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Physico-Chemical Characterization and Nutrient Profiling of Some Banana Genotypes Grown in Nagaland, India

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ABSTRACT

A study was conducted to evaluate the banana genotypes to assess the physico-chemical compositions of high value and locally grown banana genotypes and their tissue index from different location of Nagaland during 2019-20 in the Department of Horticulture, Nagaland University, SAS, Medziphema Campus. The collected genotypes were jahaji, kanthali, bharat mani, chini champa, meitei hei, bhoot manohar, pisang awak, plantain, giant cavendish and grand naine. The findings revealed that meitei hei recorded maximum fruit weight (186.04 g), fruit volume (175.4 cc) and pulp weight (140.83 g) while maximum peel thickness (0.51 mm) and peel weight (58.80 g) were observed in giant cavendish. Maximum TSS (25.31°B) and vit C (15.30 mg/100g juice) content was observed in kanthali. The highest potassium content in fruit pulp was recorded in jahaji (4.71 %), while the highest iron (9.01 ppm) and calcium (0.066%) was found in bhoot manohar. The different genotypes also represented by soft to firm in pulp texture and sweet-acidic with pleasant smelling. It was postulated that genotypes grand naine, kanthali and meitei hei performed better in context of nutrient status of fruit in subtropical and sub humid foot hill condition of Nagaland.

Keywords Banana, Fruit quality, Genotypes, Mineral, Nutrient.

INTRODUCTION

Banana (*Musa* spp.) is a monocotyledonous, monocarpic, herbaceous perennial plant, belonging to family Musaceae with two genera *Musa* and *Ensete.* It is a crop having multifarious uses as every part of the plant is utilized and hence aptly called as Kalpatharu, meaning plant of virtues. It is actually said to have originated in the tropical regions of Indo Malayan i.e. South East Asia. The banana is presumed to be one of the oldest fruits known to mankind and has been popularly called "Apple of Paradise". Edible parthenocarpy (seedless) bananas are a natural cross of two wild and cultivated species viz. *Musa acuminata*

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Colla (contribute 'A' genome) and *Musa balbisiana* Colla (contribute 'B' genome). Edible bananas have chromosomes number of 22, 33 or 44 with the basic number as n=11, so that ploidy levels are diploid (2x), triploid (3x) and tetraploid (4x) respectively with 7 genome configurations which consists of AA, AAA and AAAA (*M. acuminata*) cultivars and AB, AAB, ABB and ABBB (which are hybrid forms of *M. acuminata* ×*M. balbisiana*). The section Eumusa is usually known as *Musa* and is one of the largest of the five sections with 13-15 spp. It is considered as the most diversified, most ancient and widely distributed section of the family Musaceae. The banana plant grows up to a height of 3.5 to 12 m, with the leaves of 2.4 to 3.7 m long and half a meter wide and the clusters of fruits mostly consisting of 6 to 9 clusters with individual fruits grouped in bunches, known as "hands" consisting of 10 to 25 bananas (Elayabalan *et al.* 2017). Banana has a calorific value which ranges from 67 to 137 calories per100 g. It is rich in carbohydrates, free from fats rich in vitamins and minerals like K, Ca and Mg (Smitha *et al.* 2015) hence known as wholesome fruits. Because of its notable potassium content bananas are highly recommended by doctors for patients with low potassium content. Vitamins and minerals are abundant in banana with 123 IU of Vitamin A (retinol), 0.07 mg B_1 (thiamine), 0.15 mg B_2 (riboflavin), 0.82 mg B_3 (niacin), 0.88 mg Vitamin B_6 (pyridoxine) and 29 mcg B_9 (folic acid). Banana due to their richness in pectin restores the normal bowel activity as they are rich in non-digestible fibers which help in both constipation and diarrhea. India is the largest producer of banana in the world, producing about 37614 000' MT from an area of 948 000' ha with a productivity of 39.4 MT/ha (Anon 2024). In India the maximum production is recorded in Maharashtra (6534.35 000' MT) followed by Andhra Pradesh (5830.93 000' MT) and Tamil Nadu (4719.95 000' MT). In Nagaland the production of banana is around 94.97 000' MT from an area of 7.27 000' ha (Anon 2024). Variations in productivity ranged from 2.90 to 17.20 are usually attributed to production system, management practices and even the cultivars itself. The North-East region of India is blessed with rich flora which includes high diversity of wild and high value cultivated banana. A well planned banana improvement program needs to be undertaken with a view to evolve ideal genotypes through proper screening of the germplasms. The amount of variability found in the chemical and mineral composition of banana will also be advantageous for nutritionists and plant breeders who may desire to breed for a combination of desirable characters including high micronutrient quality. A wide variation of banana germplasms is available in Nagaland and northeast as a whole but there is lack of available information and absence of proper studies carried out regarding its varieties, quality, biochemical and nutrient profile of fruits. Keeping in view the above aforementioned, experiment was undertaken to get a complete picture of banana diversity with desired nutritional quality in Nagaland.

MATERIALS AND METHODS

The experiment was carried out at Department of Horticulture, SAS, Nagaland University, Medziphema Campus during 2022-23. Nagaland represents sub-humid sub-tropical climate with moderate temperature prevailing 20ºC to 35ºC during summer and rarely below 8º C in winter, moderate to high rainfall (2000-2500 mm per annum) and atmospheric humidity varies from 75 to 85%. Ten banana genotypes like jahaji (AAA), kanthali (ABB), bharat mani (AAB), chini champa (AAB), meitei hei (ABB), bhoot manohar (AAB), pisang awak (AAB), plantain (ABB), giant cavendish (AAA) and grand naine (AAA) were collected randomly in three different locations of Nagaland for characterization of fruit quality. The fully matured tagged bunches were harvested when fingers were fully developed and the fingers started to change their color from dark green to light green. Good and healthier bunches were selected to make a sample set. The middle fingers from the top and bottom rows of the second hand were selected as representative fingers for quality analysis in laboratory. One genotype was considered as one treatment collected from three different location. Physical parameters such as fruit weight, fruit volume, fruit peel thickness, pulp weight, peel weight and pulp/peel ratio were determined. Total soluble solids (TSS) were determined with the help of hand refractometer calibrated in ^{0}Brix range 0-32% at 20 ^{0}C with necessary correction factor. Total sugar was determined using Fehling's reagents with methylene blue as an indicator and acidity 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 (1984). The nutrient contents in leaf tissue and fruit pulp were determined by adopting standard procedures of Jackson (1973).

RESULTS AND DISCUSSION

Physiological characters of fruits

Significant variation in fruit weight (63.84 g to 186.04 g) and volume (54.48 cc to 175.40 cc) was noticed in different of banana genotypes (Table 1). Maximum fruit weight and fruit volume was recorded in meitei hei (186.04 g and 175.4 cc) and giant cavendish (181.4 g and 170.91 cc), whereas the minimum fruit weight and volume was recorded in chini champa (59.64 g and 54.48 cc) followed by pisang awak (63.84g and 58.27 cc) and kanthali (76.61 g and 71.09 cc). Belayneh *et al.* (2013) got a large variation in fruit characters with cardaba, matoke, nijiru and kitawira cooking banana. Maximum pulp weight was observed in meitei hei (140.83 g) followed by giant cavendish (122.6 g), bhoot manohar (104.22 g) and plantain (91.42 g), whereas the lowest pulp weight was recorded in chini champa (43.02 g). Giant cavendish registered the highest peel weight (58.8 g) and peel thickness (0.51 mm). The lowest peel weight and peel thickness was observed in pisang awak (13.03 g and 0.25 mm) and chini champa (16.62 g and 0.2 mm). The result was similar in accordance to the findings of Kuchi *et al.* (2017) who found the variation in physiological characters in different banana genotypes like grand naine, poyo, kalyani local, nendran, champa and cooking banana. The highest pulp/peel ratio was recorded in pisang awak (3.89) followed by bhoot manohar (3.38) and meitei hei (3.11). The lowest pulp/peel ratio was recorded in grand naine (1.59) followed by jahaji (1.84). Sreedevi and Suma (2015) noticed the higher peel/pulp ratio in conventionally cultivated variety palayamkodan. The variation in flesh texture and taste was noticed in ripe banana fruits. Genotypes pisang awak and plantain showed firm texture, whereas kanthali and bhoot manohar showed intermediate texture and the rest jahaji, bharat mani, chini champa, meitei hei, grand naine and grand naine showed soft flesh texture. Jahaji and chini champa was highly sweet in taste while meitei hei, plantain and pisang awak has been observed sweet and acidic in taste. Hapsari and Lestari (2016) also characterized the taste and flesh texture in different genotypes like pisang berlin with sugary taste, pisang raja bandung with sweet-acidic and pisang kepok with mild sweet taste.

Biochemical composition of fruits

Significant variation in biochemical composition of fruits was observed in different banana genotypes (Table 2). Kanthali recorded maximum TSS content (25.31°B) which was significantly superior over the other genotypes followed by Chini champa (23.02 °B) which was at par with bhoot manohar at (22.01 °B) and meitei hei (15.03 °B) showed the minimum TSS in ripe banana. High TSS along with high sucrose content in the banana pulp improved the quality of banana. TSS is considered to be one of the most use-

Table 1. Performance of different genotypes on physiological attributes of banana fruits.

Genotypes	Fruit weight (g)	Fruit volume (cc)	Fruit peel thickness (mm)	Pulp weight (g)	Peel weight (g)	Pulp/peel ratio
Jahaji (AAA)	103.49±5.48	93.96±4.00	0.31±0.02	67.07±3.11	36.42±1.93	1.84±0.10
Kanthali (ABB)	76.61±3.34	71.09±1.64	0.40±0.02	52.40±3.83	24.21±1.06	2.16±0.13
Bharat mani (AAB)	98.44±8.06	88.56±4.63	0.41±0.05	69.81±4.44	28.63±2.34	2.43±0.27
Chini champa (AAB)	59.64±3.16	54.48±5.17	0.20±0.01	43.02±2.62	16.62±0.88	2.58±0.14
Meitei hei (ABB)	186.04±7.44	175.40±2.42	0.42±0.02	140.83±3.55	45.21±1.81	3.11±0.12
Bhoot manohar (ABB)	135.03±11.05	126.95±1.08	0.33±0.03	104.22±4.59	30.81±2.52	3.38±0.28
Pisang awak (AAB)	63.84±4.99	58.27±2.61	0.25±0.01	50.81±2.36	13.03±1.02	3.89±0.21
Plantain (ABB)	138.25±12.05	129.44±2.14	0.32±0.03	91.42±3.30	46.83±4.08	1.95±0.17
Giant cavendish (AAA)	181.40±15.71	170.91±5.77	0.51±0.07	122.60±3.61	58.80±5.09	2.08±0.28
Grand naine (AAA)	146.12±11.06	135.32±2.52	0.45±0.04	89.71±3.69	56.41±3.95	1.59±0.14

Table 2. Performance of different banana genotypes on physico-chemical composition of fruits.

Genotypes	TSS (°Brix)	Acidity (%)	TSS/acid ratio	Total sugar (%)	Reducing sugar (%)	Vit. C (mg/100 g of pulp)	Texture	Taste
Jahaji (AAA)	21.30±3.29	0.16±0.01	133.13±17.55	12.03±1.95	5.80±0.31	8.83±1.04	Soft	Highly sweet
Kanthali (ABB)	25.31±2.42	0.20±0.01	126.55±11.47	9.50±1.26	3.01±0.13	15.30±2.23	Intermediate	Sweet
Bharat mani (AAB)	17.03±2.53	0.16±0.02	106.44±28.69	9.52±1.61	5.41±0.44	7.68±1.05	Soft	Sweet
Chini champa (AAB)	23.02±2.77	0.19±0.01	121.16±20.75	8.81±0.93	4.57±0.24	4.64±0.58	Soft	Highly sweet
Meitei hei (ABB)	15.03±2.53	0.32±0.01	46.97±8.35	10.03±0.18	6.40±0.26	3.84±0.07	Soft	Sweet
Bhoot manohar (ABB)	22.01±2.21	0.29±0.02	75.90±9.84	10.04±0.98	6.51±0.53	11.52±2.00	Intermediate	Sweet-acidic
Pisang awak (AAB)	19.23±1.69	0.27±0.01	71.22±7.05	8.61±1.33	5.72±0.45	7.68±1.15	Firm	Sweet-acidic
Plantain (ABB)	17.31±1.74	0.32±0.03	54.09±7.33	12.60±0.86	7.51±0.65	4.90±1.02	Firm	Mild acidic
Giant cavendish (AAA)	16.22±2.49	0.19±0.03	85.37±7.65	8.62±0.98	5.53±0.48	7.68±1.92	Soft	Sweet
Grand naine (AAA)	20.33±2.92	0.17±0.02	119.59±8.36	10.03±0.99	4.10±0.29	8.83±0.94	Soft	Sweet

ful index for the determination of fruit maturity and ripeness. Sandip and Sundaram (2015) mentioned that magnitude of increase of total soluble solids in banana was dependent on cultivar and found the highest TSS in monthan banana (22.24 °B). The study was in accordance with the findings of Siji and Nandini (2017) who found the variation in TSS (17.83 °B to 23.90 °B) in different genotypes. Maximum acidity content was found in meitei hei (0.32 %), plantain (0.32 %) and bhoot manohar (0.29%) while minimum acidity was found in bharat mani and jahaji (0.16 %) banana. The study is in agreement with the findings of Narayana *et al*. (2017) who reported the highest acidity content of 0.21 % in pisang awak banana under different genotypes of banana. Total sugar content was found to vary from 8.61 to 12.60% in different genotypes. Maximum level of total sugar was noticed in plantain (12.6 %) and jahaji (12.03%) while pisang awak (8.61%) and giant cavendish (8.62%) showed the lowest sugar content. The concentration of sugars has been found to be varied along with the level of maturity as reported by Narayana *et al.* (2017) who noticed the highest total sugar content in pisang awak (AAB). Maximum content of reducing sugar was observed in plantain (7.51 %) followed by bhoot manohar (6.51 %). Minimum reducing sugar content was observed in kanthali (3.01 %) which were followed by grand naine at 4.1 % which is equivalent with chini champa with 4.57 %. Ascorbic acid content in different genotypes varied significantly ranging from 3.84 to 15.30 mg /100g of pulp. Kanthali (15.3 mg/100g of pulp) showed the maximum ascorbic content followed by bhoot manohar (11.52 mg/100g of pulp). The lowest ascorbic content was observed in meitei hei (3.84 mg/100g of pulp), chini champa (4.64 mg/100g of pulp) and plantain (4.9 mg/100 g of pulp). The ascorbic acid content in kanthali genotype (15.3 mg/100g of pulp) was triple over meitei hei (3.84 mg/100g of pulp).

Nutrient content in leaves and fruits

Potassium

Potassium content in different genotypes varied from 2.71 to 4.71% in fruit pulp. Maximum potassium content was recorded in grand naine (4.71%), followed by jahaji (4.13 %) and bharat mani (4.01 %), while the minimum content was recorded in pisang awak (2.71 %) which was at par with plantain (2.79%) in

Table 3. Study on nutrient content in leaf and pulp samples of different banana genotypes.

Genotypes	K (%)		Ca (%)		Mg (%)		Fe (ppm)		Zn (ppm)	
	Leaf	Pulp	Leaf	Pulp	Leaf	Pulp	Leaf	Pulp	Leaf	Pulp
Jahaji (AAA)	3.16±0.17	4.13±0.22	1.21±0.06	0.059±0.0	0.25±0.01	1.30±0.07	108.04±5.72	4.01±0.21	29.00±1.13	2.00±0.11
Kanthali (ABB)	2.21±0.10	3.06±0.13	0.62±0.03	0.038±0.0	0.40±0.02	1.21±0.05	149.01±6.50	7.52±0.33	14.01±1.01	1.76±0.08
Bharat mani (AAB)	3.01±0.34	4.01±0.33	0.73±0.08	0.034±0.0	0.35±0.04	1.13±0.13	112.01±9.17	3.25±0.36	17.04±1.95	0.81±0.09
Chini champa (AAB)	2.07±0.11	2.75±0.15	0.51±0.03	0.062±0.0	0.32±0.02	1.25±0.07	103.00±5.45	5.61±0.30	21.05±1.59	1.93±0.10
Meitei hei (ABB)	2.30±0.09	3.65±0.15	0.58±0.02	0.053±0.0	0.32±0.01	1.19±0.05	138.05±5.52	8.91±0.36	17.03±1.43	1.26±0.05
Bhoot manohar (ABB)	2.51±0.21	3.50±0.29	1.30±0.11	0.066±0.01	0.29±0.02	1.20±0.10	180.33±14.76	9.01± 0.74	15.08±1.90	1.10±0.09
Pisang awak (AAB)	2.01±0.11	2.71±0.14	0.61±0.03	0.053±0.0	0.37±0.02	1.15±0.06	107.01±8.36	4.83± 0.26	15.00±1.81	1.72±0.10
Plantain (ABB)	2.09±0.18	2.79±0.24	0.64±0.06	0.064±0.01	0.34±0.03	1.39±0.12	114.05±9.94	8.04±0.70	16.09±0.96	1.56±0.14
Giant cavendish (AAA)	2.82±0.37	3.97±0.34	0.71±0.09	0.046±0.01	0.36±0.05	1.21±0.16	98.14±8.50	5.14±0.68	13.09±0.78	0.51±0.07
Grand naine (AAA)	3.20±0.28	4.71±0.33	0.89±0.08	0.068±0.01	0.43±0.04	1.44±0.13	103.14±7.22	6.61±0.59	12.42±0.89	1.99±0.18

Table 3. The highest potassium content in leaves was reported in grand naine (3.2 %) followed by jahaji (3.16 %) and the lowest was noticed in pisang awak (2.01 %) followed by chini champa (2.07 %) which was at par with plantain (2.09 %), kanthali (2.21%) and meitei hei (2.3%) in leaves. Mineral composition of collected fruits from different inhabitant with different soil composition exhibited variation in different genotypes due to various factors. The results obtained are in close agreement with the findings of Smitha *et al.* (2015), who also exhibited the highest potassium content (3.97 %) in cavendish banana and the lowest in nendran (2.85 %). This finding is also in accordance with the report of Yap *et al*. (2017), who documented a potassium content of 5.84 % in cavendish banana.

Iron

Iron content in different genotypes varied from 9.01 to 43.25 % in fruit pulp. Maximum iron content was recorded in bhoot manohar (9.01 ppm) followed by meitei hei (8.91 ppm) and plantain (8.04 ppm) and minimum was noticed in bharat mani (3.25 ppm) followed by jahaji (4.01 ppm) and pisang awak (4.83 ppm) in Table 3. The highest iron content in leaves was reported in bhoot manohar (180.33 %) followed by kanthali (149.01 %) and the lowest was noticed in giant cavendish (98 %) followed by chini champa (103.00 %) which was at par with grand naine (103.14 %) in leaves. Leterme *et al*. (2006) found the highest iron content (0.7-8.4 mg/100 g in edible portion) in tree foliage including Musa. It has been noticed that the mineral content gradually increased during ripening. Variation in phytochemical composition and mineral element of fruits is due to cultivar, soil, climatic conditions, temperature, light intensity, growing condition, water quality and many more factors (Ogbonna *et al.* 2016).

Calcium

The highest calcium content was noticed in grand naine which was recorded as 0.068 %, whereas the lowest calcium content was observed in bharat mani at 0.034 % (Table 3). It was found that pulp calcium showed positive and significant correlation with pulp mg (r=0.665*). The finding was in close proximity with Siji and Nandini (2017) who reported the lowest calcium content (0.35 mg/100g) in red banana. Smitha *et al.* (2015) noticed that calcium content in different banana varieties in coastal belt of Karnataka area ranged from 17.15±1.67 mg/100g to 47.19±3.53 mg /100g analyzed by flame photometry. Maximum calcium content in leaves was reported in bhoot manohar (1.30 %) which was at par with jahaji (1.21

%). Minimum leaf content was observed from chini champa (0.51 %) which was followed by meitei hei (0.58 %). The calcium concentration in leaves ranged from 0.51 to 1.30 % with an average of 0.78 % were found to be above critical nutrient level which was corroborated with the findings of Kalhoro *et al.* (2015) who reported calcium content in leaves to be above critical nutrient level with an average of 0.68 % in banana leaves.

Magnesium

Maximum magnesium was recorded in grand naine (1.44 %) which was followed by plantain (1.39 %) whereas minimum magnesium content was reported in bharat mani (1.13 %) trailed by pisang awak (1.15 %) in Table 3. Among the genotypes, grand naine (0.43%) showed the highest magnesium content in leaves, followed closely by Kanthali (0.40%). Conversely, jahaji (0.25%) registered the lowest magnesium content, remaining statistically comparable with bhoot manohar (0.29%).

Zinc

Jahaji recorded the maximum zinc content in pulp (2.00 ppm) which was at par with grand naine (1.99 ppm) and chini champa (1.93 ppm) in Table 3. The lowest zinc in pulp was exhibited in grand naine (0.51 ppm) followed by bharat mani (0.81 ppm). Jahaji (29.00 ppm) recorded significantly higher leaf potassium content compared to others followed by chini champa (21.05 ppm). The lowest zinc content in leaves was recorded in grand naine (12.42 ppm) followed by giant cavendish (13.09 ppm). Variability in the zinc content among various cultivars were said to be influenced by environment factors than by genotypes as reported by Forster *et al.* (2003).

CONCLUSION

The findings provided the basic knowledge about the physico-chemicals and nutrient analysis of different *Musa* germplasm growing under the natural habitat in Nagaland. Among the genotypes, kanthali gave better performance in fruit quality having highest results in TSS (25.31 %) and vit C (15.30 mg/100g of pulp). Regarding fruit nutrients grand naine gave more promising results. Therefore, from the evidence it can be concluded that kanthali for quality, meitei hei for fruit characters and grand naine for nutrient content may be potential genotypes in Nagaland.

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