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Studies on physico-chemical changes in hill bananas during ripening

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Abstract

Sirumalai and Virupakshi are the two important famous hill bananas of Tamilnadu. The physico-chemical quality parameters which includes physiological weight loss, pH, total soluble solids, titrable acidity and the physiological changes were evaluated during the ripening period. There was a increasing trend with total soluble solids and weight loss and reduction in physical properties (length, thickness, projected area), firmness and pH were observed during the ripening period in banana.

Keywords: Sirumalai, Virupakshi, physico-chemical, ripening

Introduction

Banana (*Musa* sp.) is the second most important fruit crop in India next to mango. India contributes 29.19% of global production of banana. It is cultivated in India in an area of 883.8 thousand ha and total production is around 30807.5 thousand tonnes (Glance, 2018) [4]. Its year-round availability, affordability, varietal range, taste, nutritive and medicinal value makes it the favourite fruit among all classes of people. It has also good export potential. It serves as an ideal and low-cost food source for developing countries where most of the population rely mostly on bananas for food. The ripened banana is of more economic importance than the unripe one. Dwarf Cavendish, Robusta, Rasthali, Poovan, Nendran, Red Banana, Ney Poovan, Virupakashi, Sirumalai, Pachanadan, Karpuravalli and Safed Velchi *Musa* are the best-known varieties of banana. Indian banana cultivars are preferred worldwide due to their strong aroma, more intense peel colouration, delicious taste and high nutritional value (Kudachikar *et al.*, 2007) [5].

Being a climacteric fruit, banana ripens slowly and naturally even after harvest. Smoking treatment is widely used by the traders to induce and fasten the ripening process. As the temperature inside the smoking chamber increases, the ethylene gas is released which is responsible for ripening (Ram *et al.*, 1979; Ranaweera *et al.*, 2020) [14]. The ripening of the fruit causes changes in skin colour, starch conversion to sugars, softening of the fruit, loss of astringency and development of a distinctive flavour (Thompson, 1996) [18]. The quality of the fruit may be associated with the physico chemical changes during ripening. Quality of the plantain chips was affected mainly by the ripening stage (Onyejegbu and Olorunda, 1995) [10]. Newilah *et al.* (2009) [9] studied the physico-chemical changes on cooking and dessert banana. Also, the temperature effect on the storage of banana during ripening was investigated (Ahmad *et al.*, 2006) [11]. Thus, it is important to understand the changes during ripening stages of banana to find its suitability for different value addition process.

The objective of the study was to evaluate the effect of ripening on physico-chemical properties and the physiological properties of banana varieties Sirumalai and Virupakshi for quality assessment.

Materials and methods

The harvested fruits were subjected to smoking treatment to induce ripening process in the air tight chamber for 24 hrs (Ranaweera *et al.*, 2020) [14]. The smoke treated banana varieties (*Sirumalai* and *Virupakshi*) were procured from local market in Coimbatore. These fruits were transported immediately to the laboratory and the experiments were conducted to study the effect of ripening on physical properties and the physico-chemical changes.

Physical properties

Physical attributes of thirty matured bananas (*Sirumalai* and *Virupakshi*) were analysed in Department of Food process Engineering, AEC&RI, Tamil Nadu Agricultural University, Coimbatore.

Mass of the fruit (M) was determined by digital weighing balance with 0.01g accuracy. The flexible ruler was used to measure the outer and inner length (l_o and l_i) and the mean length (L) was calculated by its average (Shahir *et al.*, 2015) [16]. The width (W) and thickness (T) were measured with a Vernier caliper with 0.01mm accuracy. Assuming banana fruit as ellipsoidal shape, its volume and ellipsoidal ratio was calculated as below

$$V_e = \frac{\pi}{6} (LWT) \quad (1)$$

$$\text{Ellipsoidal ratio} = \frac{W}{T} \quad (2)$$

The geometric mean (D_g) and the arithmetic mean diameter (D_a) was determined from the following equations (Mohsenin, 1986) [8].

$$D_g = (LWT)^{1/3} \quad (3)$$

$$D_a = (L + W + T)/3 \quad (4)$$

Projected area of the fruit was determined graphically by placing the fruit on the graph sheet and the number of squares were counted (Mohsenin, 1986) [8].

Mean, standard deviation, standard error and the coefficient of variance of the physical attributes of two cultivars were analysed in SPSS 16 software.

Five randomly selected fruits from the whole bunch were evaluated to determine the quality at regular intervals. Physico-chemical properties *viz.*, length, thickness, projected area, physiological loss in weight, firmness, pH, total soluble solids and titrable acidity were determined at each day during ripening period.

Physiological loss in weight (PLW)

Physiological weight loss was calculated by the difference between initial and final weight on each day relative to the initial weight (Patil and Shanmugasundaram, 2015) [11].

$$\text{Physiological weight loss} = \frac{\text{Initial weight} - \text{final weight}}{\text{Initial weight}}$$

Firmness

Firmness of the fruit was determined by hand held penetrometer and the force required to pierce the fruit was found in Kgf (Newilah *et al.*, 2009) [9].

Preparation of samples

Thirty grams of the fruit pulp was sampled along the length of the fruit and blended with 90 ml of distilled water for 2 min and filtered using filter paper (Whatman no. 1). The filtrate was used for the analysis of pH, Total Soluble solids and Titrable acidity.

pH, TSS and Titrable acidity

pH was determined by digital pH meter (Model: Hanna HI2211, India) by inserting the probe into the filtrate. A drop of the filtrate was placed on the prism of the hand-held refractometer (Model: Erma, RHB-32ATC) to measure the total soluble solids (Newilah *et al.*, 2009) [9]. Titrable acidity was found by titrating the filtrate with 0.1N sodium hydroxide until the phenolphthalein indicator changes to pink/red (Ranganna, 1986) [15]. The results are expressed in percentage in terms of malic acid, which is the predominant acid in banana.

Statistical analysis

Mean, standard deviation, standard error and the coefficient of variance of the physical attributes of two cultivars were analysed. Analysis of variance (ANOVA) of physico-chemical parameters during ripening was done using SPSS 16 software.

Results and Discussion

The physical attributes of hill banana varieties *viz.*, Sirumalai and Virupakshi were presented in Table 1. Result shows that all the properties were statistically significant at 10% level of significance. According to the results, the mean values of the properties for variety Sirumalai were significantly greater than that of Virupakshi variety.

Table 1: Physical attributes of two varieties

Properties	Sirumalai			Virupakshi			Significance level
	Max	Min	$\mu \pm SD$	Max	Min	$\mu \pm SD$	
Mass(M), g	95.00	72.00	80.55 \pm 4.97	62.20	42.80	52.14 \pm 5.28	**
True volume(V), cm ³	85.60	42.50	68.51 \pm 9.22	60.25	40.96	49.24 \pm 5.38	***
Ellipsoidal volume (V_e) cm ³	82.26	38.64	64.87 \pm 9.42	57.25	35.79	45.51 \pm 5.17	***
Ellipsoidal ratio	01.68	01.00	01.05 \pm 0.03	01.33	01.04	01.14 \pm 0.07	***
Length(L), cm	13.00	10.50	11.56 \pm 0.63	12.05	09.70	11.01 \pm 0.68	***
Width(W), cm	03.76	02.63	03.35 \pm 0.23	03.36	02.74	03.00 \pm 0.15	***
Thickness(T), cm	03.52	02.56	03.18 \pm 0.21	02.87	02.33	02.62 \pm 0.14	***
GMD (D_g) cm	05.40	04.19	04.97 \pm 0.25	04.78	04.08	04.42 \pm 0.16	***
AMD (D_a) cm	06.44	05.38	06.03 \pm 0.27	05.98	05.03	05.55 \pm 0.24	***
Projected area by graph, cm ²	91.43	55.25	77.86 \pm 7.61	71.81	52.50	61.54 \pm 4.63	***

*, ** and *** indicates significance at 1%, 5% and 10% level compared with Virupakshi variety

Change in physical properties

The change in length, thickness and projected area are shown in the figure 1, 2 and 3 for both the varieties Sirumalai and Virupakshi respectively. From the results, it is observed as the ripening stage proceeds the length, thickness and projected area of both the varieties decreased by 5.07%, 9.90% and

29.40% for Sirumalai variety and by 9.60%, 9.44% and 20.93% for Virupakshi variety respectively. Comparing the change in physical properties of two varieties in terms of percentage, the length and the projected area showed significant difference but change in thickness was not significant.

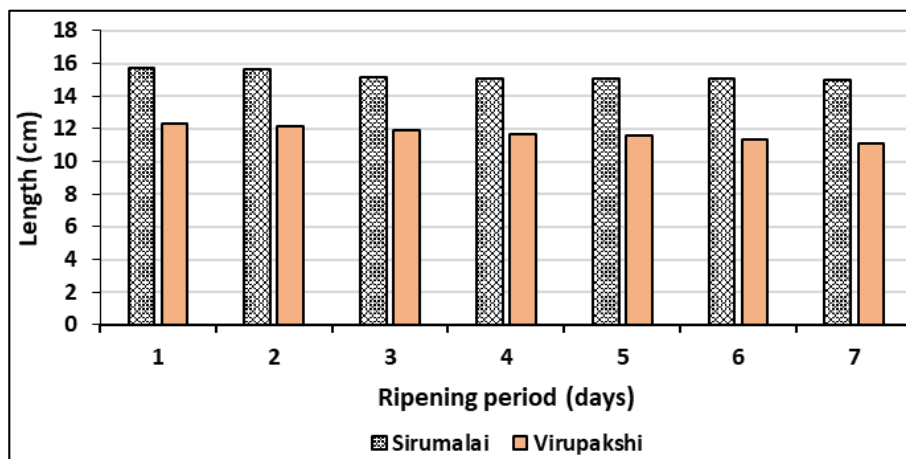


Fig 1: Effect of ripening on measured fruit length of banana varieties Sirumalai and Virupakshi

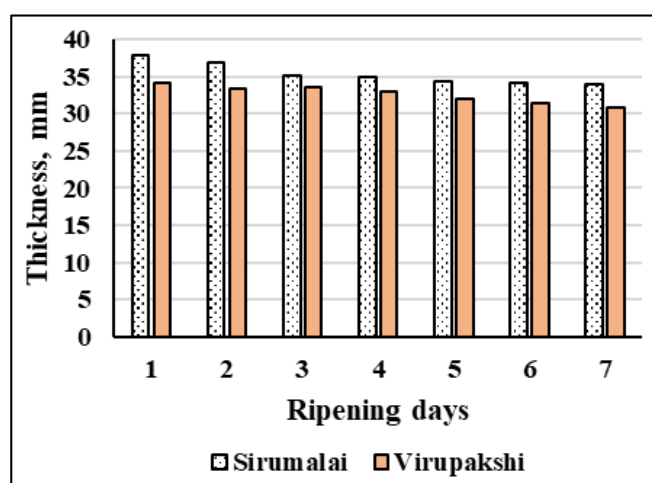


Fig 2: Effect of ripening on measured fruit thickness of banana varieties Sirumalai and Virupakshi

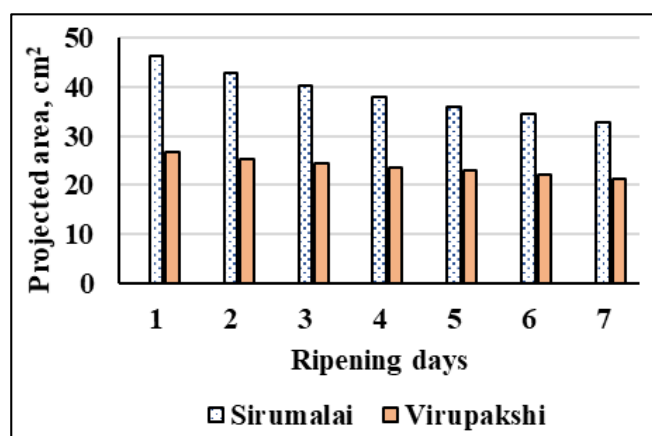


Fig 3: Effect of ripening on measured projected area of banana varieties Sirumalai and Virupakshi

Change in physiological properties

The increase in weight loss of the two varieties of banana is presented in figure 4. The weight of banana showed a significant change as the ripening stage proceeded. The physiological loss in weight at the end of the ripening stage

was 13.27% and 18.70% for Sirumalai and Virupakshi respectively. Respiration and metabolic activity in a climacteric fruit continues even after harvest which is reflected on the weight loss of the banana (Blankenship *et al.*, 1993) [2], (Mebratie *et al.*, 2015) [7].

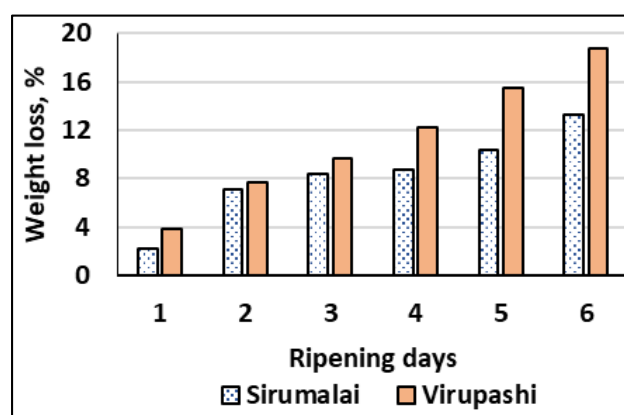


Fig 4: Effect of ripening on measured weight loss of banana varieties Sirumalai and Virupakshi

Change in pH, TSS and titrable acidity during ripening

Change in pH, TSS and Titrable acidity during ripening are indicated in the figure 5 (Sirumalai) and figure 6 (Virupakshi). Banana contains malic acid, citric acid and oxalic acid in its flesh but during ripening these acids are reduced due to starch degeneration which caused titrable acidity to be increased and pH to be decreased. The titrable acidity increased from 0.32 to 0.65% for Sirumalai variety and from 0.25 to 0.49% for Virupakshi variety (Fig. 5 and 6). Decrease in pH from 5.33 to 4.32 and 5.60 to 4.80 were observed for Sirumalai and Virupakshi varieties (Fig. 5 and 6). The results were similar to the study conducted by Onyejebu and Olorunda (1995) [10].

The TSS of both the banana varieties increased during the ripening stage which was due to the hydrolysis of starch into sugars (Marriott *et al.*, 1981) [6]. The TSS of Sirumalai and Virupakshi increased from 3 to 15 ° Brix and 3.05 to 19 ° Brix respectively (Fig. 5 and 6). Similar trend was observed by Ferris *et al.* (1997) [3].

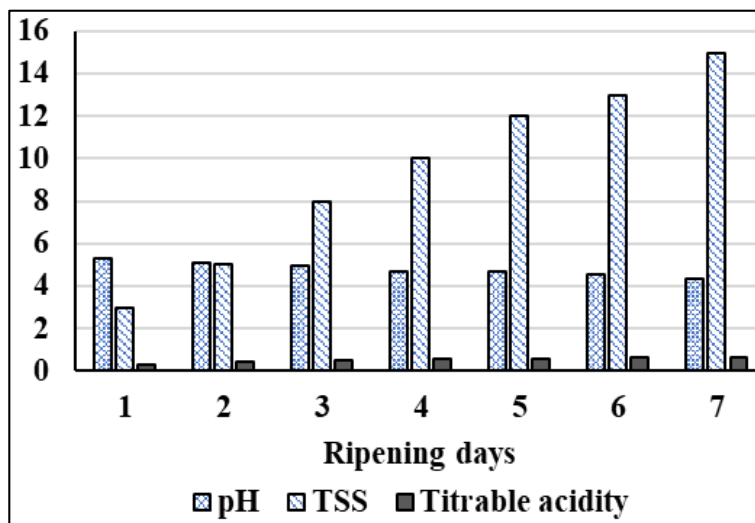


Fig 5: Effect of ripening on pH, TSS and titrable acidity in banana variety Sirumalai

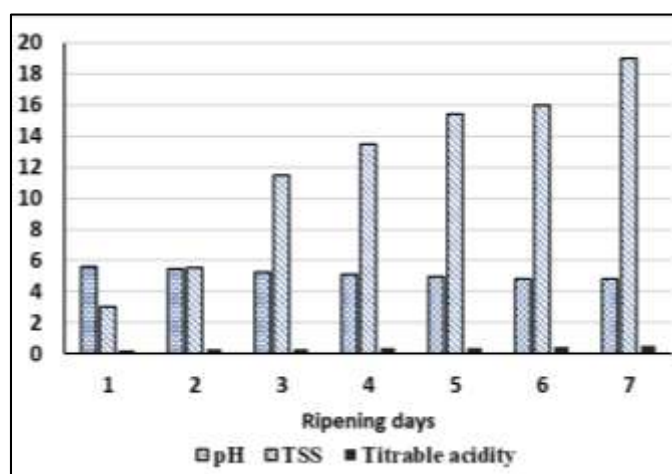


Fig 6: Effect of ripening on pH, TSS and titrable acidity in banana variety Virupakshi

Change in firmness

The firmness of both the variety decreased as the ripening days increased which is associated to the conversion of starch to sugar, movement of water from peel to the pulp and also due to breakdown of pectin constituents (Peleg and Brito, 1977; Thompson, 1996; Soltani *et al.*, 2011) [12, 17, 18]. The firmness of banana decreased from 6.83 to 2.44 Kg f for Sirumalai and 5.62 to 1.52 Kg f for Virupakshi variety as shown in figure 7.

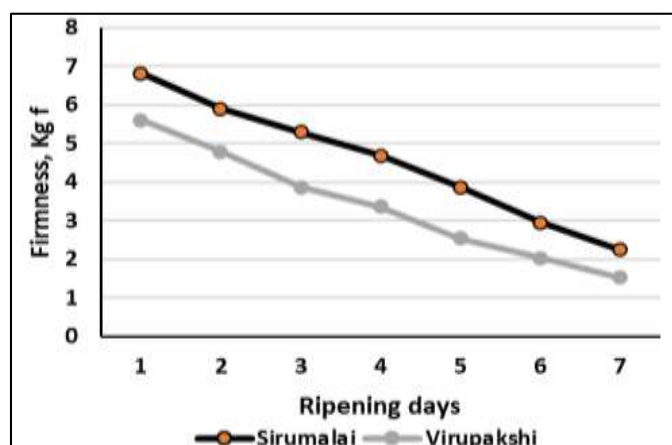


Fig 7: Effect of ripening on firmness of banana varieties Sirumalai and Virupakshi

Conclusion

The Physical properties of banana such as length, thickness, projected area, geometric mean diameter, arithmetic mean diameter, ellipsoidal ratio was determined for two varieties namely Sirumalai and Virupakshi. The change in physiological properties was determined during the ripening period of 7 days. The observation was recorded every day. The data available would facilitate designing of equipment for post-harvest processing and handling.

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