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COMPARATIVE EFFECTS ON STORAGE PERIOD OF VARIETIES PINEAPPLE FRUITS

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ABSTRACT

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Pineapple is considered as one of the most wanted tropical fruits and it is widely taken for fresh consumption as well as their flesh and juice are used for preparation of different product in Agro-processing industries. For such industrial processes, it is important to know the information of characteristics changes of pineapple during day after storage. Four varieties of pineapple were collected from different areas of Bangladesh named Honey Queen (H.Q), Giant Kew (G.K), Asshini and Ghorasal. Some Physico-chemical properties (weight loss, moisture content, ash and edible portion, pH, TSS, titrable acidity (TA), total sugar, reducing sugar) biochemical properties (ascorbic acid) and sensorial attributes (color, odor, firmness, appearances, sweetness and overall acceptability) of pineapple juice were studied during day after storage. This study examined the Comparison of different varieties of pineapple fruit characteristics and sensory quality of the pineapple fruits during storage. It was shown that there was a significant changes between the storage periods in relation to different varieties of fruits. The firmness of pineapple fruits were in outside and inside to be 0.21 to 0.27 N/m² and 0.06 to 0.10 N/m², respectively. The pH values of different varieties were found to be in the range of 4.30 to 4.36. The highest and lowest sweetness index were estimated to be 36.30 and 22.15 for Honey Queen and Asshini respectively. The highest and lowest magnitude of sugar contents of four pineapple varieties were found to be in the range of 14.16 to 15.8 mg/100g. The average TSS values were found to be 15.12%, 12.33%, 13.14% and 12.95% for H.Q., G.K., Asshini and Ghorasal, respectively. The comparative study indicated the characteristics of different varieties of pineapple changes during after storage.

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INTRODUCTION

Pineapple (*Ananus comosus* L. Merr.) has long been one of the most appreciated fruit tropical and sub-tropical area, because of its attractive flavor and refreshing sugar-acid balance. Pineapple has long been an important cash crop. The climate and the soils of many parts of Bangladesh are suitable for pineapple production. It is widely cultivated in Bandarban, Khagrachari, Moulvibazar, Sylhet, Chittagong, Rangamati Hill tract, Tangail (The daily Star, 2014). At least ninety varieties of pineapple are cultivated in the world. In Bangladesh, however, three varieties of pineapple are mostly grown. The cultivated varieties are Giant Kew (locally Kalandar), Honey Queen (Jaldubi) and Red Spanish (Ghorashal) etc. Apart from this variety, one local variety named "Asshini" (late variety) is grown by a few farmers of Madhupur, Tangail district. About 45,685 ha of land are now 2 under pineapple cultivation with a total production of about 2, 34,865 metric tons. Another local variety named "Ghorashal" is cultivated at Palash upazila in Narsingdi district. In respect of the total production of fruits which grown in Bangladesh it ranks 4th among the major fruits (BBS, 2014). But Bangladeshi pineapples are more juicy and tasty than any other countries (Banglapedia, 2006). The H.Q variety is largely produced in Sylhet, Habiganj, Moulviganj, Kamalgonj and Satgaon with coverage of 4454.00 ha (The Daily Star, 2014). However, the Honey Queen is the small fruit compared to other varieties which has a necessary demand. Rabon and Borab areas of Palash, Narsingdi district are found that farmers of the area are involved themselves in pineapple cultivation and they raise a new orchard with their own initiative (Banglapedia, 2006).

Pineapple is used for the preparation of alcohol, calcium citrate, citric acid, vinegar, oxalic acid, pineapple gum and flavor. It is a good source of vitamin A, B & C, carotene, ascorbic acid and is rich in calcium, phosphorus, magnesium, potassium and iron (USDA Nutrient data base 2008 and Rashid et.al 1987). There are some of the many health benefits of eating ripens pineapples such as packed with vitamins and minerals, prevents cough and colds, strengthens bones, keeps gums healthy, lowers risk of macular degeneration, alleviates arthritis, improves digestion etc. (USDA nutrient database 2008). Besides, it is also a source of bromelain, a digestive enzyme (Lodh et al., 1973). Various food items like squash, syrup, jelly, etc. are prepared from pineapple. Its juice is helpful for healing fever, jaundice, influenza and cold, among other ailments (USDA nutrient database 2008). Diversified uses of pineapple have also led to develop many fruit processing industries both in developed and developing countries including Bangladesh. However, the processing characteristics of pineapple such as different physio- chemical properties are not properly studied for the different varieties grown in Bangladesh. That's why it is necessary to know the different properties of different varieties of pineapple. This study was conducted to find out the physio- chemical characteristics and sensory quality of the different pineapple varieties during days after storage. The objective of the research was to study the effect of storage period of pineapple varieties on physico-chemical properties and sensorial attributes and to make a comparison of different properties among the varieties of pineapple.

MATERIALS AND METHODS

Experimental materials

The experiment was carried out in the laboratories of the Department of Agro-Processing, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, during the period from July, 2014 to June 2015. The laboratory of Agro-Processing department was used for chemical analysis of fruits and the laboratory of Post-Harvest Technology division, BARI was used for preliminary studies.

Materials used for this experiment

The materials used for the experiment were the freshly harvested pineapple fruits of the variety Giant Kew, Honey Queen, Asshini and Ghorashal. The fruits Giant Kew and Asshini were collected from field of the growers of Gachabari village and Jalchitra market, Madhupur Upazila in Tangail district, Honey queen variety was collected from Sylhet and Ghorashal variety was collected from Palash upazilla, Narsinghdi district. The fruits of optimum maturity stage were identified and harvested in the morning hours and immediately transferred with careful handling and placed to the Department of Agro-Processing laboratory, Bangabandhu

Sheikh Mujibur Rahman Agricultural University, Gazipur. The fruit was kept for twelve days for storage to analyze the different properties of fruits at different days after storage. The experimental pineapples were loaded immediately in a recognized wooden box with utmost care and covered with a polythene paper to protect the fruits from direct sunlight. For transport fruits were placed on leaves with crowns and layer to layer to decrease mechanical damage. Then the fruits were immediately transferred to the Agro-processing Laboratory.

Pineapple Storage for experimental use

The different varieties of pineapple were placed in the Agro-Processing laboratory at the room temperature located at the floor. The floor was covered with newspaper. Very little information available in Bangladesh on physico-chemical changes, shelf life changes during storage and ripening. Storing at room temperature will increase the acidity level of the pineapple, but will not improve sweetness.

Sample preparation

Pineapple were weighed using a top loading balance (Salter Model, Japan), the weight of the samples were determined and juice extraction from samples were performed according to the method described by Lim (1985). The crown and stem portions were removed and the skin were peeled by using knife. After that the fruits were sliced and the fruit slices were pressed using a blender (Jensons Lab, Japan) into paste for one to two minutes to get the pineapple juice and then the juice was collected. The mixture was then filtered through a muslin cloth Juice was collected in similar way for other varieties and the extracts were then stored in a normal room temperature.

The extracted juice was used for present study. Standard procedure was used for determining the different characters. The data obtained from different pineapples samples were recorded. The experimental treatments were as follows:

Table 1. Treatments of the study

Variety	Days after storage (DAS)											
	D ₀			D ₄			D ₈			D ₁₂		
H.Q.	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
G.K.	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
Asshini	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
Ghorasal	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3

N.B. D₀: 0 DAS, D₄: 4 DAS, D₈: 8DAS, D₁₂: 12DAS and T1, T2 and T3 are recap

For experiment, fifty six numbers of different varieties of pineapple were taken. For experiment three number of each variety fruit were taken. Table 1 show that there were forty eight number of different varieties of pineapple were taken for physico-chemical parameters and total eight number of varieties were kept for shelf life observation after 0, 4, 8 and 12 DAS.

Analyses of physical properties

The effect of different postharvest treatments on shelf life and the quality changes of pineapples storage were studied here. The data were collected on different characteristics of sensory evaluation and analyzed. The following parameters were studied.

Percent weight loss of fruit

Per weight loss was calculated by using the following equation:

$$\text{Percent weight loss (\% WL)} = \frac{IW - FW}{IW} \times 100$$

Where,

WL = Percent total weight loss, IW = Initial weight of fruits (kg), FW = Final weight of fruits (kg)

Moisture content

Moisture content was determined by using the Standard Official methods of Analysis (AOAC 1990). This involved drying to a constant weight at 105^o C at calculated moisture as the loss in weight of the dried samples. The crucible was thoroughly washed and dried in an oven at 100^oC for 30 min and allowed to cool inside desiccators. After cooling they were weighed using a weighing balance and recorded as W₁, then 2.0 gm of the finely ground samples were put into crucibles and weighed to determine the value of W₂. Thereafter, the sample and crucible were placed inside the oven and dried at 105^o C for 4 hour, then cooled & weighed at the same temperature for 30 min until constant weights were obtained to get W₃.

The percent moisture content was calculated using the following equation:

$$\% \text{ moisture content} = \frac{W_1 - W_2}{W_1 - W_3} \times 100$$

Where,

W₁= Initial pineapple sample weight with crucible

W₂= Final pineapple sample weight with crucible

W₃= Initial weight of empty crucible

Determination of total ash

Total ash content of the sample was determined by incineration in a muffle furnace, as described by AOAC based on the vaporization of water and volatile with being organic substances in the presence of Oxygen in the air to CO₂ at a Temperature of 550^o C (Dry ash) . About 1.0 gm of finely ground dried sample was placed in a porcelain crucible and incinerated at 550^o C for 6 hour in a muffle in furnace. The ash was cooled in a desiccators and weighed. The percentage of ash content in the sample was calculated.

$$\text{Ash content (\%)} = \frac{\text{wt.of ash}}{\text{Total wt.of sample}} \times 100$$

Edible portion (%)

Initially the total weight of fruit without crown was weighed by using a balance. Then the fruit was peeled by using sharp knife and the central core was removed and the remaining fruit pulp was weighed. Finally the percentage of edible portion of the fruit was measured with the following equation (Ranganna 1994).

$$\text{Edible portion of fruit (\%)} = \frac{\text{wt of edible portion}}{\text{Total wt. of fruit}} \times 100$$

Shelf life

The shelf life was recorded by counting the days required to attain the last stage of ripening, but the fruit remaining still ready for marketing (Ranganna 1994).

Firmness Test

The firmness of pineapple fruit can be determined (outside and inside) by measuring penetration force using an Instron Universal testing machine.

Analyses of Chemical properties

pH measurement of pulp juice

The pH of pineapple juice samples was evaluated with the Sartorius Professional Meter PP-50. The measurement was a mean value of triplicates.

Determination of TSS

The Total soluble solids of pineapple juice samples were measured using digital refractometer Digit at 19-20^o C. Results were reported as degrees Brix.

Table 3. Effects of physical properties of different varieties of pineapple during day after storage.

Characteristics	Varieties of pineapple															
	Honey Queen				Giant Kew				Asshini				Ghorashal			
	D0	D4	D8	D12	D0	D4	D8	D12	D0	D4	D8	D12	D0	D4	D8	D12
Moisture content %	84.2	83.3	83.1	82.5	86.1	85.2	83.2	82.7	86.3	85.3	84.0	82.7	86.1	84.4	83.8	82.3
Ash content %	0.32	0.34	0.36	0.41	0.25	0.28	0.32	0.36	0.28	0.3	0.34	0.38	0.31	0.32	0.34	0.40
Edible portion %	60.5	62.3	63.2	63.8	62.6	63.9	64.8	65.8	64.5	65.5	66.40	66.8	58.14	60.13	60.90	61.16
Wt loss %	4.26	7.06	9.2	11.7	5.04	7.40	9.50	11.9	-	--	-	-	3.5	5.47	7.5	9.4

Table 3 shows the physical properties such as ash content (%) and the edible portion (%) of different varieties of pineapple are increased during increased storage time. But the moisture content of fruits are decreased during increased storage period.

Vitamin C estimation

Ascorbic acid content was determined to the method of Ranganna (1994) by using 2,6-Dichlorophenol-Indophenol Visual Titration Method. i) 3% metaphosphoric acid (HPO₃): It was prepared by dissolving 50 g HPO₃ in distilled water and volume make up to 1000 ml.ii) Ascorbic acid standard: Weigh accurately 100 mg of L-ascorbic acid and make up to 100 ml with 3% HPO₃. Dilute 10 ml to 100 ml with 3% HPO₃ (1 ml= 0.1 mg of ascorbic acid).iii) Dye Solution: 0.0525 gm of sodium bicarbonate dissolve in hot glass distilled water and add 0.0625 gm of 2,6 dichlorophenol- indophenols cool and make up 250 ml (Lane and Eynon 1923). The following steps were followed for estimation of ascorbic acid:

a) **Standardization of dye solution:** Five ml of standard ascorbic acid solution was taken in a conical flask and 5 ml of metaphosphoric acid (HPO₃) solution was added to it and shaken. A micro burette was filled with the dye solution and the mixed ascorbic acid solution was titrated with dye where appearance of pink color indicated the end point, which persisted at least 15 seconds. The milliliters of dye solution required to complete the titrations recorded.

Dye factor was calculated using of the following formula-

$$\text{Dye factor} = \frac{1}{\text{Titre}}$$

b) **Preparation of sample:** Ten grams of fresh pulp was homogenized with 50 ml of 3% metaphosphoric acid solution in a blender machine. After blending it was filtered and transferred to a 5000 ml volumetric flask and was made up to the mark with 3% metaphosphoric acid.

c) **Titration:** Ten ml of pulp extracted sample was taken in an aliquot and titrated with dye solution (2, 6-dichlorophenol-Indophenol) till pink color was appeared which persisted at least 15 seconds. The titration was replicated thrice for each time.

The ascorbic acid content of the sample was calculated by using the following formula-

$$\text{Vitamin C content (mg/100g)} = \frac{T \times D \times V_1}{V_2 \times W} \times 100$$

Where,

T = Titer

D = Dye factor

V₁ = Volume made up

V₂ = Volume of extract taken for estimation

W = Weight of sample taken for estimation

Titration acidity

The titratable acidity, expressed in % of citric acid was determined by the titrimetric method (Ranganna 1994). The following reagents were used for the determination of titratable acidity.

Reagent preparation:

Dissolve 0.40 gm of NaOH in water, and volume make up 100 ml. Dissolve 1.00 gm of phenolphthalein indicator in ethanol and volume make up 100 ml.

Extraction of pineapple juice

10g of fruit pulp was taken in 100 ml beaker and homogenized with distilled water in blender. The blended materials were then filtered and transferred to a 250 ml volumetric flask and the volume was made up to the mark with distilled water.

Procedure

10 ml of pulp solution was taken in a 100 ml conical flask. Two or three drops of phenolphthalein indicator were added and then the conical flask was shaken vigorously. It was then filtrated immediately with 0.1N NaOH solution from a burette till a permanent pink color was appeared. The titration was done for three times. The percentage of titrable acidity in fruit pulp was calculated by using following formula-

$$\text{Titrable acidity (\%)} = \frac{T \times N \times V_1 \times E}{V_2 \times W \times 1000} \times 100$$

Where,

T = Titre

N = Normality of NaOH

V1 = Volume made up

E = Equivalent weight of acid

V2 = Volume of extract taken for estimation

W = Weight of sample taken for estimation

Determination of total sugars**Reagents preparation**

Fehling's solution (A) Dissolve 69.28 gm of copper sulphat ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) in water, make up volume 1000ml. Fehling's solution (B) Dissolve 346 gm of Potassium Sodium Tartrate and 100 gm of NaOH in water, make up volume 1000ml.

Methylene blue indicator

Dissolve 1 gm of Methylene blue in 100 ml of water. 10% lead acetate solution: Dissolve 10 gm of lead acetate in water and volume make up 100 ml.

10% Potassium Oxalate solution: Dissolve 10 gm of Potassium Oxalate in water and volume make up 100 ml.

Standard invert sugar solution: Weight accurately 0.25 gm of glucose in water and volume make up 100 ml.

1N NaOH solution: Take 40 gm of NaOH in water volume make up 1000 ml. The Standardization of Fehling's solution could be calculated according to following procedure (Ranganna, 1994).

a) Standardization of Fehling's solution: Fifty ml of both Fehling's solution A and Fehling's solution B were mixed together in a beaker. Ten millimeter of the mixed solution was pipette into a 250 ml conical flask and 25 ml distilled water was added to it standard sugar solution was taken in a burette. The conical flask containing mixed solution was heated on a hot plate. When the solution began to boil, three drops of ethylene blue indicator solution was added to it without removing the flask from the hot plate. Mixed solution was titrated by standard sugar solution.

The end point was indicated by depolarization of the indicator. Fehling's Factor was calculated by using the following formula-

$$\text{Factor for Fehling solution} = \frac{\text{Titre} \times 2.5}{1000}$$

b) Preparation of sample: Twenty gram of fresh pineapple fruit pulp was taken in a 100 ml beaker an then it was transferred to a blender machine and homogenized with distilled water. After blending it was made up to the mark with distilled water. The pulp solution was filtered. One hundred milliliter of filtrate was taken in a 250ml volumetric flask. Five milliliter of 45% neutral lead acetate solution was added to it and then shaken and waited for 10 minute. Five milliliter of 22% potassium oxalate solution was further added to the flask and the volume was made up to the mark with distilled and filtered.

Reducing sugar content (%)

10 mL of mixed Fehling's solution was taken in a 250 ml conical flask and 50 mL distilled water was added to it. Filtrated pulp solution was taken in a burette. Conical flask containing the mixed Fehling's solution was heated on a hot plate. Three to five drops of methylene blue indicator were added to the flask when

boiling started, and titrate with solution taken in the burette. The end point was indicated by decolourization of indicator. Percentage of reducing sugar was calculated according to the following equation:

$$\text{Reducing sugar content (\%)} = \frac{F \times D}{T \times W} \times 100$$

Where,

F= Fehling's factor, D = Dilution, T = Titre and W = Weight or volume of the sample

Titration of total invert sugar

Fifty milliliter purified solution (filtrate) was taken in a 250 ml conical flask. Five gram citric acid and 50 ml distilled water were added to it. The conical flask containing sugar solution was boiled for inversion of sucrose and finally cooled. Then the solution was transferred to a 250 ml volumetric flask and neutralized by 1N NaOH using phenolphthalein indicator. The volume was made up to the mark with distilled water. Then the mixed Fehling's solution was titrated using similar procedure followed as in case of invert sugar (reducing sugar) mentioned earlier. The percentage of total invert sugar was calculated by using the formula used in case of reducing sugar.

Non-reducing sugar

Non-reducing sugar was estimated by subtracting reducing sugar from total invert sugar as following:
% non-reducing sugar = % total invert sugar - % reducing sugar.

Estimation of total sugar

Total sugar was estimated by adding the reducing sugar and non-reducing sugar as following:
% total sugar = % reducing sugar + % non-reducing sugar

Determination of the sweetness index

The sweetness index can be calculated according to the (Ranganna, 1994) formula

$$SI = \frac{\text{Total soluble solid}}{\text{Acidity}}$$

RESULTS AND DISCUSSIONS

Physical characteristics of different varieties of pineapple

Results on physical changes of pineapple as obtained at 4 days interval from initial stage to 12 DAS for the present experiment were presented and discussed below:

General Physical Parameters

Weight loss

Table 2. Effects of weight loss during days after storage

Characteristics	Physical parameters at different varieties of pineapple at DAS															
	Honey queen				Giant Kew				Asshini				Ghorashal			
	D ₀	D ₄	D ₈	D ₁₂	D ₀	D ₄	D ₈	D ₁₂	D ₀	D ₄	D ₈	D ₁₂	D ₀	D ₄	D ₈	D ₁₂
Fruit weight with crown (g)	820	710	625	520	1.85	1780	1685	1500	2000	1980	1685	1600	790	631	525	425
Diameter (cm)	35	34	34	33	35	34	32	29	36	33	32	29	33.3	32	30	28.9
Length (cm)	11	9	8.6	8.2	13.5	13	14	12	15	14	14	12	10	8.6	8.16	8.9

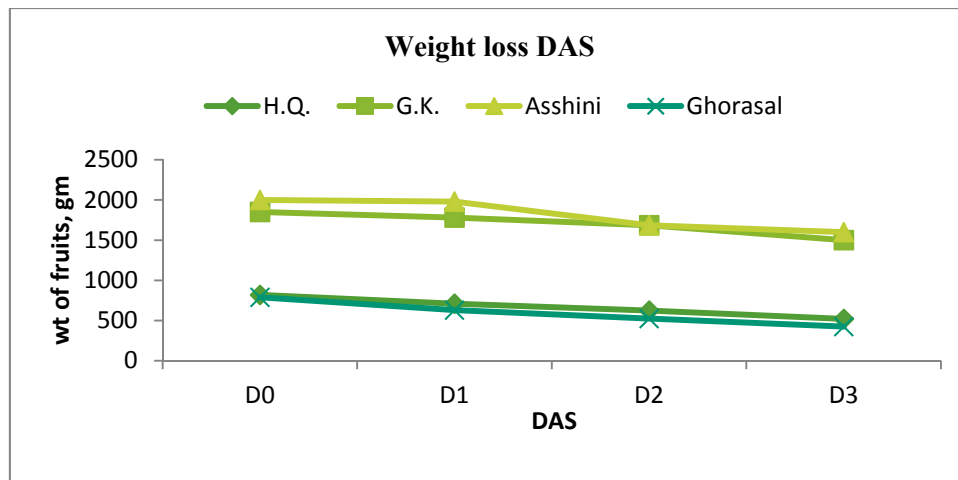


Figure 1. Effects of different varieties of pineapple on weight loss at different DAS

The Figure 1 showed that the weight loss was slightly decreased during the storage period of different varieties. It was observed that the higher wt. of Asshini and G.K., so the wt. losses trends above the other H.Q. and Ghorasal variety. It was observed that there was a slightly decreased between D0 to D1 but rapidly decreased between D1 to D2. The other parameters length and diameters are almost same condition.

Moisture content

It was observed that fig.2. the moisture content decreased with the increase during storage period. Moisture content of pineapple pulp decreases from 82.5 to 84.2% for H.Q., 82.7% to 86.1% for G.K., 82.7 to 86.3% for Asshini and 82.30 to 86.19 % for Ghorasal during the storage period of 0 to 12 DAS. The highest decrease in moisture content was found 3.7% in Asshini variety and lowest decrease in moisture content was found 1.4% in H.Q. variety. These values are approximately similar to those values as found by Hasan (1980) who found 87.30% and 84.50% in H.Q. and G.K., respectively.

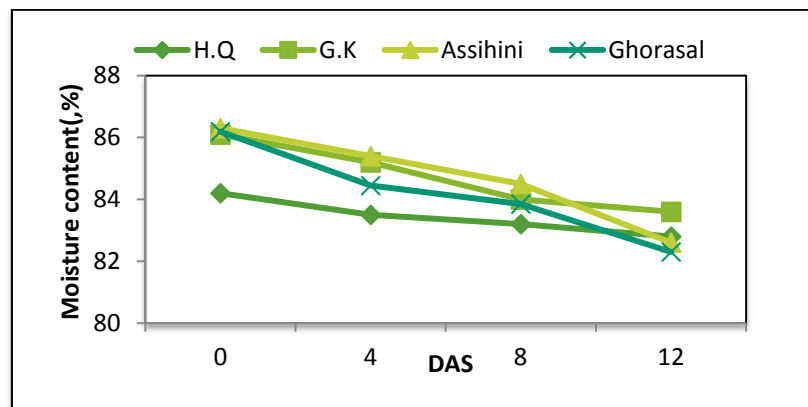


Figure 2. Moisture content (%) of pineapple juice of different varieties at different DAS.

Ash content (%)

It was observed that the ash slightly increased with the increase in storage time. Ash in the pulp of varieties of pineapple were found to be in the range of 0.32 to 0.41% (Honey queen), 0.25 to 0.36% (Giant Kew), 0.28 to 0.38% (Asshini) and 0.31 to 0.40% (Ghorasal) during the storage of 12 days. These values are very similar to those values as found by Das and Medhi (1996) who got found ash content of 0.23% to 0.50% fresh weight (fw) pineapples which is very similar to experiment variety.

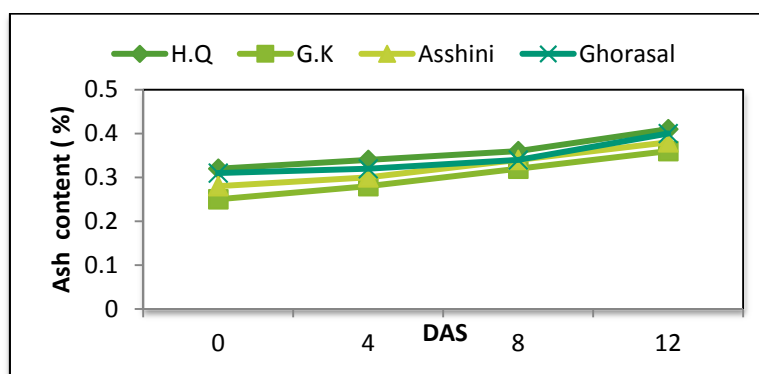


Figure 3. Ash content (%) of different varieties of pineapple at different DAS

Edible portion

The edible portion of fruits was significantly affected with days after storage (Fig.4). The edible portion of H.Q, G.K., Asshini and Ghorashal varieties were 60.5 to 63.86%, 62.60 to 65.80%, 64.56 to 66.80% and 58.14 to 61.16% increased respectively during the storage period of 0 to 12 days. It was observed that at the 12th day of storage, the highest (66.8%) values of Asshini were recorded. The trend of increasing edible portion was similar with the varieties when Asshini was top and Ghorashal was smaller producing the edible portion. Ahmed and Rahman (1974) studied that the edible portion of pineapple fruits contained 67.70% of their whole weight.

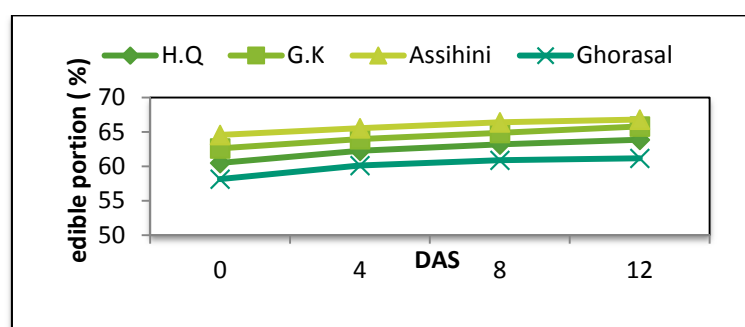


Figure 4. Effects of different varieties of pineapple of edible portion (%) at different DAS

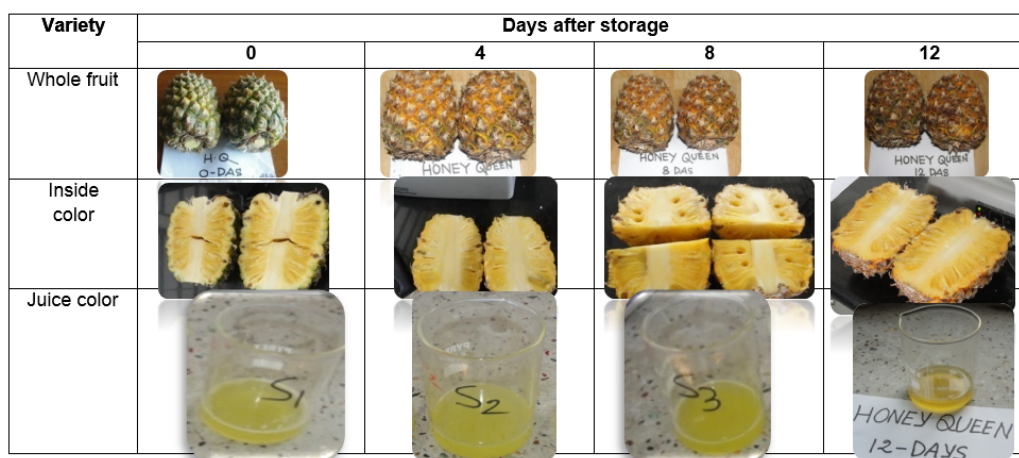
Shelf life

Shelf life of pineapple fruits was calculated by counting the number of days required to ripen fully with retained optimum marketing and eating qualities. It was shown that the effective shelf life of pineapple which acceptable till 8 DAS as eating but at 12 DAS were not quality for consumption. It also showed that the peel and crown of the pineapples were accepts but their core, inter pulp are likes slightly acceptable but the juice color are not quality acceptable at 12 DAS.

Color

It has been shown that the peel color of pineapple was changed from green color to bright yellow which increased as the duration of storage progressed. The change in color during storage might be increase in carotene pigments of the pulp caused by enzymatic oxidation and photo degradation due to series of physical and chemical changes like the breakdown of chlorophyll and increase pigments of the pulp caused by enzymatic oxidation.

Color



Effects of chemical properties of fruits during storage period

pH

It was observed that pH values show increase in trends with time. The pH values changes in the range of 4.31 to 4.38, 4.28 to 4.33, 4.21 to 4.32 and 4.29 to 4.36 for the varieties of H.Q, J.K, Asshini and Ghorashal, respectively.

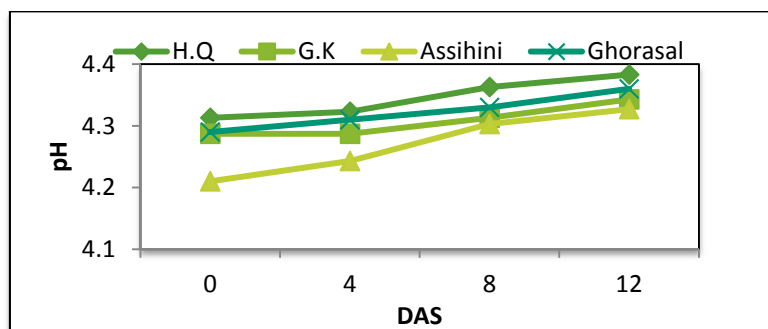


Figure 5. pH of different pineapple varieties at different DAS

TSS

Figure 6 showed that the TSS of pineapple fruits was increased with the increased 0, 4, 8 and 12 days after storage. Among for variety H.Q. exhibits highest amount of TSS (14.26 to 15.96%) following by Asshini (12.73 to 13.56%), G.K. (11.40 to 13.26%) and Ghorashal (11.55 to 14.36%). TSS is one of the most important quality factors for most of the fruits and for pineapple; a TSS of 13.8 to 17.0% indicates the highest quality of fruits to attain the optimum harvesting stage (Morton, 1987). As a result, the increasing trend of percent total soluble solids contents of fruit during storage could be attributed mainly to the breakdown of starch into simple sugars during ripening along with a proportional increase in TSS and further hydrolysis decreased the TSS during storage.

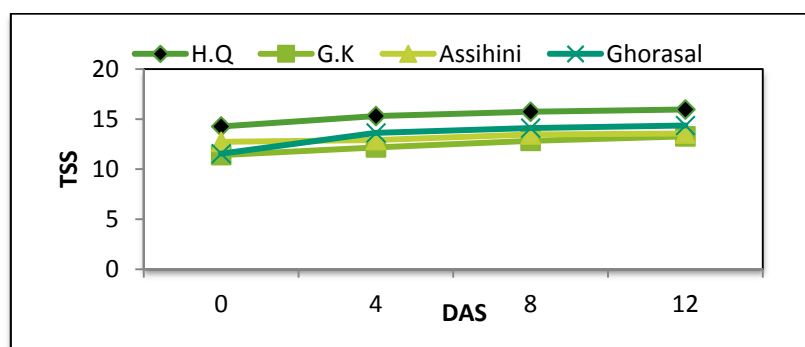


Figure 6. TSS content of different varieties of pineapple at different DAS

Titrate acidity

The Figure 7 showed that the titratable acidity is slightly decreased with increased the storage life. The values of titratable acidity for varieties are: Honey Queen: 0.49 to 0.41 % with a mean value of 0.46 % which was the maximum, Asshini: 0.68 to 0.62%, Giant Kew: 0.62 to 0.54% and Ghorashal : 0.56 to 0.46 % .Singleton (1958) suggested that acid content increase during maturation in warm condition and also said that decreased in the titratable acidity of pineapple in acidity during the ripening of pineapple was due to the loss in the dominant citric acid.

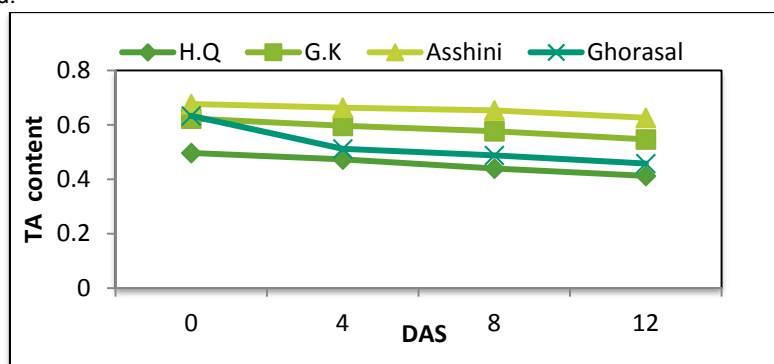


Figure 7. TA content (%) of different varieties of pineapple at different DAS

Sweetness index

Figure 8 shown that the sweetness index increased with increase the storage time. The acidity was the highest in the fruits Asshini refers to Giant Kew while the soluble solids were the highest in the H.Q. variety. These results showed that the fruits H.Q. are sweeter than other varieties.

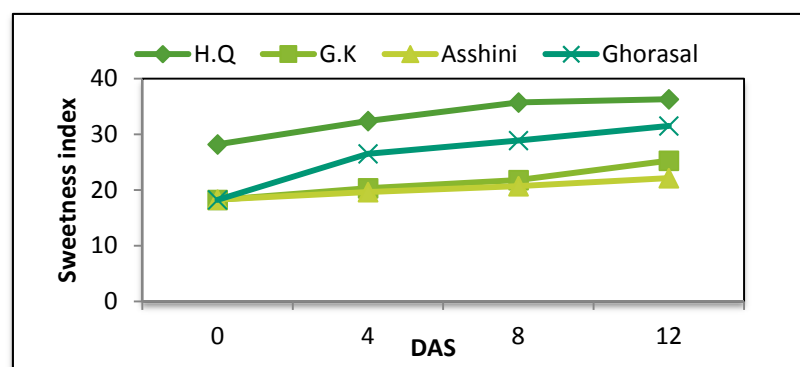


Figure 8. Sweetness index of different varieties of pineapple at different DAS

Vitamin C content

It was observed that among the storage period (0, 4, 8 and 12 DAS), the ascorbic acid content in Honey Queen (14.2 to 8.73), Giant Kew (15.8 to 11.6), Asshini (15.5 to 10.9) and Ghorashal (14.70 to 9.89) were similar for the variety. Vitamin C content in the variety Giant Kew and Asshini are higher than that of Honey Queen and Ghorashal variety, indicating that Giant Kew and Asshini are slightly more acidic than Honey Queen and Ghorashal. Rashid (1987) reported that pineapple contains 10-25 mg/100 gm of vitamin C.

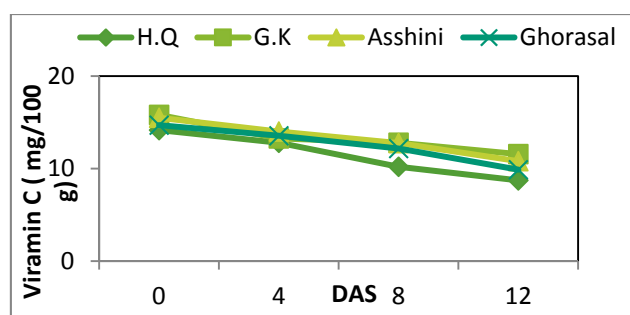


Figure 9. Vitamin C content of the different varieties of pineapple at different DAS

Total sugar content

It was shown that the total sugar gradually increased with increased during storage day (Fig. 10). Of the four varieties the Honey Queen (11.71 to 14.7 mg/100 gm) contains higher amount of total sugar than the Giant Kew (10.2 to 12.0 mg/100 gm), Asshini (9.9 to 11.5 mg/100 gm) and Ghorashal (11.55 to 13.20 mg/100 gm) during storage periods. Amankwa (1995), Upadhyay and Tripathi (1985) observed that total sugar in the pineapple juice increased gradually with time which was similar trend as found in the present study.

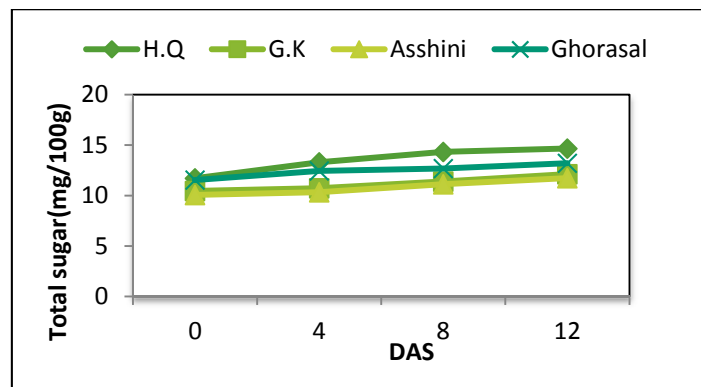


Figure 10. Total sugar content of different varieties of pineapple at different DAS

Sensory evaluation

Table 5. Comparison of different varieties of pineapple under sensory evaluation

Characteristics (observed at 12 DAS)	Different varieties of pineapple			
	Honey Queen	Giant Kew	Asshini	Ghorashal
Appearance	fairly good	slightly bad	acceptable	fairly good
Firmness	very firm	fairly firm	slightly firm	firm
Sweetness	very strong	fair	fair	strong
Tartness	strong	fair	fair	strong
Overall acceptability	likes slightly	accepts	accepts	likes slightly

Table 4. Effects of chemical properties of different varieties of pineapple during day after storage.

Characteristics	Varieties of pineapple															
	Honey Queen				Giant Kew				Asshini				Ghorashal			
	D0	D4	D8	D12	D0	D4	D8	D12	D0	D4	D8	D12	D0	D4	D8	D12
pH	4.31	4.32	4.36	4.38	4.28	4.28	4.31	4.34	4.21	4.24	4.30	4.32	4.29	4.31	4.33	4.36
TSS	14.2	15.3	15.7	15.9	11.4	12.1	12.8	13.2	12.7	12.9	13.46	13.56	11.5	13.63	14.10	14.36
TA	0.49	0.47	0.44	0.41	0.62	0.59	0.57	0.54	0.67	0.66	0.653	0.626	0.56	0.512	0.488	0.458
SI	28.2	32.3	35.7	36.3	18.2	20.3	21.7	25.2	18.2	19.6	20.72	22.15	20.2	26.50	28.89	31.50
TS	11.7	13.3	14.3	14.6	10.4	10.7	11.4	12.1	10.1	10.3	11.13	11.73	11.5	12.44	12.68	13.20
RS	8.26	9.73	10.2	10.7	6.76	7.70	8.83	9.16	6.23	7.50	8.467	8.867	7.40	9.234	9.850	10.20
VC	14.2	12.8	10.2	8.73	15.8	13.3	12.8	11.5	15.5	14.0	12.76	10.80	14.7	13.56	12.17	9.89

Table 4 shows the chemical values of different varieties of pineapple fruits are changed during different storage time. The chemical properties such as pH, TSS, SI, TS, RS of H.Q., G.K., Asshini and Ghorashal varieties are increased during increased from starting day to 12 DAS which are almost similar to the level for pineapple fruit. The TA and VC of different varieties of pineapple shows that the chemical values decreased during storage time.

The color, firmness, sweetness, appearance, sweetness and tartness, overall acceptability were recorded by sensory evaluation. Sensory analysis was carried out by a panel of six non- trained assessors, recruited among students, Professors and employees of BSMRAU, Gazipur. Assessors evaluated the pineapple fruit quality using sorting preference tests and hedonic scale. Each assessor evaluated three sample of each cultivar, previously randomized to avoid position bias and presented in recipients with lids, coded with random three symbols. The sensory evaluation test was done to determine the quality and acceptance of the pineapple fruits derived from four varieties of pineapple. The results from the taste panel are shown in Table 5. The average score by the taste panelists showed an acceptability of the fruits appearance.

Table 6. Effects of shelf life of pineapple during storage

Date	Whole fruit, kg	Firmness, N/m ²		Edible portion, kg	% edible portion
		Outside	Inside		
0 DAS	0.915	0.270	0.077	0.560	61.2
4 DAS	0.795	0.210	0.075	0.495	62.3
8 DAS	0.830	0.227	0.075	0.538	64.8
12 DAS	0.860	0.220	0.095	0.547	63.7

Firmness of tissue makes sure the quality of fruits at storage condition. The fruits lost its firmness with increase in storage period. From Table 6, it was shown that the firmness of outside and inside of pineapple ranges are 0.210 to 0.270 N/m² and 0.075 to 0.095 N/m² respectively. It was observed that the firmness of pineapple are slightly changed because when their moisture percentages are decreased during storage and then unchanged their inside and outside firmness.

CONCLUSION

The present research was conducted on physico-chemical characteristics changes, shelf life and quality of pineapple through various experimental analyses of pineapple varieties during the different storage period. The data were recorded on color change, firmness, moisture content, TSS, reducing sugar, non-reducing sugar, total sugar, titratable acidity, TSS, ascorbic acid, pH, edible portion and shelf life. From the physical analysis peel color of pineapple was matured green at the preliminary time of experiment. Peel color and firmness changes were significantly influenced during storage. Moisture content of pineapple fruits was significantly affected during storage. From the analysis it is found that the moisture content, titratable acidity, Vitamin C were decreased during storage and the properties such as ash (%), edible portion (%), pH, TSS, sweetness index, total sugar and reducing sugar were increased during storage.

The firmness of pineapple fruit was measured both in outside and inside to be 0.21 to 0.27N/m² and 0.075 to 0.095 N/m², respectively. It might be concluded that storage of harvested pineapple could be extended up to twelve days after harvesting for its improved quality except vitamin C which was higher during consumption right after harvest.

RECOMMENDATIONS

- Different processed product should be prepared from different varieties of pineapples and their comparison study should be carried out.
- Imparting short training for the farmers to acquaint with varieties of pineapple, modern technology of cultivation of pineapple and storage facilities.

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