	6.17	0.84
MZU-H-3	17.15	8.53	41.97	8.85	3.47	2.13	5.60	0.63
MZU-H-4	23.67	9.76	48.63	6.37	3.53	3.30	6.83	1.07
MZU-H-5	16.33	8.80	43.53	7.23	3.81	1.54	5.35	0.73
MZU-H-6	22.33	9.13	45.33	8.12	3.63	3.30	6.72	0.83
MZU-H-7	19.67	9.03	36.47	7.70	4.05	2.48	6.53	0.85
MZU-H-8	23.10	8.73	44.53	6.53	3.77	1.54	5.31	0.81
MZU-H-9	23.00	9.60	45.57	7.47	3.25	3.55	6.80	0.91
MZU-H-10	21.70	8.87	46.43	7.80	4.03	1.44	5.47	0.70
MZU-H-11	21.33	8.67	46.97	7.63	3.63	2.54	6.17	0.81
MZU-H-12	22.67	8.83	38.43	7.83	3.57	3.26	6.81	0.87
MZU-H-13	21.33	8.47	47.67	8.17	4.08	1.65	5.73	0.70
MZU-H-14	21.67	8.87	39.43	6.83	3.26	3.04	6.30	0.92
MZU-H-15	23.67	9.57	46.49	6.80	3.80	3.40	7.20	1.05
$CD_{0.05}$	3.51	0.57	6.22	0.51	0.34	0.62	0.47	0.09

lowest was in MZU-H-9 (3.25%). Similarly, the highest non-reducing sugar was in MZU-H-9 (3.55%) and the lowest was in MZU-H-10 (1.44%). The total sugars was found highest in MZU-H-1 (7.33%) and the lowest in MZU-H-8 (5.31%). The variation in total sugars among the accessions may be due to genetic makeup of plant. The highest sugar: acid ratio was recorded in MZU-H-1 (1.18), which was followed by MZU-H-4 (1.07) and MZU-H-15 (1.05) the lowest was in MZU-H-3 (0.63).

Preference of consumers always depends on physical parameters of fruits like fruit weight, fruit diameter, pulp content and pulp: peel ratio of any fruit. In *hatkora*, more weight of the fruit, bigger size, more the pulp content and more pulp: peel ratio, greater is the acceptability by the consumer. Similarly, consumers also prefer the fruit with less seed. 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. Therefore, from the present investigation, MZU-H-1, MZU-H-4 and MZU-H-15 were selected as superior collections of *hatkora* for use in various purposes.

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