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Proximate Composition of Banana fruit Peel of Varieties Grand Naine (AAA), Rajapuri (AAB) and Ney Poovan (AB) at different stages of Ripening

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ABSTRACT: The causal agent for banana anthracnose disease infects banana fruits in the field/plantation (called latent infection) and disease symptoms appear gradually only on fruit peel after harvesting and storage. The present study was aimed to evaluate nutritional compounds such as moisture, pH, acidity, phenolics and antioxidants content of banana peel to know the possible influence on banana anthracnose the biochemical analyses of peels of three banana varieties viz., Grand Naine, Rajapuri and Ney Poovan at three different stages of their ripening were made. Results of analyses showed that the percentage moisture content of peel significantly decreased in Rajapuri (85.33 % – 81.66 %) and Ney Poovan (86.00 % -73.00 %) at their yellow stage of ripening. The maximum pH value (6.24) of banana peel of Grand Naine was recorded at green stage of fruit ripening. The maximum TSS (3.73 ^{0} Brix) and the minimum (2.00 ^{0} Brix) were recorded at yellow stage of maturity in Ney Poovan and Grand Naine varieties of banana respectively. Total phenol was increased from 44.90 mg at green to 53.43 mg/100 g at yellow- stage of maturity in Grand Naine. Comparatively lesser Titratable acidity (as % citric acid) of 0.19 % at green in the fruit peel of Grand Naine was observed. Antioxidant capacity measured in terms of scavenging of DPPH was observed maximum in fruit peel of Ney Poovan variety at green stage of fruit ripening.

Keywords: Biochemical properties, banana peel, three varieties of banana.

INTRODUCTION

Banana (*Musa acuminata*) which belongs to the family Musaceae is one of the most ancient fruits in the world and has a high consumer demand throughout the world. In India , important banana growing states are Tamil Nadu, Karnataka, Madhya Pradesh, Kerala, Assam, Uttar Pradesh, Maharashtra, Bihar, Gujarat, West Bengal and Himachal Pradesh. Banana plants are large, perennial herbs grown to a height from 2–9 m and reported to be evolved in Southeast Asia, New Guinea and the Indian subcontinent.

Banana is also known as "*Adam Fig*" and "*Apple of Paradise*". It is a is a source of food, beverages, fermentable sugars, medicines, flavorings, cooked foods, silage, fragrance, rope, cordage, garlands, shelter, clothing, and smoking material, numerous ceremonial and religious uses (Wasala *et al*., 2014). As reported by by Emaga *et al*., 2007, banana peel is a rich source of dietary fiber, protein, crude fat, lipid, pectin, essential amino acids, polyunsaturated fatty acids, and micronutrients. Fruits of banana are highly perishable and subjected to fast deterioration, as their high moisture content and high metabolic activity persist after harvest (Demirel and Turhan, 2003). About 40% of the fresh fruit weight is in banana fruit peel itself (Tchobanoglous *et al.*, 1993*)*. Puraikalan (2018) reported that the India variety peel indicates the percentage of 11.7, 3.6 and 14.4 for protein, fat and fiber respectively these peels also had a significant amount of total phenols, flavonoids and tannin.

One study that compared the antioxidant compounds in banana peel and pulp extracts found that the content of antioxidant compounds was higher in the peel than in the pulp (Someya *et al.*, 2002) implying a potentially higher value of the peel in terms of antioxidant content. The entire banana fruit is rich in bioactive compounds, such as phenolic constituents, carotenoids, vitamins, and dietary fiber (Mohapatra *et al*., 2010; Borges *et al*., 2020). Unripe banana naturally consists of more than 70% starch, with the remainder being protein, lipid, and fiber (Orsuwan *et al*., 2017; Kaur *et al*., 2020). Khawas and Chandra Deka (2016) reported that phenolics, flavonoids, and radical scavenging activity were maximum at early developmental stage, whereas compounds like protein, fat, carbohydrates, and starch increased with maturity and declined at over-ripe stage.

The banana crop is affected by biotic agents like fungi, bacteria, viruses, nematodes in addition to abiotic stress. Among biotic factors anthracnose disease caused by *Colletotrtchum gloeosporioides* is one of the most important postharvest disease. Ranasinghe *et al.* (2002) reported that anthracnose was the most important postharvest disease of banana that could result in 30 to 40% losses of marketable fruits. Anthony *et al.* (2004) reported that postharvest diseases especially anthracnose was responsible for 20 % of harvest losses of banana in Sri Lanka. Hence the present investigation

was undertaken to know the influence of biochemical properties of banana peel on anthracnose disease.

MATERIAL AND METHODS

Different physico-chemical properties of three banana varieties viz., Grand Naine, Rajapuri and Ney Poovan at different stages of their ripening green (< 12 weeks after flowering), green to yellow (12-17 weeks after flowering) and yellow stage (< 17 weeks after flowering) were used for investigation.

A. Moisture (%) content of banana peel

Five gram of the peel sample was taken in apre-weighed Petri dish and dried in an oven at 70°C till constant weight. The per cent moisture in fruit peel was calculated using the following formula

$$\text{Moisture content (\%)} = \frac{\text{(Weight of fresh sample - Weight of dry sample)}}{\text{Weight of fresh sample}} \times 100$$

pH of banana peel. The pH of banana peel sample was estimated by crushing 2 g of banana peel in 2ml of distilled water and pH was measured by using pH meter.

Total Soluble Solids (^{0}Brix) of banana peel. One gram of banana peel sample was crushed in 2ml of distilled water and the Total soluble solid (TSS) content was carried out by using ERMA hand refractometer.

Total phenolics of banana peel. The total phenolic content of banana peel was estimated by using the Folin and Ciocalteu reagent method following catechol as standard. Briefly, 1g of banana peel was mixed with 10 ml of water from this 0.1 ml of sample was taken and mixed with 1 ml of 10 % v/v Folin - ciocalteu reagent. After 5min, 2ml of 20 % sodium carbonate was added and incubated the tubes at room temperature for 15 min. The obserbance of blue colour from sample was measured at 765nm and expressed total phenols as mg catechol equivalent per gram of banana peel (Madaan *et al.,* 2011).

B. Acidity (%) content of banana peel

The titratable acidity of banana peel was estimated by titration method. Briefly, 2 g of sample was taken in a conical flask and volume made up 100 ml with distilled water from this 15 ml of sample was taken and titrated against 0.1 N NaOH using phenolphthalein as indicator dye till a permanent pink colour was appeared. The volume of NaOH solution required from titration was noted and the acidity value was expressed as % citric acid equivalent.

$$\text{Acidity (\%)} = \frac{\text{Titre value} \times \text{Normality of NaOH} \times \text{Volume made up} \times \text{Eq. wt. of acid} \times 100}{\text{Volume of sample taken} \times \text{weight of sample g} \times 100}$$

C. Total antioxidant capacity of banana peel

Total antioxidant activities of banana peel samples were estimated by Molybdate assay (Kalava and Menon 2012). Briefly, 1 gm of sample mixed in 2 ml of distilled water from this 0.1 ml of sample solution was taken and mixed with 1ml of reagent solution (0.6M sulphuric acid, 28 mM sodium phosphate and 4mM ammonium molybdate) in tubes. The tubes were capped and incubated at 95°C for 90 min. After cooling down to room temperature, the light absorbance was measured at 695 nm. Total antioxidant capacity was expressed in terms of Ascorbic Acid Equivalent Antioxidant Capacity (AEAC).

AEAC = (Ab control – Ab sample)/ (Ab control – Ab ascorbic acid) × concentration of ascorbic acid (mg/mL) × volume of extract (mL) used × 100/g sample

Where, Ab is Absorbance at 695 nm.

RESULT AND DISCUSSION

A. Per cent moisture content of banana peel

The data on per cent moisture contents of banana peels of three varieties at their three maturity stages are given in Table 1. In Rajapuri (85.33 % – 81.66 %) and Ney Poovan (Ealakki Bale) (86.00 % -73.00 %), the per cent moisture contents in peel decreased significantly from green – to yellow stage of maturity. Non-significant loss of per cent moisture was recorded in banana peel of Grand-Naine variety. Adeyemi and Oladiji (2009) reported that the moisture contents of 73.47 %, 77.19 %, and 79.22 % in unripe, ripe and overripe banana fruits respectively. Moisture content of 87.88% in *Musa balbisiana* varieties have been reported by Hamid *et al*. (2016). Obiageli *et al*. (2016) reported higher moisture content of 71.37%in banana at its immature stage the high moisture content was an indication that the fruit cannot be stored for a long period and it leads to fungal disease development.

P^H of banana peel. The pH of banana peels of three banana varieties measured at their three maturity stages at are presented in Table 2. Highest pH of 6.24, 5.91 and 5.63 was noticed in the banana peel of banana variety Grand Naine of green, green to yellow and yellow stages of fruit variety than the Rajapuri (5.81, 5.83 and 5.77) and Ney Poovan (5.88, 5.66 and 5.37) at green, green to yellow and yellow stage of maturity respectively. pH of fruit peel exudates as reported by De Cost and Chandima (2014) cultivars Seenikehel (AAB), Alukehel (AAB) and Mondan (ABB) were greater than 6.0 at mature unripe stage and banana were moderately susceptible to anthracnose disease. According to Alkarkhi *et al.* (2011), the pH value for ripe banana peel lies between 4.86 and 5.69 and for unripe fruits between 4.30 and 5.33. During natural ripening pH of fruit tissues increases (2-6.1) as reported in the pericarp of avocado (Kramer *et al.,* 2006).

Table 1: Percent Moisture contents of banana peel at different stages of fruit maturity.

Banana variety	Maturity stage		
	Green stage	Green to yellow stage	Yellow stage
Grand Naine	87.00	87.33	88.00
Rajapuri	85.33	83.66	81.66
Ney Poovan	86.00	82.66	73.00
Mean	86.11	84.55	80.88
F test	**Stage****	**Varieties****	**Stage*Varieties****
S. Em ±	**0.40**	**0.47**	**0.81**
CD at 1%	**1.18**	**1.36**	**2.36**

**---Statistically significant at 1 %

Table 2: pH of banana peel at different stages of fruit maturity.

Banana variety	Maturity stage		
	Green stage	Green to yellow stage	Yellow stage
Grand Naine	6.24	5.91	5.63
Rajapuri	5.81	5.83	5.77
Ney Poovan	5.88	5.66	5.37
Mean	5.98	5.80	5.59
F test	**Stage****	**Varieties****	**Stage*Varieties****
S. Em ±	**0.03**	**0.03**	**0.05**
CD at 1%	**0.11**	**0.12**	**0.22**

**---Statistically significant at 1 %

Total Soluble Solids (^{0}Brix) in banana peel. The data on TSS (^{0}Brix) content of banana fruit peel of three varieties of banana at three different stages of fruit maturity are presented in Table 3. The maximum (3.73°Brix) and the minimum (2.00 °Brix) TSS contents were recorded in Ney Poovan and Grand Naine varieties of banana at their yellow stage of maturity respectively. In Rajapuri banana variety the TSS contents increased from 0.80 - 3.00°Brix in peel from green stage to yellow stage of fruit maturity, where as in Grand Naine and Ney Poovan banana variety the TSS contents increased from 1.00 - 2.00°Brix and 1.00-3.73°Brix peel from green stage to yellow stage of fruit maturity respectively. The lower TSS in green banana is acceptable since it is known that amylase, sucrose synthases and invertase can act in the degradation of starch formation and accumulation of soluble sugars (Emaga *et al*, 2007; Terra *et al.*, 1983). Unripe fruits have high starch content, which is hydrolysed with ripening, resulting in sugar accumulation; and the soluble solids content is an indicative of the sugar content in the fruit (Aquino, 2014). Sahil *et al.* (2018) reported the TSS between 1.4 to 5 °Brix in the order of Ripe Banana Pulp> Ripe Banana Peel> Green Banana Peel>Green Banana Pulp.

Table 3: Total Soluble Solutes (TSS °Brix) contents of banana peel at different stages of fruit maturity.

Banana variety	Maturity stage		
	Green stage	Green to yellow stage	Yellow stage
Grand Naine	1.00	1.30	2.00
Rajapuri	0.80	1.23	3.00
Ney Poovan	1.00	1.10	3.73
Mean	0.93	1.21	2.91
F test	**Stage****	**Varieties****	**Stage*Varieties****
S. Em ±	**0.06**	**0.07**	**0.12**
CD at 1%	**0.23**	**0.27**	**0.46**

**---Statistically significant at 1 %

Total phenolics of banana peel. The total phenol contents in peels of three varieties of banana at three maturity stages were estimated and expressed as mg catechol equivalent per 100 g of peel (Table 4). An increased total phenols from 44.90 mg at green to 53.43 mg at yellow stage of maturity per 100 g of peel was recorded only in the Grand Naine variety of banana. In other two banana varieties the total phenolics decreased at all the three stages of fruit maturities. Fatemeh *et al*. (2012) found the total phenol of cavendish banana peel from 1.31 - 3.99 g GAE/100 g of sample. According to Bakar *et al*. (2018) total phenolic content was highest in Tanduk (54.60 mg GAE/ g) followed by Rastali (37.69 mg GAE/g), Berangan (33.61 mg GAE/g) and Nangka (28.63 mg GAE/g) BPF banana varieties. Shyamala and Prakash (2011) reported the nutritional composition, antioxidant components of fruit peels of three varieties of banana *viz.,'Pachabale'*, *'Yelakkibale'* and *'Nendran'*. Polyphenols were in the range of 200-850 mg TAE/100g of peel. A recent report based on molecular analyses suggested that phenolic compounds might be reason for variations in the susceptibility of banana to crown rot and anthracnose diseases (Ewane *et al*., 2012).

Table 4: Total phenol content (mg catechol/100g) of banana peel at different stages of fruit maturity.

Banana variety	Maturity stage		
	Green stage	Green to yellow stage	Yellow stage
Grand Naine	44.90	57.00	58.43
Rajapuri	54.27	53.51	53.30
Ney Poovan	55.56	54.64	53.37
Mean	51.57	55.05	55.03
F test	**Stage****	**Varieties****	**Stage*Varieties****
S. Em ±	**1.65**	**1.90**	**3.30**
CD at 1%	**6.52**	**7.53**	**13.05**

**---Statistically significant at 1 %

B. Acidity (%) content of banana peel

Acid contents expressed in per cent citric acid in banana peels of three varieties of banana at three maturity stages are presented in table 5. Comparatively lesser Titratable acidity of 0.19, 0.24 and to 0.29 % at green, green to yellow and yellow stage respectively was obtained in the fruit peel of Grand Naine banana variety than of other two varieties Rajapuri at green (0.28 %), green to yellow (0.31 %) and yellow (0.33 %) and Ney Poovan0.20, 0.33 and 0.38 % at green, green to yellow and yellow stage respectively. Observations of lower acidity at unripe stages of banana have made by Bleinroth & Medina (1995). Acidity increases as fruit ripening process increases until a maximum at yellow colour of the peel and then decreases as fruit senescence begins. Shyamala and Prakash (2011), found that the vitamin C content was high in banana peels variety (Yelakkibale) (17.83 mg/100 g dw) contrasted with the other two variety and biochemical roles.

C. Total antioxidants content in banana peel

Abilities of antioxidation of free radicals of fruit peels of three banana varieties were studied using a free radical DPPH (2, 2-diphenyl-1-picrylhydrazyl). The data presented in table 6 clearly indicated that the per cent maximum DPPH scavenging activities of 36.25, 31.75 and 26.08 were observed in the fruit peel of Ney Poovanat green, green-yellow and yellow stage of ripening respectively. At yellow stage of fruit maturity, the DPPH radical scavenging activities in peels of Rajapuri and Grand Naine banana varieties were 11.75 and 14.66 per cent of Ney Poovan. The findings (Shanthy *et al*., 2011) suggest that the unripe banana peel sample had higher antioxidant potency than ripe and over ripe ones. Nagarajaiah and Prakash (2011) reported that higher free radical scavenging activity (90 %) was obtained in Nendran peel in ethanol extract compared to aqueous (64%) and methonol extract (62 %).

Table 5: Titratable acidity (citric acid g/100g) of banana peel at different stages of fruit maturity.

Banana variety	Maturity stage		
	Green stage	Green to yellow stage	Yellow stage
Grand Naine	0.19	0.24	0.29
Rajapuri	0.28	0.31	0.33
Ney Poovan	0.20	0.33	0.38
Mean	0.22	0.29	0.33
F test	**Stage****	**Varieties****	**Stage*Varieties****
S. Em ±	**0.01**	**0.01**	**0.02**
CD at 1%	**0.04**	**0.05**	**0.08**

**---Statistically significant at 1 %

Table 6: Antioxidant (DPPH) (%) content of banana peel at different stages of fruit maturity.

Banana variety	Maturity stage		
	Green stage	Green to yellow stage	Yellow stage
Grand Naine	29.25	16.25	14.66
Rajapuri	28.41	21.08	11.75
Ney Poovan	36.25	31.75	26.08
Mean	31.30	23.02	17.50
F test	**Stage****	**Varieties****	**Stage*Varieties****
S. Em ±	**0.22**	**0.25**	**0.44**
CD at 1%	**0.86**	**1.00**	**1.73**

**---Statistically significant at 1 %

CONCLUSION

From the above study it can be concluded that the proximate analysis of banana peel cv. Grand Naine

exhibited the maximum moisture content, pH, total phenol, TSS of banana peel. Ney Poovan fruit peel at yellow stage showed highest Titratable acidity, DPPH scavenging activities. Above these results indicate that different chemical composition of banana peel helps to know either susceptible or resistant to anthracnose disease of banana. Further studies are needed for isolation of the other active ingredients, and evaluation of cytotoxicity effects.

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