International Journal of Research and Review
www.ijrrjournal.com E-ISSN: 2349-9788; P-ISSN: 2454-2237

Original Research Article

Effects of Different Postharvest Treatments on Ripening and Quality of Banana (*Musa sapientum*)

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ABSTRACT

Banana is one of the most common fruits that have been consumed in everyday diet. Due to its huge demand and availability banana production has been very popular among various agricultural countries. Therefore, innovative cost-effective method is necessary to promote and smoothen the banana production among farmers commercially mitigating the demand. In the experiment, two varieties of banana have been taken as materials. Here T2 was treated with hot water (50^0C) for five minutes. T3 was treated with hot water (50^oC) and packaged with perforated polythene. T4 was mixed with neem (*Azadirachta indica*) leaves extracts and packaged with perforated polythene. T5 was treated with garlic (*Allium sativum*) cloves extracts and packaged with perforated polythene. T1 was control, not treated with nothing. The highest total weight loss (18.98%) was found at the 12th day of storage in control (T1) and T5 illustrated the lowest total weight loss (8.62%). The highest color score (5.10) and lowest color score (4.10) were found in Kobri and Amritsagor, respectively. At the 12th day of storage untreated bananas showed the lowest color score (2.5) but T5 showed the highest color score (4.5). At the 15th day of storage highest firmness score (5.00) was in T5 but the lowest firmness score (3.42) in control (T1). Amritsagor showed the highest disease severity than other varieties, at the 15th day of storage, the T1 showed the highest disease severity (30%) whereas the T5 showed the lowest disease severity (13%). All the postharvest treatments exhibited significance differences in influencing disease incidence. Control treatment was showed the highest disease incidence (72%) and the lowest (36%) in T5. This study shows various treatments approach to be effective and economic comparing to traditional method of postharvest treatments. Therefore, the post harvest treatments can be adapted as a new method of banana quick ripening with good quality fruits suitable for both domestic and farming approach especially for temperate low income country like Bangladesh.

Key Words: Post-harvest treatments, Ripening, Quality, Banana.

INTRODUCTION

The word banana (*Musa sapientum*) comes from the Arabic word "banan" meaning finger, it is one of the most important dietary fruit in the world. It belongs to the family of musaceae. The banana plant is not a tree, it is the world's largest herb. [1] The "trunk" of a banana plant is not made of wood, it is made of tightly overlapping leaves. It is one of the most important fruit crops in the world) as it is available throughout the year, relatively inexpensive and is within the reach of *all* classes of buyers. [2] Bananas come in various shapes and forms. In fact, there are over 1000 banana varieties**.** The most common one, which the commercial banana industry relies on, is the sweet and seedless

Cavendish banana (A Cavendish banana is the fruit of a banana cultivar belonging to the Cavendish subgroup of the AAA cultivar group**)**. The wild progenitors of the domesticated banana are *Musa acuminata* (where the haploid genome is designated as 'A') and *Musa balbisiana* (the B genome). The food and nutrition situation in Bangladesh is fragile due to inadequate and imbalanced diet intake.

Agriculture accounts for 17% of total Bangladeshi GDP. While the country produces over 118 different fruit crops, bananas are the only fruit crop available year-round and have the highest per capita consumption. [3] Bangladesh ranks 14th among the top 20 banana producing countries in the world. The country produces nearly 1.00 million tons of bananas annually. In Bangladesh, the total banana cultivated area in the year 2006-07 was 145280 acres (58818 ha) and it was decreased to 130589 acres (52870 ha) in the year 2010-11. [4] Major Districts of cultivated Banana are Narsingdi,Gazipur, Rangpur, Bogra, Nator, Pabna, Noakhali, Faridpur, Khulna inour country. Districts of wild grown Banana are Sylhet, Moulvibazar, Netrokona, Rangamati, Khagrachhari, Bandarban. Generally, banana plants are found throughout the country in most of the rural homesteads. There are a number of banana cultivars in Bangladesh. Among them, BARI Kola-1, Amritsagar, Sabri, Champa and Kabri are the commercial cultivars. The other cultivars are Mehersagar, Dudsagar, Agniswar, Genasundari, Kanaibanshi, Basrai, Binisuta,etc. [5]

Amritsagor (AAA genome) is the most popular dessert banana in Bangladesh. It is also known as Amrit Amritsagor or Amritsagar. The ripe banana develops a bright yellow color. RaamAmritsagor is the most famous Amritsagor for its large size, test and flavor.

Kobri (AB genome) is also known as Kabri, Bangla, Shail, Thutae and Manua. The fruits of this hardy plant are very sweet but sometimes contain seeds. The peel is light yellow in color.

The total per capita consumption of banana in Bangladesh is about 4.7 kg. This is very much lower than that consumed by Europe especially Belgium (26.7 kg), Sweden (16.7 kg) and Germany (14.5 kg) while USA consumed 13.1 kg and the UK at 10.5 kg. [6]

Consumption of a diversified diet to meet the needs of macro and micro nutrients needs to be promoted. [7-9] Banana is a very important source of different macro and micronutrients and very important for human health. One medium-sized banana contains 422 milligrams of potassium. One serving of banana is considered to be about 126 grams. One serving of banana contains 110 calories, 30 grams of carbohydrate and 1 gram of protein. Bananas are naturally free of fat, cholesterol, and sodium. Bananas provide a variety of vitamins and minerals: Dietary Fiber-3g, Folate-25.0 mcg, Iron-.3 mg, Magnesium-34 mg, Manganese-.3 mg, Niacin-.8 mg, Potassium-450 mg, Protein-1g, Riboflavin-.1 mg, Vitamin A-81 IU, Vitamin B6 -.5 mg, Vitamin C-9mg.Banana is highly nutritious [10] and is more easily digestible than many other fruits including apple. [11]

Postharvest losses of fresh fruits and vegetables of Bangladesh are about 25-50%, [12] where it is only 5-25% in developed countries. [13] Banana being a highly perishable fruit, shows high post-harvest losses to the extent of about 20-30%. [14] Lack of suitable post harvest management practices may lead to a huge economic loss for the banana producing regions. Different postharvest management practices are in use to enhance its shelf life by delaying the ripening, reducing respiration rate, and controlling the disease causing organisms, during transport and storage. An integrated approach can ensure product safety and quality that reaches the consumer, residing far away from the production area. [15]

But in our country, farmers are not aware about the scientific method of cultivation to grow more production with

minimum materials. They are also not acquainted with the treatments applied for quick ripening with good quality fruits. The study is designed with keeping that in mind to understand the application of external treatments on banana ripening and visual observation of banana ripening stages.

MATERIALS AND METHODS

Experimental Location

The experiment was conducted in the laboratory under the department of Agriculture, Noakhali Science and Technology University, Noakhali. The maximum and the minimum temperatures as well as humidities in the storage room were 29.3^{o}C and 14.2^{o}C and 85% and 50% respectively.

Experimental materials

Freshly harvested bananas viz Kobri, Amritsagor of uniform size, shape and color were collected in 02.10.2017 from Pauramarket, Sadar, Noakhali by the help of a banana trader named Jamshed Mia. Two varieties of banana were harvested in the morning hours and transferred to the NSTU campus as early as possible by auto-rickshaw with careful handling to avoid injury and placed in the laboratory room of the Department of Agriculture, NSTU. Following their arrival in the department laboratory, bunches were cooled by fan to quickly remove the field heat. Both upper and lower 1-2 hands of each cultivar were cut off to maintain uniform shape and size. Individual fingers were separated from the hands of bunches and one sixty fingers of each varieties were used for the experiment. Brief descriptions of the banana varieties are shown in the following.

Amritsagor

Amritsagor is one the best table banana of this country and is considered to be the leading cultivar in Bangladesh. Amritsagor is an important banana cultivar, cultivated all parts of the country, particularly in the northern part of Bangladesh. The farmers cultivate this cultivar for its semi-dwarfness in size and for high yield. Amritsagor is a medium-dwarf cultivar. Its fruits are large and have a greenish to dull yellow colour when ripe. Bananas of this variety are pendent, peduncle, and rachis are pubescent. The average bunch weight is about 15 kg. Each bunch has 6-8 hands and each hand contains 12-16 fingers. The fingers are long and distinctly curved in the middle and apex prominently nippled. The pericarp is medium thick. The banana when ripe has soft pulp with fine textures, good aroma and the variety is completely seedless. As it is a climacteric fruit, its physico-chemical properties changes rapidly after harvest.

Kobri

It is a popular and one of the most important commercial varieties in Bangladesh and is considered even better than Amritsagor by many consumers. This tall Bunches are pendent and peduncles pubescent. Finger is medium long with curvature less distinct than Amritsagor. The average bunch weight is about 10 kg. A bunch contains 85-120 fingers. There are 7-10 hands per bunch and each bunch possesses 11-16 fingers. Fruits are medium-sized. The peel is thin and the pulp is ivory-yellow in colour. Its texture is firm and taste sweet. Pericarp is medium thick and pulp of the ripe fruit is soft with mild to distinct aroma. However, hard lumps sometimes form in the pulp and the ripe fruits drop easily. Peduncle is short and apex slightly nippled.

Methods

Mature green bananas of more or less uniform size, shape and color were selected. A total of twenty fingers of each variety were selected for conducting the experiment. The skins of banana were cleaned with the help of soft tissue paper just before setting.

Experimental treatments

The experiment consists of two factors as follows:

Varieties:

V1- Kobri

V2- Amritsagor

Postharvest treatments

T1: Control
T2: Hot water treatment for 5 minutes (50^0C)
T3: Hot water treatment for 5 minutes and packaging with perforated polythene (50^0C)
T4: Neem extract and packaging with perforated polythene
T5: Garlic extract and packaging with perforated polythene

Application of experimental treatments

The selected banana fruits were randomly assigned in the study for the postharvest treatments. After the application of treatments, the fruits were kept on floor at room temperature. Each treatment comprised of four fingers. The procedures for applying the postharvest treatments to the fruits of each variety were as follows.

Control

Few fingers of each variety were randomly selected and kept on the table of the department laboratory at ambient conditions for observation. (29.2-29.3°C and 50-85% RH).

Hot water treatment

For hot water treatment, the banana fingers were immersed into hot water for five minutes at 50-55 ^{0}C before placing them on the table at ambient atmospheric conditions. For hot water treatment, a hot water bath was used.

Hot water treatment and covered with perforated polythene

For hot water treatment, the banana fingers were immersed into hot water at 50-55 ^{0}C for five minutes before placing them into perforated polythene. Individual banana fingers were kept sealed in transparent perforated polythene by thread and kept on the table of department's laboratory at ambient atmospheric conditions for observations. Eight perforations were made on each polythene bag.

Neem extract covered with perforated polythene

Initially stock neem was prepared by crushing the fresh leaves in water using a crusher. The stock extract was then used to prepare treatment concentrations of 1:2 ratio. The fruits were dipped into the treatment solutions for 5 min to ensure that enough quantity of extract being absorbed. The treated fruits were allowed to air dry for a period of 10 min and then individual banana fingers were bound in transparent perforated polythene and held on the table at ambient atmospheric conditions for observations.

Garlic extract covered with perforated polythene

Initially stock garlic was prepared by crushing the garlic in water using a crusher. The stock extract was then used to prepare treatment concentrations of 1:2 ratio. The fruits were dipped into the treatment solutions for 5 min to ensure that enough quantity of extract being absorbed. The treated fruits were allowed to air dry for a period of 10 min and then individual banana fingers were bound in transparent perforated polythene and held on the table at ambient atmospheric conditions for observations.

Data collection

Changes in the different parameters namely color, firmness, weight loss, disease incidence, disease severity, shelf life were investigated. The methods of studying above-mentioned parameters are discussed in the following.

Parameters studied

In the present experiment the following parameters were studied:

- **Physical characters:**
  - Weight loss
  - Color,
  - Firmness and
  - Shelf life.
- **Microbial characters:**
  - Disease incidence,
  - Disease severity.

The experimental fruits were cleaned by tissue paper to remove the dirt and latex before applying the treatments. The four fruits of each treatment were used to investigate colors, firmness, total weight loss, disease incidence, disease severity and

shelf life. The methods of studying the above parameters are described below:

Weight loss of banana

Four bananas of each treatment were weighed by using a kg balance at the first day of storage and at every 3-day intervals. Weight losses of fruits as influenced by different postharvest treatments were estimated using the following formula:

% Weight loss (WL) = {(IW-FW)*100}/IW

Where,

WL = Percent total weight loss

IW = Initial weight of fruits (g)

FW = Final weight of fruits (g)

Color

Days required to reach different stages of color during storage and ripening were determined objectively using numerical rating scale of 1-7.

Where 1 = green, 2 = pale, 3 = < 25 % yellow, 4 = < 50 % yellow, 5 = <75 % yellow, 6 = 75 to 100 % yellow and 7= Black end (Fully yellow and Black)

Firmness

Days required to reach different stages of firmness during storage and ripening were determined objectively using numerical rating scale of 1-5.

Where 1 = hard green, 2 = sprung, 3 = between sprung and eating ripe, 4 = eating ripe, and 5 = overripe.

Disease severity

Disease severity represents the percent diseased portion of infected fruit. The infected fruits of each treatment were selected to determine percent fruit area infected, and was measured based on eye estimation.

Disease incidence

Disease incidence means percentage of banana infected with diseases. The incidence of banana was recorded at every 3 days intervals. The diseased fruits were identified symptomatically.

The disease incidence was calculated as follows:

Disease Incidence (%) = (Number of banana infected/Total number of banana) × 100.

Shelf life

Shelf life of banana fruits as influenced by different postharvest treatment was calculated by counting the days required to ripe fully as to retaining optimum marketing and eating qualities.

Statistical Analysis

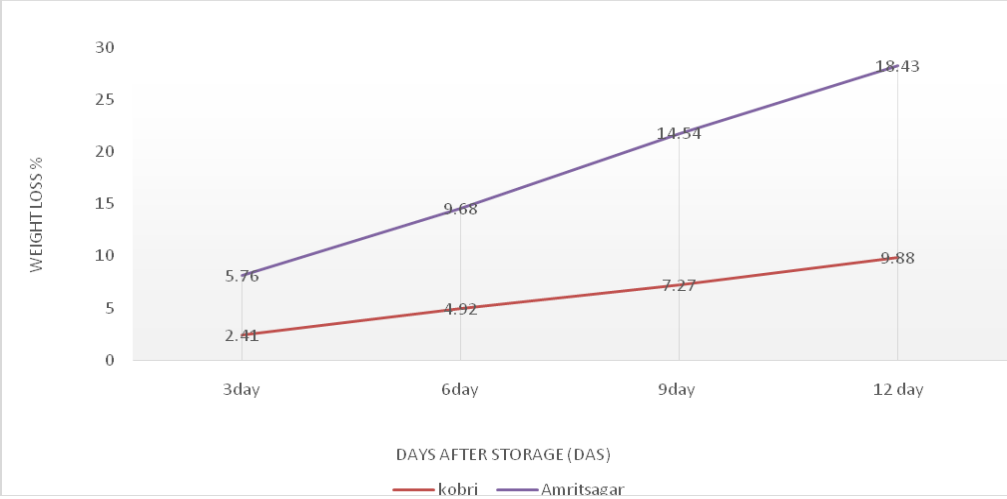
All the statistical analysis and all other data processing were done by using SPSS windows. Differences between two varieties of banana regarding their weight loss, disease severity, disease incidence were determined by independent-samples T Test. Differences of weight loss, disease severity, disease incidence among different time interval and different treatments of Amritsagor and Kobri varieties were determined by one-way ANOVA test. Statistical significance was accepted at $p<0.05$ for all test.

RESULTS

The experiment was conducted due to study the effect of different treatments in respect of physical changes and shelf life of banana were represented in this chapter. Qualitative evaluations of external and general ripening behavior observed during the period of the study have also been briefly mentioned.

Total weight loss

In respect of weight loss of banana great variation was observed among the varieties at all the day of storage period. At 3rdday of storage the total weight loss was the highest in Amritsagor (5.76%) variety and the lowest in kobri (2.41%). The weight loss at 12th day, the highest value (18.43%) was found in Amritsagor and the lowest (9.88%) in Kobri (Fig. 1).



	3 days	6 days	9 days	12 days	**P-Value
Amritsagar	5.76[a]	9.68[a]	14.54[bd]	18.43[cd]	<0.001
Kobri	2.41[A]	4.92[B]	7.27[C]	9.88[D]	<0.001
*P-Value	<0.001	<0.001	0.001	0.001	

**Independent-Samples T test by varieties of banana and statistically significant was set at P<0.05.*
*** One-way ANOVA test by different time interval and statistically significant was set at P<0.05.*
[abcdABCD]Mean with different superscript letters are significantly different among different time interval after PostHoc test.
Fig.1 Effect of weight loss (%) between two varieties at different days of storage

Table: 1 Simultaneous effect of varieties and treatments on weight loss (%) of banana at different days after storage.

Cultivar	Post-harvest treatments	Weight loss (%) at different days of storage(DAS)			
		3 days	6 days	9 days	12 days
Kobri	T1	3.60[a]	7.77[a]	10.84[a]	14.30[a]
	T2	3.00[b]	6.5[ae]	9.75[a]	11.5[bf]
	T3	2.10[cf]	4.50[befg]	6.54[be]	11.45[cf]
	T4	1.88[dfg]	3.20[dh]	6.00[ce]	7.12[d]
	T5	1.40[g]	2.60[dgh]	3.15[d]	4.43[e]
**P-Value		<0.001	<0.001	<0.001	<0.001
Amritsagar	T1	8.00[af]	12.76[a]	19.60[a]	23.56[a]
	T2	7.50[bf]	12.49[b]	18.00[b]	22.75[b]
	T3	5.33[c]	9.22[c]	14.25[c]	17.60[c]
	T4	4.25[d]	7.70[d]	12.40[d]	15.36[d]
	T5	3.67[e]	6.30[e]	8.60[e]	12.83[e]
**P-Value		<0.001	<0.001	<0.001	<0.001

*** One-way ANOVA test by treatments and statistically significant was set at P<0.05.*
[abcdefgh]Mean with different superscript letters are significantly different among different treatments after PostHoc test.
T1 = Control, T2 = Hot after treatment (50-55 ^{0}C for 5 min), T3 = T2 with perforated polythene bag, T4 = Neem extract with perforated polythene, T5 = Garlic extract and perforated polythene.

The highest level of weight loss (19.60%) was recorded in Amritsagor with control treatment at 9day of storage and the lowest weight loss (3.15%) was found in Kobri with garlic extract & perforated polythene treated fruit.

Color changes

Results discovered that the common days needed reaching sequent stages of ripening varied considerably attributable to the postharvest treatments Kobri, Amritsagor showed variations in time periods to achieve sequent stages of ripening. The longer amount was needed for Amritsagor than Kobri to achieve completely different stages of ripening attributable to varietal character. The best color score (5.10) was ascertained in Kobri and also the lowest color scale (4.10) in Amritsagor at twelfth day of storage (Fig. 2).

By considering the combined effects of variety and post-harvest treatments combination were important in color changes throughout storage. The very best color score (7.0) was found in Kobri with garlic extract and the lowest color scale (1.00) was found in Amritsagor with control treatment.

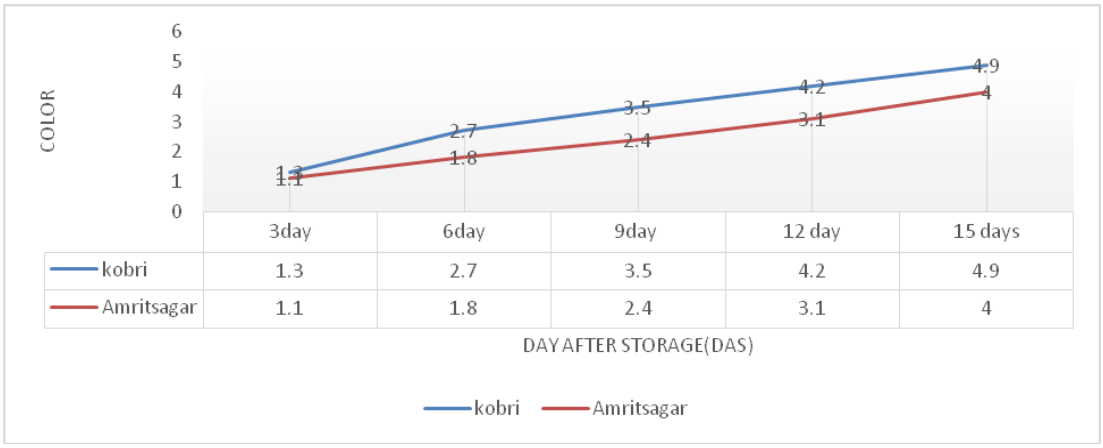


Fig: 2 Color changes of banana between the two varieties at different days after storage

Table.2 Simultaneous effect of varieties and treatments on color change of banana at different days after storage.

Cultivar	Post-harvest treatments	Colors at different days after storage(Days)					
		Initial	3 days	6 days	9 days	12 days	15 days
Kobri	T1	1	1.0	1.5	3.0	4.0	6.0
	T2	1	1.5	2.5	3.5	4.5	6.0
	T3	1	2.0	2.5	4.0	5.5	6.0
	T4	1	2.5	3.5	4.0	5.5	6.5
	T5	1	2.5	4.0	5.5	6.0	7.0
Amritsagar	T1	1	1.0	1.0	1.5	3.0	4.0
	T2	1	1.0	1.5	2.5	3.5	4.5
	T3	1	1.0	2.5	3.0	4.0	5.0
	T4	1	1.0	3.0	3.5	4.5	6.0
	T5	1	1.0	3.5	4.5	5.5	6.5

Where, T1 = Control, T2 = Hot after treatment (50-55 ^{0}C for 5 min), T3 = T2 with perforated polythene bag, T4 = Neem extract with perforated polythene, T5 = Garlic extract and perforated polythene.

Change in firmness of banana

Firmness is a very important criterion quality of banana. The changes in firmness of banana pulp from hard to consumption ripe are obvious change that happens throughout storage period. Throughout firmness change the pulp becomes softer and sweeter will increase and therefore the characteristics aroma is created. The higher rates of firmness (1.3, 2.70, 3.5, 4.20 and 4.90) were found in Kobri and lower firmness (1.10, 1.80, 2.40, 3.10 and 4.0) in Amritsagor at 3th, 6th, 9th, 12th and 15th day of storage (Fig3).

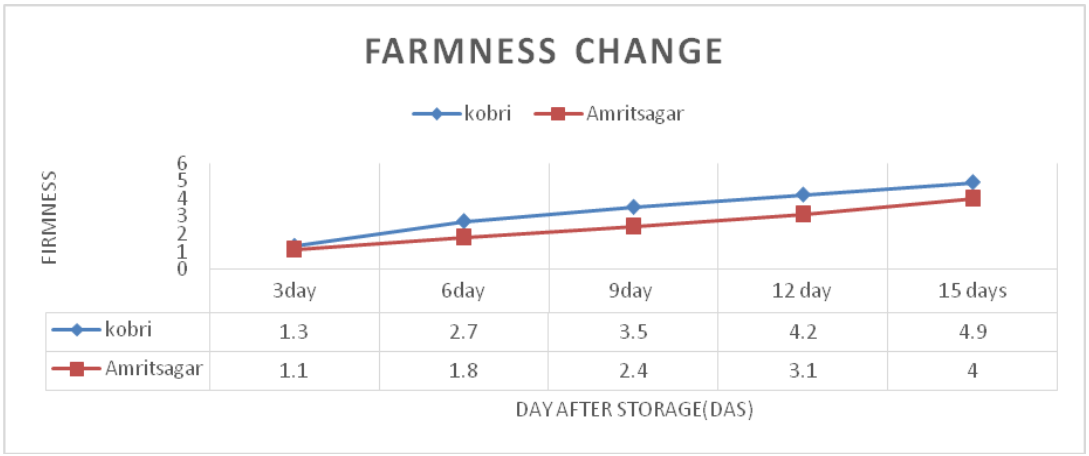
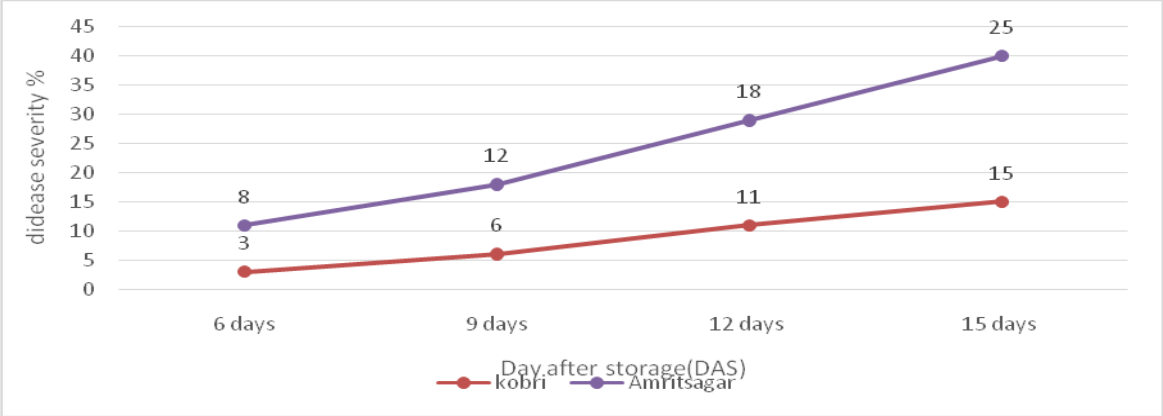


Figure:3 Firmness change of banana between the two varieties at different days after storage

Disease severity

The result of the banana disease severity showed that there was difference between the varieties which were, at 6th, 9th, 12th and 15th day of storage. The higher disease severity

(8%, 12%, 18% and 25%) was observed in Amritsagor and lower disease severity (3%, 6%, 11% and 15%) in Kobri at 6th, 9th, 12th and 15th day of storage, respectively.



Cultivar	Disease severity(%) at different days after storage(DAS)				
	6 days	9 days	12 days	15 days	**P-Value
Kobri	3^{a}	6^{b}	11^{c}	15^{d}	<0.001
Amritsagar	8^{A}	12^{B}	18^{C}	25^{D}	<0.001
*P-Value	<0.001	<0.001	<0.001	<0.001	

**Independent-Samples T test by varieties of banana and statistically significant was set at P<0.05.*
*** One-way ANOVA test by different time interval and statistically significant was set at P<0.05, ^{abcdABCD}Mean with different superscript letters are significantly different among different time interval after PostHoc test.*

Figure-4: Disease severity between two varieties of banana at different days after storage.

Disease incidence

No fingers were found diseased tilled the first day after storage in case of all the varieties investigated. At the 12th day of storage the highest disease incidence (68.72%) was found in Amritsagor and the lowest disease incidence (40.59%) was found in Kobri (Table 3).

Amritsagor showed the highest incidence level of 38.88% in control at 6th day of storage, which sharply increased up to 88.88% at the 12th day of storage. On the contrary, Kobri showed the lowest incidence level of 8.67% in garlic extract with perforated polythene at 6th day of storage, which sharply increased up to 28.33% at the 12th day of storage (Table3).

Table:3 Disease incidence of banana at different days after storage.

Cultivar	Disease incidence (%) at different days after storage(DAS)				
	6d	9d	12d	15d	**P-Value
Kobri	14.51^{a}	26.82^{b}	40.59^{c}	37.18^{d}	<0.001
Amritsagar	26.90^{A}	47.88^{B}	68.72^{C}	55.52^{D}	<0.001
*P-Value	<0.001	<0.001	<0.001	<0.001	

**Independent-Samples T test by varieties of banana and statistically significant was set at P<0.05.*
*** One-way ANOVA test by different time interval and statistically significant was set at P<0.05.*
^{abcd}Mean with different superscript letters are significantly different among different time interval after PostHoc test.

Table:4 Simultaneous effect of varieties and treatments on incidence severity of banana at different days after storage.

Cultivar	Post-harvest treatments	Disease incidence (%) at different days after storage(Days)			
		6d	9d	12d	15d
Kobri	T1	25^{a}	42^{a}	50^{a}	45^{a}
	T2	16^{b}	30^{b}	45^{b}	37^{b}
	T3	11^{c}	27^{c}	40^{c}	28^{c}
	T4	10^{d}	16^{df}	38^{d}	22^{d}
	T5	8^{e}	16^{ef}	28^{e}	18^{e}
**P-Value		<0.001	<0.001	<0.001	<0.001
Amritsagar	T1	38^{a}	77^{a}	88^{a}	66^{a}
	T2	33^{aef}	50^{adei}	75^{ac}	65^{a}
	T3	25^{begh}	50^{afg}	66^{ad}	60^{a}
	T4	20^{cfgj}	35^{bdefh}	62^{ae}	44^{a}
	T5	16^{dhi}	25^{eghi}	50^{bcde}	40^{a}
**P-Value		<0.001	<0.001	0.034	0.916

*** One-way ANOVA test by treatments and statistically significant was set at P<0.05,*
^{abcdefghi}Mean with different superscript letters are significantly different among different treatments after PostHoc test.
Where, T1 = Control, T2 = Hot after treatment (50-55 ^{0}C for 5 min), T3 = T2 with perforated polythene bag, T4 = Neem extract with perforated polythene, T5 = Garlic extract and perforated polythene.

Amritsagor showed the highest incidence level of 38% in control at 6th day of storage, which sharply increased up to 88% at the 12th day of storage. On the contrary, Kobri showed the lowest incidence level of 8% in garlic extract with perforated polythene at 6th day of storage, which sharply increased up to 28% at the 12th day of storage (Table4).

Shelf life of banana

The highest shelf life (14.5 days) was observed in Kobri and lowest (12 days) in Amritsagor (Fig. 5).

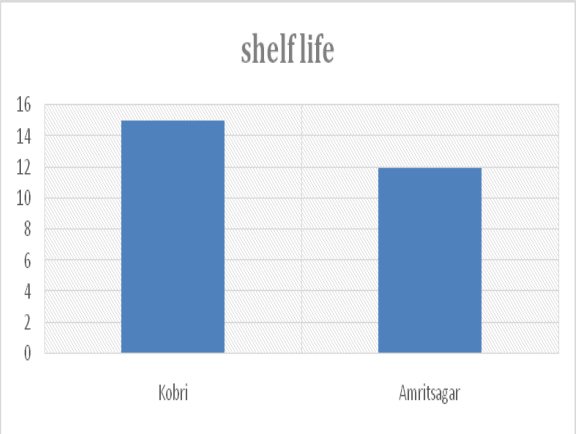


Fig.5 Shelf life of banana

DISCUSSION

The experiment was carried out at the Laboratory of the Department of Agriculture during the period from October to November, 2017. The objectives of the present investigation were to evaluate the pattern of ripening, prolongation of shelf life of bananas viz. Kobri and Amritsagor under different postharvest treatments during storage period. Wide variations were observed between two varieties of banana with different postharvest treatments in relation to various parameters on the days required to reach different stages of ripening, weight loss, shelf life, disease incidence, disease severity, firmness of banana were recorded.

Weight loss in banana was influenced by postharvest treatments and varieties. At 3rdday of storage the total weight loss was the highest in Amritsagor (5.76%) variety and the lowest in Kobri (2.41%). The weight loss at 12th day, the highest value (18.43%) was found in Amritsagor and the lowest (9.88%) in Kobri. Statistically significant difference of weight loss was found between the two varieties of banana of same storage time. Statistically significant difference was found among different time interval of storage of the same variety of banana regarding their weight loss.

The different postharvest treatments exhibited more pronounced effect on weight loss of banana during storage. Total weight loss treated and untreated banana was increased with the duration of storage. At 6th, 9th and 12th days of storage of Kobri variety control treatment showed maximum (7.77%, 10.84%, 14.30%) total weight loss and minimum total weight losses (2.6%, 3.15%, 4.43%) were recorded in garlic extract and perforated polythene treatment. At 6th, 9thand 12thdays of storage of Amritsagor variety control treatment showed maximum (12.76%, 19.6%, 23.56%) total weight loss and minimum total weight losses (6.3%, 8.6%, 12.83%) were recorded in garlic extract and perforated polythene treatment. Between the two varieties, statistically significant difference of the weight loss among the different post-harvest treatments of the same days of storage.

Results discovered that the common days needed reaching sequent stages of ripening varied considerably attributable to the postharvest treatments Kobri, Amritsagor showed variations in time periods to achieve sequent stages of ripening. The longer amount was needed for Amritsagor than Kobri to achieve completely different stages of ripening attributable to varietal character. The best color score (4.9) was ascertained in Kobri and also the lowest color parameter (4) in Amritsagor at twelfth day of storage.

By considering the combined effects of variety and post-harvest treatments combination were important in color changes throughout storage. The very best color score (7.0) was found in Kobri with garlic extract and the lowest color scale

(4.00) was found in Amritsagor with control treatment.

Firmness is a very important criterion quality of banana. The changes in firmness of banana pulp from hard to consumption ripe are obvious change that happens throughout storage period. Throughout firmness change the pulp becomes softer and sweeter will increase and therefore the characteristics aroma is created. The higher rates of firmness (1.3, 2.70, 3.5, 4.20 and 4.90) were found in Kobri and lower firmness (1.10, 1.80, 2.40, 3.10 and 4.0) in Amritsagor at 3th, 6th, 9th, 12th and 15th day of storage.

The result of the banana disease severity showed that there was difference between the varieties which were, high at 6th, 9th, 12th and 15th day of storage. The higher disease severity (8%, 12%, 18% and 25%) was observed in Amritsagor and lower disease severity (3%, 6%, 11% and 15%) in Kobri at 6th, 9th, 12th and 15th day of storage, respectively. Statistically significant difference of disease severity was found between the two varieties of banana of same storage time. Statistically significant difference was found among different time interval of storage of the same variety of banana regarding their disease severity.

At the 12th day of storage the highest disease incidence (68%) was found in Amritsagor and the lowest disease incidence (40%) was found in Kobri. Statistically significant difference of disease incidence was found between the two varieties of banana of same storage time. Statistically significant differences were found among different time interval of storage of the same variety of banana regarding their disease incidence.

On the contrary, Kobri showed the lowest incidence level of 8% in garlic extract with perforated polythene at 6th day of storage. The highest shelf life (15 days) was observed in Kobri and lowest (12 days) in Amritsagor. The maximum shelf life (15.00 days) was found in Kobri with garlic extract with perforated polythene bag treated fruits and. The minimum shelf life (9.5 days) was recorded in Amritsagor with control treatment. Between the two varieties, statistically significant difference of the disease incidence among the different post-harvest treatments of the same days of storage.

Postharvest treatments and varieties showed highly great variation in shelf life of bananas. The shelf lives of banana varieties Kobri, Amritsagor 15 and 12 days respectively. From the varietal effects, it was observed that the longer shelf life was obtained in Kobri than the others.

CONCLUSION

The present study was conducted at the Laboratory of the Department Agriculture of NSTU. The objectives of the experiment were to evaluate the pattern of ripening and prolongation of shelf life of banana viz. Kobri and Amritsagor under different promising postharvest treatments viz. Control, hot water treatment, hot water treatment with perforated polythene bag, Neem extract with perforated polythene and garlic extract with perforated polythene during storage.

Various parameters investigated were shelf life, weight loss, disease incidence, disease severity, firmness, color of banana was recorded. The changes in color and firmness were found to increase with the duration of the investigation. Weight loss in banana was influenced by postharvest treatments and varieties. Among the postharvest treatments, garlic extract with perforated polythene was found to be the best in respect of all parameters of banana, which was followed by neem extract with perforated polythene. However, further study may be done for better understanding of the effects of post-harvest treatments on ripening and quality of banana.

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How to cite this article: Kamal AHM, Ghosh S, Hossain MS et.al. Effects of different postharvest treatments on ripening and quality of banana (*musa sapientum*). International Journal of Research and Review. 2019; 6(2):303-313.

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