Original Research Article

Physico-chemical characteristics of different banana genotypes in Nagaland

ABSTRACT

The current study aims to evaluate the physico-chemical characteristics of selected banana genotypes of Nagaland. Ten banana genotypes were collected from farmer's field and the fruits were analyzed for TSS, acidity, total sugar, reducing sugar, TSS/Acid ratio, crude protein and total carotenoids. All the analysis was done in randomized block design with three replications. In order to obtain suitable interpretation the generated data was subjected to statistical analysis such as One-way Analysis of Variance (ANOVA) at 0.05%α. The experimental result revealed wide variation in the physico-chemical attributes of the selected genotypes. The maximum total soluble solids, acidity, total sugar and reducing sugar were found in Bhootmanohar, Chinichampa, Grand Naine and Meiteiheibanana respectively. Highest TSS/Acid ratio, crude protein and total carotene were obtained in Bhootmanohar, Grand Naine and Bharatmani respectively. The cluster analysis of the mean of different physico-chemical characteristics revealed two major clusters and one out group.

Keywords: Banana, physico-chemical, crude protein, carotenoids, cluster analysis

1.INTRODUCTION

Banana (*Musa* spp.) is a monocotyledonous, herbaceous, perennial succulent plant and one of the most important edible food crops worldwide. In some of the African countries like Uganda, Bukaba and Tanzania it has established as a staple food and one of the most important traded tropical fruits in the world [1]. As a diet, it is highly satisfying, easy to digest, nearly fat free, rich source of carbohydrate with calorific value of 67g/100g and is free from sodium making it a salt free diet suitable to all the age groups and people of all levels. It contains various vitamins and has therapeutic values for the treatment of many diseases [2].

The banana fruit can be eaten raw or cooked, can be processed into flour and can be fermented for the production of beverages such as banana juice, beer, vinegar and wine [3] [4] [5][6].Other parts of the banana plant are also eaten e.g. the flower is eaten raw or cooked in South-east Asia; the core of the pseudostem is used for cooking in Myanmar and West Bengal; leaf buds are eaten as a vegetable the corm is a source of starch and has been eaten in times of famine in Africa and Asia [4].

In North East Region of India, the production of banana is 1492 000' MT from an area of 1.0071 lakh with a productivity of 11.32 MT/ha, out of which production in Nagaland is around 117.04 000' MT from an area of 0.0834 lakh with a productivity of 14.03 tonnes/ha. Assam leads in both area (0.53308 lakh) and production (913.27 000' MT) followed by Mizoram with an area of 0.1101 lakh and production of 117.04 000' MT. Lowest production has been found to be in the state of Sikkim (3.71 000' MT) [7].

Ripe banana has antioxidant properties and is rich in potassium (342.3 mg/100 g), carotenoids (735 mg/100 g), ascorbic acid (12.7 mg/100 g), citric acid and malic acid [8]. Banana has low sodium and fat content, and is used for treating diarrhoea and provides resistance to chronic disease like cardiovascular dysfunction, muscular degeneration and muscle cramps [9][10].

Banana is delicious and most nourishing of all fruits. Many *in vitro* studies, animal model studies and clinical studies showed that various parts of banana act as food medicines for treatment of diseases like diabetes, hypertension, cancer, ulcers, diarrhoea, urolithiasis, Alzheimer's and infections. It helps in treating some emotional and bodily sicknesses, and it contains high amount of iron, which helps to stimulate the production of haemoglobin in the blood, reduces the risk of blood pressure and stroke due to its high potassium and low salt content [11].

It is a cheaper source of sugar and act as starch filler that provides texture and can be supplemented to other fruit juices. The main constraint of adding banana pulp to food products is its discolouration during processing and storage. It is due to oxidation of tannins and activity of polyphenol oxidase on phenolic compounds [12]. The enzymatic activity can be reduced or inactivated by the use of chemicals such as potassium metabisulphite (KMS) and ascorbic acid. Keeping in view the medicinal and nutritional importance of banana fruits, the work was conducted to study the physico-chemical characteristics of fresh banana fruits for its further utilization and processing into different value added products.

2.MATERIAL AND METHODS

The present study was carried out in department of horticulture, school of agricultural science and rural development, Medziphema campus, Nagaland University. A total of ten different genotypes of bananas found in Nagaland were analyzed for its physic-chemical characteristics. The banana fruits were harvested from the farmer's homestead garden from different districts of Nagaland. Total soluble solids (TSS) were estimated at ambient temperature by hand refractometer and the values were expressed as ^{0}Brix. Acidity was analyzed by the methods of Ranganna[13]. Total sugar and reducing sugar of banana fruits were determined by the methods of AOAC [14]. The nitrogen content of banana samples was estimated by micro Kjeldahl's wet digestion method. The values of nitrogen contents were multiplied by the factors 6.25 to get crude protein content[15]. Total carotenoids content of banana fruits was determined by the method given by Roy [16]. All the ~~analysis~~ analyses was done in randomized block design with three replications. In order to obtain suitable interpretation the generated data was subjected to statistical analysis such as One-way Analysis of Variance (ANOVA) at 0.05%.Duncan's multiple range test was used for the comparison of means at 95% confidence level (p=0.05). Qualitative analysis of fruit physic-chemical characteristics were quantified using multivariate Bray Curtis Cluster analysis method using PAST version 4.03 windows software and presented as two dimensional dendrogram.

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3. RESULTS AND DISCUSSION

The ripened banana samples were evaluated for various physic-chemical characteristics and the results have been presented in Table 1 and Figure 1. Each value is the mean value of triplicate analysis.

TSS is an important attribute of fruits that can serve as a useful index in the determination of fruit maturity and ripeness. The TSS of fruit pulp gives a rough idea of the sweetness because it includes all types of soluble solids. As reported by Lu [17], total soluble solids (TSS) are an important quality attribute for many fresh fruits during ripening. In the present study, significant difference was observed in TSS content and ranged from 15.78-24.39 ^{0}B. Highest TSS content was observed for genotype Bhootmanohar (24.39 ^{0}B) and the lowest for Lumungashe (15.78 ^{0}B). Genotypes like Grand Naine (22.33 ^{0}B), Chinichampa (22.23^{0}B), Jahaji (21.88^{0}B) and Kanthali (21.69^{0}B) were all statistically at par. In a study by Siji and Nandini [18], TSS content of Kanthali, Nendran and Robusta were recorded at 23.90^{0}B, 22.00^{0}B and 20.30^{0}B respectively.Variation in TSS content was estimated by many researchers. Cano *et al*., [19] evaluated two Spanish and one Latin-American banana and outline TSS in the range of 16.30 to 24.56^{0}B. Mattos *et al*., [20]reported that among 26 accession of banana the mean total TSS content was 19.48^{0}B with a range of 14.60^{0}B to 25.70^{0}B. A study by Sandipkumar and Shanmugasundaram[21] revealed that the magnitude of increase in total soluble solids in banana is dependent on cultivar.

In the present investigation, varietal differences in terms of titrable acidity were observed to be statistically significant. Data shows significant variation in different genotypes for titrable acidity within the range of 0.40-

0.72%. The genotype Bhootmanohar was found to be least acidic (0.40%) when compared to other genotypes. The maximum acidity value was recorded in Chinichampa(0.72%) followed by Nendran (0.53%). According to Sadler and Murphy [22], titrable acidity is a measured for the determination of total acid content present in a food. Sugar gives only sweetness but along with this acidity in different ratio contribute to a fine and characteristics taste of a particular fruit. In fruits, acidity decreases with ripening of fruits though it is a genetical character of individual variety. Cano *et al*., [19]and Uma *et al*., [23] has also observed the variation in acidity content in pulp of banana. High total titratable acidity is a desirable feature for the processing industry [24] [25], which emphasize the suitability of Chinichampa for processing industry.In a comparative study, Sreedevi and Suma [26] revealed that acidity content of inorganically cultivated Palayankodan was higher when compared to organically cultivated Palayankodan. The TSS/Acid ratio index provides information on fruit flavour. Bhootmanohar genotype gave the highest value (60.98) and distantly followed by Kanthali (49.30). Genotypes like Bharatmani (34.40) and Nendran (34.55) are statistically at par. The lowest TSS/Acid relation was reported in Chinichampa (30.88) which is also statistically at par with Meiteihei (31.43).

Table 1. Physico-chemical characteristics of different banana genotypes

Treatments	TSS (^{0}Brix)	Acidity (%)	Total Sugar (%)	Reducing Sugar (%)	TSS/Acid ratio	Crude protein (g/100g)	Total carotenoids (mg/100g)
Bhootmanohar	24.39^{f}	0.40^{a}	15.00^{ef}	8.00^{fg}	60.98^{g}	0.91^{bcd}	3.01^{b}
Chinichampa	22.23^{e}	0.72^{g}	9.21^{a}	5.78^{bc}	30.88^{a}	1.10^{de}	3.57^{d}
Jahaji	21.88^{e}	0.49^{de}	15.64^{fg}	7.15^{e}	44.65^{d}	1.14^{de}	3.64^{de}
Kanthali	21.69^{e}	0.44^{c}	10.10^{b}	5.61^{ab}	49.30^{f}	0.97^{cd}	3.24^{c}
Lumungashe	15.78^{a}	0.41^{ab}	13.82^{d}	6.00^{c}	38.49^{c}	0.73^{ab}	2.79^{a}
Bharatmani	17.20^{b}	0.50^{e}	11.50^{c}	6.30^{d}	34.40^{b}	0.62^{a}	4.20^{f}
Nendran	18.31^{c}	0.53^{f}	15.25^{f}	7.82^{f}	34.55^{b}	1.04^{cde}	4.05^{f}
Grand Naine	22.33^{e}	0.47^{d}	16.20^{g}	6.28^{d}	47.51^{ef}	1.24^{e}	3.82^{e}
Kwetho	20.16^{d}	0.43^{bc}	9.46^{ab}	5.43^{a}	46.88^{e}	0.84^{bc}	3.48^{d}
Meiteihei	16.03^{a}	0.51^{ef}	14.37^{de}	8.20^{g}	31.43^{a}	0.85^{bc}	2.68^{a}
Range	15.78-24.39	0.40-0.72	9.21-16.20	5.43-8.20	30.88-60.98	0.62-1.24	2.68-4.20
SE(m)±	0.35	0.01	0.25	0.10	0.70	0.07	0.07
CD (*p*=.05)	1.03	0.02	0.75	0.29	2.09	0.21	0.20

Averages followed by the same letter belong to the same group (Duncan test at 5% probability)

Figure 1. Physico-chemical characteristics of different banana genotypes

There was high variation in the composition of total sugar levels. Total sugar levels of all the evaluated genotypes range between 9.21% and 16.20%. Grand Naine (16.20%), Jahaji (15.64%), Nendran (15.25%) and Bhootmanohar (15.00%) had the highest total sugar levels. In contrast, there was not much variation in the composition of reducing sugars. Meiteihei (8.20%) genotype has the highest reducing sugar levels although it did not differ statistically from the Bhootmanohar (8.00%) genotype. The reducing sugar levels of Bharatmani and Grand Naine are 6.30% and 6.28% respectively which are statistically at par. The lowest values were observed in the Kwetho (5.43%) and Kanthali (5.61%) genotypes. Presence of these sugars has significant impact to banana cultivators since they are involved in reactions of non-enzymatic darkening during processing [27].

Examining at Table 1, there was a significant differences in protein concentration of the analyzed banana genotypes. The protein content of the genotypes analyzed ranged from 0.62 to 1.24 g/100g. The highest protein content was observed in Grand Naine (1.24 g/100g) tailed by Jahaji (1.14 g/100g), Chinichampa (1.10 g/100g) and Nendran (1.04 g/100g) while Bharatmani (0.62 g/100g) had the lowest value of protein concentration. In a similar findings, the protein concentration of eight banana genotypes of Kerala range between 0.91 g/100g to 1.37 g/100g as reported by Siji and Nandini[18]. Climacteric fruits have high protein content when they are mature. Fruit maturation and ripening is associated with increase in ethylene production. It is assumed that ethylene regulates the expression of genes involved in the maturation due to increased levels of protein in banana pulp tissue which is in line with the maturity of the fruit [28]. The amount of amino acids required by the body is supplied by protein.

A wide variation of total carotenoid concentration was found in the pulp of the ten analyzed genotypes ranging from 2.68 mg/100g in white fleshed Meiteihei to 4.20 mg/100g in orange fleshed Bharatmani. The total carotenoids content in Nendran was recorded as 4.05 mg/100g which is statistically equal to Bharatmani. Similarly, Chinichampa (3.57 mg/100g) and Kwetho (3.48 mg/100g) are statistically at par. Many researchers have reported about variation in total carotenoids content in banana pulp in their studies [29][30][31]. The banana flesh colour intensity indicates the carotenoid concentration. Deeper flesh coloration recorded greater carotenoid concentration in the present study. A similar finding has been reportedby Englberger*et al.*,a,b; Amorim *et al.*,; Davey *et al.*, andNewilah*et al.*,in their studies [32][33][34][35][36].

3.1 CLUSTER ANALYSIS

A multivariate Bray Curtis Cluster analysis (single linkage) was performed to the means of different physic-chemical parameters to produce a similarity matrix. Analysis revealed two major clusters (Figure 2) and one out group. Cluster I comprised of genotypes Meiteihei, Nendran, Bharatmani, Lumungashe and Chinichampa for which Chinichampa forms an out group. Cluster II consists of four genotypes and form two subcluster where Jahaji and Grand Naine form one subcluster and Kanthali and Kwetho form another subcluster. The genotype Bhootmanohar forms an out group of both cluster I and II.

	Bhootmanohar	Chinichampa	Jahaji	Kanthali	Lumungashe	Bharatmani	Nendran	Grand Naine	Kwetho	Meiteihei
Bhootmanohar	1.00	0.78	0.90	0.89	0.82	0.78	0.82	0.91	0.86	0.79
Chinichampa	*	1.00	0.87	0.87	0.87	0.91	0.89	0.85	0.88	0.89
Jahaji	*	*	1.00	0.93	0.90	0.88	0.91	0.97	0.93	0.87
Kanthali	*	*	*	1.00	0.87	0.86	0.85	0.95	0.97	0.81
Lumungashe	*	*	*	*	1.00	0.94	0.93	0.89	0.89	0.93
Bharatmani	*	*	*	*	*	1.00	0.95	0.86	0.88	0.93
Nendran	*	*	*	*	*	*	1.00	0.89	0.86	0.95
Grand Naine	*	*	*	*	*	*	*	1.00	0.94	0.84
Kwetho	*	*	*	*	*	*	*	*	1.00	0.82
Meiteihei	*	*	*	*	*	*	*	*	*	1.00

Figure and table 2. Dendogram and similarity matrix of differentbanana genotypes

4. CONCLUSION

The present study was conducted to determine the physico-chemical characteristics of the commonly available ten banana genotypes in Nagaland. The experimental result revealed wide variation among the different banana genotypes in physico-chemical attributes. The maximum total soluble solids, acidity, total sugar and reducing sugar were found in Bhootmanohar,Chinichampa, Grand Naine and Meiteihei respectively. Highest TSS/Acid ratio, crude protein and total carotene were obtained in Bhootmanohar, Grand

Naine andBharatmani respectively. The cluster analysis of the mean of different physic-chemical characteristics revealed two major clusters and one out group.

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