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Evaluation of Changes in Physico-Chemical Parameters of Banana (*Musa Spp.)*during Ripening in Storage

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Abstract—*The experiment was conducted to evaluate the eating quality of the fruit which in turn influence on physical and chemical changes of banana during ripening in storage. Different stages of maturity were analyzed for their physico-chemical and mechanical properties in two days intervals of storage. Fruits were treated with ethrel solution and dried than kept for ripening under controlled conditions at 24±1 °C. Banana fruit was treated with three treatment viz. Control (C), Mould (M), Bacteria (B) and stored at ambient temperature for further experiment. As the storage progressed, various physical changes observed in banana fruit such as increased in pulp to peel ratio, decreased in intensity of greenness of peel which turns into yellow. A significant difference in firmness was found at different stages of ripeness of bananas. A similar trend was observed for other mechanical properties viz. cohesiveness, chewiness and stickiness during the storage. Ascorbic acid (vitamin C), Moisture content, pulp to peel ratio and TSS, p^H of bananas fruit showed increasing and percentage of titratable acidity trend to decrease at different treatment during storage period of 6 days at ambient atmosphere. The present study aimed to quantify the changes in physico-chemical and mechanical properties in banana fruits at advanced stages of maturity during ripening.*

Keywords: *Banana, Chemical,enthral,Mechanical, Ripening, Firmness*

1. INTRODUCTION

Banana (*Musa spp.*) is the fourth most important food crop in the world. India is the largest producer of banana with an annual production of 23.205 million MT from an area of 0.647 million ha[17].India contributes 23.69 % of the world's share of bananas (Musa sp.)[8]And for commercial purposes banana is harvested at the mature green stage. Therefore banana ripening is very important at commercial enterprises. The most popular methods in large scale ripening are application of ethylene gas in to the ripening or dipping fruits in enthral [4].These operations are relatively expensive in developing countries like India. Temperature and relative humidity (RH) in the ripening chamber are important environmental factors affecting the ripening process and the final quality[2,7,15].

The common criteria for fruit ripeness are softness of texture and the development of the peel's yellow coloration [9]. Peel colour is used as a predictor of shelf-life for retail distribution and texture is an important part of eating quality[2].Banana fruits are fairly well balanced source of nutrient containing various mineral salts, vitamins and high amount of carbohydrates with a little oil and protein [5,12]. Consumers are looking for variety in their diets, and are aware of the health benefits of fresh fruits. Bananas are considered nutritive with high content of vitamins A and C but poor in vitamins B [1,15]. Because of its high nutritive, consumption rate and maturation to eating an experiment was designed to study the physicochemical changes of the mineral element composition of banana fruits during ripening in storage.

2. MATERIAL AND METHODOLOGY

1. Sample collection

Mature green banana (*Musa spp.*) fruits of uniform size and free from physical defects were purchased from a local market and bunches were taken to our department laboratory. Total 16 fruit fingers were taken from different bunches and treated with Control (C), Mould (M), Bacteria (B). Two banana fingers of each treatment replication were collected at 0^{th}, 2^{nd}, $4^{th}$and 6^{th}days of storage for physical and chemical analysis.

2. Physico-chemical characters:

2.1 Fruit firmness analysis:

Texture is critical to fruits and vegetables. Fruits and vegetables continue to metabolize, synthesize and catabolize after harvest[4,6].The Textural characteristics of banana was measured as penetratic parameter as one of the better indices of fruit firmness[3, 11]. The parameter determines the extend of force required to penetrate the peel and pulp of fruit to a depth of 10 mm by using a verticalprobe with diameter 2mm.The peak penetration was recorded and expressed in Newton (N) and was taken as indicator of firmness fruit.

2.2 Vitamin C Content

Vitamin C content was determined in fruit juice by using the dye 2,6-dichlorophenyl indophenols method described in [14].The results were calculated as mg per 100 g fresh weight.

2.3 Total Soluble Solids (TSS) & pHMeasurement

As the fruit matures during ripening, soluble solid content of fruit increases[15]. The fruit was peeled off and pulp portion was scooped out by a knife, crushed and ground. The obtained pulp was centrifuged in tubes using a lab centrifuge (Eltek MP-400R, Electrocraft, India) to get clarified juice. The TSS of the clarified juice was measured using a digital pocket refractometer (Model: Pal-3, Atago instruments, Japan).

pH is hydrogen ion concentration of banana fruit. It influences the palatability of food. pH of clarified juice was measured using a digital pH meter (Elico India Ltd, Hyderabad).

2.4 Moisture content, Pulp to peel ratio & Titrate Acidity:

Moisture content decreases the visual quality and contributes to the loss of subsequent softening [2].and measure by drying method[2,14]. Pulp to peel ratio of fruit of each selected stage was determined by dividing weight of pulp by peel weight with the help of electronic weighing balance. Acid content of fruits diminishes when ripens Titratable acidity was determined by direct titration of diluted pulp with 0.1N NaOH as described [13].

3. RESULTS AND DISCUSSION

3.1. Total soluble solids (TSS) & pH

In general, TSS was observed to show an increasing during 6th day of storage. TSS was recorded 3.9 ^{0}B on the initial day of experimentation while it increased up to 13.0 ^{0}B in controlled samples on the last day of analysis. In mould and bacteria treated bananas, TSS was recorded 5.4 ^{0}B& 14.3^{0}B on initial day of analysis while it increased to 14.7^{0}B&15.6^{0}B on last day of experimentation. The increase in TSS with ripening period may be attributed to conversion of starch into sugars which increased with ripening period and graphical representation is given in **Fig.1**

pH increased with the storage time samples and was recorded 3.6 on the initial day of experimentation while it increased up to 5.0 in controlled sampleson the last day of analysis. In mould, bacteria treated bananas, pH was noted 4.2& 4.6 on initial day while it increased to 5.3& 5.4 on 6th day of experimentation respectively .The observations in change of pH with ripening period was shown by graphical representation is given in **Fig. 1**

3.2. Titratable acidity and Vitamin C

The varietal differences in terms of titratable acidity were observed to be highly changes at different days of storage. It was observed that the amount of acid content decreased gradually with the passing of storage times. The maximum titratable acidity was noticed from 0th, 2nd, and 4th& 6th days of storage followed C, M, and B treatment as shown by graphical in **Fig. 2**.Ascorbic acid (vitamin C) of bananas increased at 22.6mg to 95.8mg after 6 days of storage at ambient temperature.

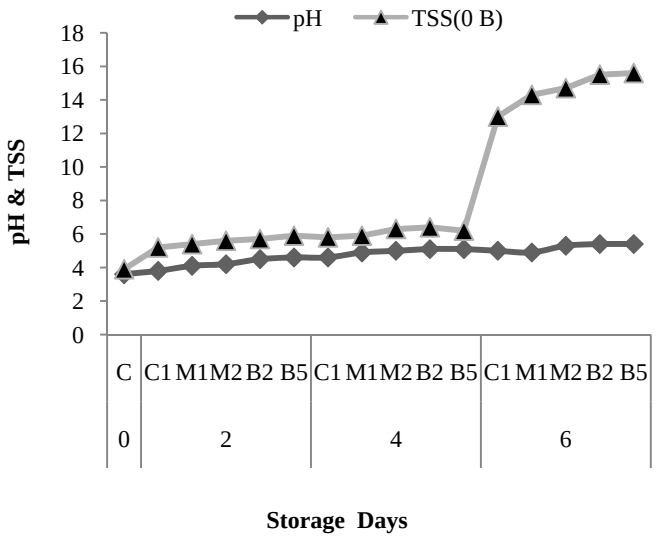

Fig. 1: pH, TSS changes with storage days

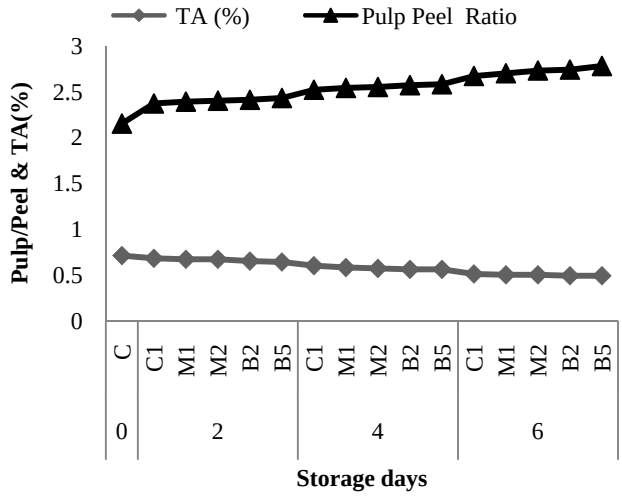

Fig. 2: Pulp/peel &TA (%) changes with storage days

3.3. Pulp peel ratio& Moisture Content

Variation in pulp to peel ratio were significant increased from 0th day up to the 6th days of storage. In this result the highest 2.78 and lowest 2.15pulp to peel ratio were obtained attributed due to carbohydrate break down and the osmotic transfer of water from peel to pulp.

Significant variations were observed in moisture content during storage i.e. 60.21% at 0th and 72.23% at after 6th days of storage.It occurs due to breakdown of starch osmotic withdrawal of water from peel to pulp.

3.4. Fruit firmness

The change in maximum peel force of banana for six storage days is graphical representation in **Fig.3** Maximum peel force for control sample on the 0th day was recorded 10.4 N which increased up to 2nd day of storage and declined thereafter. The same trend was followed by the bananas (M2, B2) except M1 and B5 treated bananas, where increase in maximum peel force was observed up to 4th day of storage and decreased thereafter.

The change in average peel force of banana for six storage days is graphical representation in **Fig.3**.

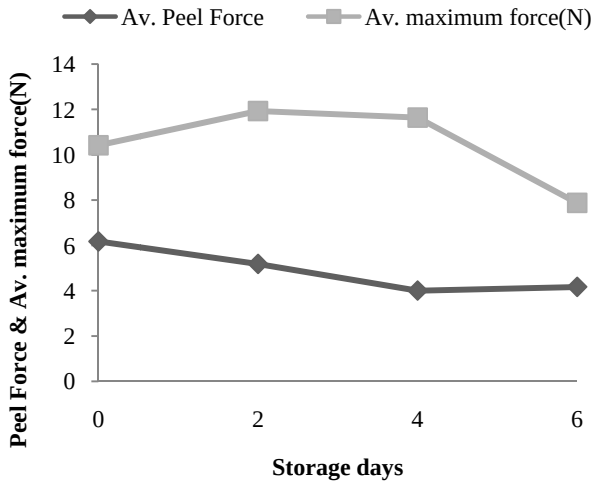

Fig. 3: Av. Peel Force & Av. maximum force (N) vs. storage days

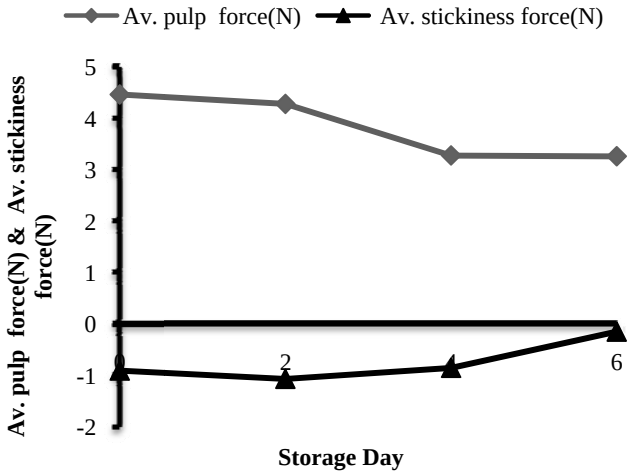

Fig. 4: Av. pulp force (N) & Av. stickiness force (N) vs. storage days

Average peel force for control sample on the 0th day was recorded 6.17 N which decrease up to 4th day of storage and increase thereafter. The same trend was followed by the different treated bananas (M1, M2, B1, and B2).

The change in average pulp force of banana for six storage days is presented in graphical in **Fig.4**. The pulp force (N) was computed as mean of the force applied on the pulp after breaking peel.The pulp force for control sample on the 0th day was recorded 4.47 N which decrease gradually 4th day of storage and remain same thereafter. The same trend was observed followed by the different treated bananas (M2, B2) except M1 and B5 treated bananas where increase was observed after 4th day of storage and declined thereafter.

The stickiness force of the different banana samples increased up to 2nd storage day and declined thereafter followed by graphical representation in **Fig.4**

4. CONCLUSION

It concluded that TSS increased with ripening due to the conversion of starch into sugar. Different treatment showed variable responses on ripening behaviour of banana.During storage force required to puncture the fruit peel and pulp increased initially followed by decline in later phase of ripening. This may be attributed to decline in firmness of fruit with ripening.

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