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Effect of Storage Time and Room Temperature on Physicochemical and Geometric Properties of Banana (*Musa Spp.*) Fruit

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Abstract

Information of banana (Musa spp.) fruit on physicochemical and geometric properties are important to maintain quality parameters. Banana is the most consumed fruit and has great importance for small-scale farmers and has a healthy diet. This study investigated the effect of storage time and room temperature on the physicochemical and geometric properties of banana fruit. Due to its attractive texture and color bananas is popular. However, because of perishability, it has a short shelf life. Banana fruit physicochemical and geometric properties (weight loss, hardness and penetration, color, pH, total soluble solids, and titratable acidity were significantly affected by storage time and room temperature. During storage at room temperature, the color values L-value (lightness) and b- value (yellow) were increased(36.4 to 52.1 and 22.93 to 42.34) respectively. However, the value decreased from -15 to -25.1. Weight loss and TSS also increased from 10.4 to 14.3 and 3 -15°Bxrespectively. TA decreased from 0.47 to 0.14 and pH increased4.2 to7.3.Hardness with peel and without peel decreased from 1089.5 to 316.76 N and 937 -183.46 N respectively. Penetration with peel and without peel decreased from 72.5 to 18.81 and 52.25 to 10.88 N respectively. Therefore, storage time and room temperature were affecting the physico-chemical and geometric properties of stored banana fruits at room temperature and CRD design was used for analysis. Based on the research, limitation further research is needed to study the effect of storage time at room temperature on nutrition composition, ant-oxidants, size, and shape of stored bananas by taking more time.

Keywords: *Banana, Physicochemical Properties, Storagetime, Room temperature*

1. Introduction

Banana(*Musa* spp.) fruit *is the most popular fresh* fruit *in all over the world*. It is the major fruit crop grown in many developed and developing countries [1]. Bananas is the most commonly consumed fruits and it has great importance to small-scale farmers in the developing countries of the tropics and subtropics '[2].[3] stated that banana is the world's second most important fruit crop after oil palm. About 87% of the entire bananas grown worldwide are produced by small-scale farmers for consumption or sale to local and regional markets [4]. This makes banana to be the prime leading fruit crop in terms of volume and value in the world market [5]. In most world countries both developed and developing production of banana fruits becoming more due to its benefit. In 2020, bananas production for southwest Asia continent countries like Viet Nam was 2.19 million tonnes and its production of increased from 470,000 tonnes in 1971 to 2.19 million tonnes in 2020 growing at an average annual rate of 3.37% [6]. According to [7], in Ethiopia about 107,890.60 hectares of land is covered by fruit crops. From these bananas contributed about 58.59% of the fruit crop area followed by avocados which contributed 16.53% of the area.

Fruits and vegetables are universally considered vital elements in a healthy diet. Like other fruits and vegetables, banana fruits are the most popular fruit and one of the world's most important staple foods, along with rice, wheat, and maize [8]. Not only they provide crucial vitamins and proteins, but also have health-giving qualities[9]. It is a good source of potassium, magnesium, copper, manganese, vitamin C and B6. Banana is also a good source of energy, low in protein and fat content, and has several medicinal properties [10]. Due to its attractive texture, good glucose sugar and flavor bananas are popular by consumers.

Banana (*Musa spp.*) is a highly perishable fruit. The perishability of the banana fruit is attributed to immense physiological changes after harvest [11]. The port of total postharvest loss on bananas is considered to be 30-40 % [12]. Postharvest pest and diseases affect a wide variety of banana fruit that lack appropriate postharvest storage facilities, particularly in developing countries. Infection by fungi and bacteria may occur during the growing season, at harvest time, during handling, storage, transport, and marketing, or even after purchase by the consumer 26.5% of which 56% of the loss occurred at the retail level due to rotting before reaching to consumers in Ethiopia [13]. Temperature is the most important environmental factor that influences the deterioration of harvested climacteric fruit. It has been shown that temperature has a profound effect on the rates of biological reactions [14]. Physical injuries to the produce must be avoided wherever possible during the handling and distribution of fruits [15]. Postharvest losses are one of the concerns of food security and poverty reduction strategies in many developing countries including Ethiopia and Vietnam [16]. Banana fruit contains low fat, an excellent source of dietary fiber, vitamin C, vitamin B6, and manganese[17]. The presence of potassium and fiber in large amounts in bananas also helps to combat atherosclerosis, which can lead to heart attack and stroke[18].

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Since banana fruits are highly perishable in nature they undergo many physiological and biochemical changes that lead to ripening and senescence. According to [19] in developing and developed countries banana fruit is considered to be the best of all fruit crops because of its excellent flavor, attractive fragrance, beautiful peel color, delicious taste, and nutritional value. Despite its nutritional and health importance, there is a huge postharvest loss of this fruit due to its perishable nature. However properties and shelf life of bananas can be extended by controlling storage temperature and food industries can use it during scarcity to consume and produce different products. To reduce postharvest loss and to increase the shelf life, efforts are needed to develop postharvest technologies to manage storage temperatures that are not health hazardous and would suit the climatic and socio-economic conditions of countries [20]. Therefore, appropriate temperature management is the most important tool for extending shelf life and maintaining the quality of banana fruit as well preservephysico-chemical and geometric properties.

Therefore this study aims to investigate the effect of storage time and room temperature on physico-chemical and geometric properties of banana fruits.

2. Materials and Methods

Description study of the area

The experiment was conducted in the Viet Nam national University of Agriculture (VNUA) at the laboratory of Food Processing and technology.

Sample collection and preparation

Unripe and free from any defects banana fruits were purchased from the supermarket around VNUA in University Viet Nam from the producer and it was transported into the food science laboratory at VNUA. After it was transported into the laboratory, it put at room temperature and relative humidity (22°C–28°C and 82%–85% RH) according to (Opara et al,.2012; Ahmad et al.,2006). During the determination of physicochemical and geometric properties, banana fruits were cut at 2 cm and hardness and penetration were determined.

Experimental design and treatment application

The experiment was laid out in a completely randomized design (CRD) with four replications considering storage at room temperature and storage time by using Minitab software version 16. The factors consisted of (1) storage time and (2) room temperature and eighteen banana fruits were used.

Data Were Collected

Physiological Weight loss

The percentage of physiological weight loss was determined by using the methods of [21]. Weight loss of fruits was calculated from the initial weight of fruits per treatment and at each storage interval period. It was determined using a sensitive balance (type JD2000-2). Fruit weight daily variation from the initial measurement was expressed as a weight loss %.

$$\text{Weight loss (\%)} = \frac{\text{Initial weight} - \text{final weight}}{\text{Initial Weight}} \times 100$$

Hardness and penetration

The hardness and penetration with peel and without peel were measured by using a textural analyzer instrument according to [22]. During the measurement of hardness and penetration of banana fruits with peel and without peel first, the texture analyzer was adjusted at force 107 N, and speed was adjusted at 92 mm/min. maximum and low height or distance adjusted at 66.99 mm and 50.41mm respectively. For calibration, 2000N weight was used. Then hardness and penetration were measured three times per fruit every day. On both ends of the fruit, the stem-calyx axis was measured for hardness and penetration.

Color

The color of each fruit was measured three times at six parts at both two side and at middleside three parts and in the opposite side also three parts. This was done at mid-way along the stem-calyx axis with a chromameter (model CR-400, Konica Minolta, Japan) on each opposite side of fruit. According to [23] the following values for color were reported for the CIELAB scale: L* (lightness; a* (greenness: and b* (yellowness).

Total soluble solids (TSS)

The TSS was determined following the procedures described by [22]. A refractor meter (WAY-2s Abb'e,0-20 °Brix) was used to determine TSS by placing 1 to 2 drops of clear juice on the prism.

TA content

Banana juice was prepared and titrated with 0.1 N NaOH up to pH 8.1 using phenolphthalein as an indicator was calculated as percentage malic acid[22].

$$\text{TA (\%)} = \frac{(\text{C} \times 100 \times \text{ml of NaOH} \times \text{N of NaOH})}{(\text{ml of sample})} \times \text{D}$$

where C is constant = 0.067 (for malic acid), N of NaOH = 0.1, mL of NaOH = readings of sample volume, and D (dilution factor).

pHvalue

ApH7bufferwasusedtodeterminethepH,analiquotofjuicewasextractedfromthesamplefruitandthepHofthejuicewasmeasuredwithapHmeter(UB-10pH/mVmeterultrabasic). Method of [24] was used.

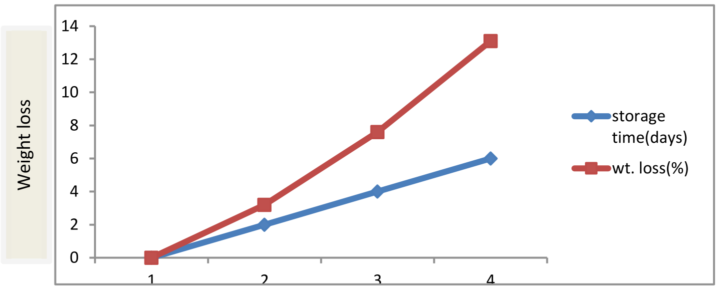
Statisticalanalysis

Data analysis was performed using genetic origin laboratory, narrative, and descriptive statistics. An Excel application was used for raw data analysis. Duncan's multiple range test procedure was used to distinguish treatment measures with p≤0.05.

Results and Discussion

Physiological Weight loss

Physiological weight loss increase as storage duration increases at room temperature loss of weight increased. This circumstance resulted from increased fruit evaporation of water brought on by temperature. Similar findings were reported by [25] who showed 5.5% weight loss in Cavendish banana fruit during storage at 14°C for two weeks and [26] who discovered higher weight loss at (22.5°C) compared to a lower temperature (17.5°C).



Storage time (days)

Figure 1: The relationships between weight loss and storage time banana fruit temperature.

Stored banana for zero day

Stored banana for 3 day

Stored banana for 5 day

Stored banana for 7day

Figure2:Color of Stored Banana for 0, 3, 5, and 7Days

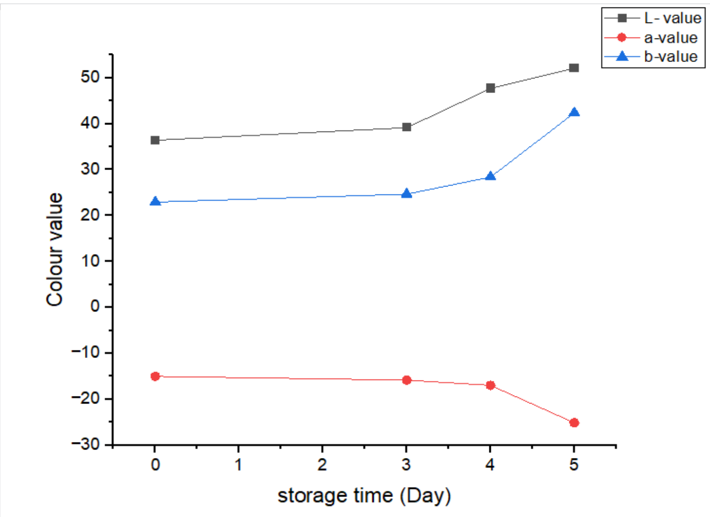


Figure 3: Effect of storage time on color value (L,a , and b value)

Changes in color values (-L, -a, -b) during the storage period of seven days at room temperature were presented in the above graph fig. 3. It can be observed from fig.3 that the lightness value which is -L value and yellowness b- value increased during the storage period of seven days. The increase in the color score during storage might be due to a series of physicochemical changes like the breakdown of chlorophyll and an increase in carotenoid pigments of the pulp caused by enzymatic oxidation and photodegradation. This might be due to the chlorophyll degradation, which subsequently reveals the yellow carotenoid pigments. These results concurred with those of[28] who stated that mature fruit has a green peel hue.

The development of carotenoids in fruit stored at 18-34°c underwent a series of changes, and one of the major changes was an increase in carotenoids from 498 to 8071 ug/100 g, which caused the color of Alphanso and other varieties of mango to change from light green or green or dark green to light green or yellow or orange-yellow [28];[29]. The greenness of the banana which is a-value was decreased slowly; during storage time increased.This is due to fact that, the breakdown of the chlorophyll in the peel happened and the development of small brown flecks over the peel. The work of [30] also support this idea. Therefore, storage temperature and time significantly affect the color quality characteristics of banana fruit. During storage time the value of L* and b* were increased and value a* was decreased.

Hardness and Penetration

Hardness and penetration were measured by using a texture analyzer and adjusting speed and height as well as force. After that, samples were put under the probe of a texture analyzer, and direct reading was taken through observing and recording. The below two figures show the effect of storage time on hardness and penetration with peel and without peel of banana fruits studied for (0,3,5 and 7) days.

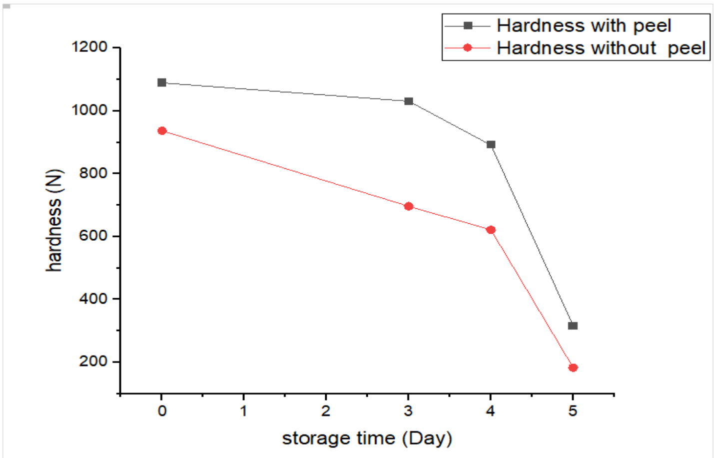


Figure 4: Effect of storage time on banana hardness

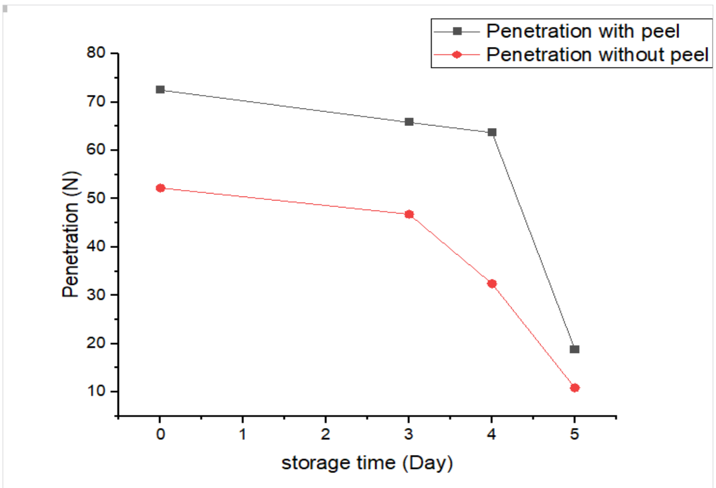


Figure 5: Effect of storage time on penetration of banana fruit

Storage time had a significant effect on banana fruit hardness and penetration (Figures 4 and 5).The hardness and penetration of the banana gradually reduced throughout the storage period and decreased quickly. Figure 4 shows that as storage time increases, both hardness with peel and without peel decrease. The hardness with peel decreases gradually,and then decreases sharply but the hardness of banana without peel decreases rapidly. Fig.5 show that as storage time increases, penetration force decreases. The penetration of banana fruits without peel during storage time decreased rapidly. This could be due to outer part cell wall removed and the breakdown of different insoluble compounds. –'[31] state that the reductions in hardness and penetration value during storage might be due to the breakdown of insoluble compounds. The breakdown of the cell wall is another reason why banana hardness and penetration decrease over time when they are stored. These works were further assisted by the activity of the fast changes in hardness during the ripening phases [32]. The processes of starch breakdown into soluble sugars, water loss from the peel, and a reduction in hardness and penetration are also linked to the processes of fruit softening. The writings of[33] support this notion as well.

Generally, the reduction in score during storage might be due to the breakdown of insoluble Pectin substances to soluble forms [34] formed in the tissues during ripening. These findings are correlated with [35] in Vietnam, who reported that firmness of Buoi mango was highly dependent on storage temperature. Similar observations were reported by [36] in green mature Alphaso and other 7 varieties of mango that firmness was decreased from (28.96-17.46 lbs/sq.inch) at 18- 34°C due to a series of physico-chemical changes.

Total soluble solid (TSS)

The effect of storage time on TSS of banana fruitsstudied by using hand refractometre and it's effect presented by below Figure 6.

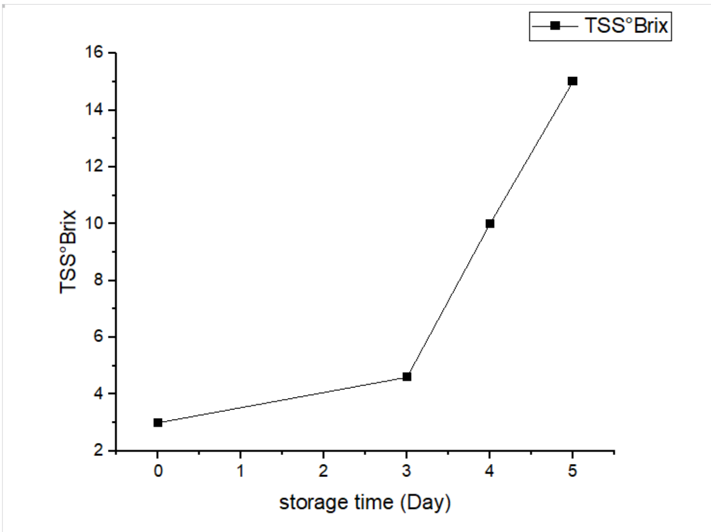


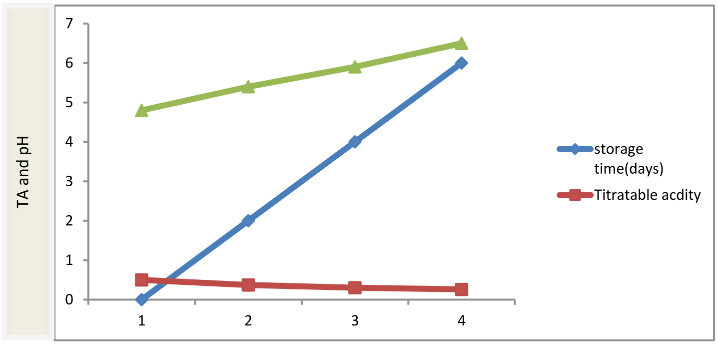
Figure 6: Effect of storage time on total soluble solid of banana fruit

Fig. 6 demonstrates that the amount of total soluble solid rose as storage duration at room temperature increased.

TSS had a value of 3 °Bx at 0 days, and by 3 days, it had increased to 4.6 °Bx. TSS steadily increases in value from 0 to 3 days. Due to an increase in the ripening stage, it increases exponentially from 4.6 °Bx to 15 °Bx after three days. The change in cell wall structure and conversion of complex carbohydrates into simple sugars during storage could be to blame for the rise in total soluble solids (TSS). [37] shared similar opinions, noting that storage temperature also affects TSS levels and that TSS contents were low (14.15%) at high temperatures (25°C) in comparison to higher (16.6%) TSS concentrations at low.This is because, when the fruit ripens, the phosphorylase enzyme breaks down the fruit's carbohydrates into simple sugars, converting them from starch into soluble sugars. Because of the rise in ripening stage and conversion of starch into soluble sugars, the total soluble solid of banana fruit increased as storage duration increased.

TA and pH

During the storage period the TA valuedecreases and the pH valueincreases. Thedecrease in acidity may be due to the susceptibility of citric acid to oxidative breakdownaffected by the aging environment [38] Anincrease in pH during mango ripening was reported by other authors ''''''[39] and was similar to that observed in the present study.



Storage time (days)

Figure 7: The relationships between storage time, pH and titratable acidity

Figure 7 shows that with increasing pH, the titratable acidity decreased significantly ($p<0.05$). The decrease in acidity may be due to its conversion to sugar and its further utilization in metabolic processes in the fruit. These results are further consistent with those of the [40] Alfonso who discovered the titratable acidity value of mangoes.

Conclusion

Physico-chemical and geometric properties of banana fruit were affected by storage time and room temperature. Therefore, storage of banana fruit for a long period of time at room temperature is not good because of physic-chemical and geometric properties were affected. As storage time increased at room temperature properties like physiological weight loss,pH, and TSS were increased. However, hardness and penetration with peel and without peel and, TA were decreased. Color valuelike lightness(L- value) and yellowness (b-Value) were increased and but greenness was (a- value) was decreased. To extend the shelf life of banana fruits and to maintain physiochemical and geometric properties it is not necessary and recommended to store under room temperature rather than low optimum temperature. Therefore, controlling the ripening temperature is crucial for obtaining the greatest banana fruit possible within a certain marketable shelf life. Further research is needed to study the effect of longer storage time at room temperature on nutrition composition, ant-oxidants, size and shape of stored banana fruit.

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