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Studies on Change in Physico-Chemical Parameters of Pineapple Fruits of Cultivars Kew and MD-2 during Storage at Ambient Temperature

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A B S T R A C T

Storage studies of matured green pineapple fruits of cultivar Kew and MD-2 were carried out at ambient condition. The physiological weight loss (PLW) was highest (9.62±0.65%) in MD-2 cultivar whereas the PLW was lowest (9.16±0.31%) in Kew cultivar on 9th day after storage (DAS). The firmness of fruit was highest (2.86±0.56 kgcm^{-2}) in MD-2 and TSS was highest in Kew (18.18±0.32 °B) on 9th DAS and there was significant difference during storage. Titrable acidity was lowest (0.08±0.01%) in MD-2 and Vitamin C was lowest (8.66±0.66%) in Kew on 9th DAS. The reducing (6.60±0.82%) was highest whereas the non-reducing (1.58±0.58) was lowest in Kew on 9th DAS. The overall acceptability (OAA) score was highest (8.03±0.11) in MD-2 on 6th DAS.

Introduction

Pineapple (*Ananas comosus* L.) is a tropical plant of family Bromeliaceae and it is widely cultivated in India. The major growing states are west Bengal, Assam, Kerala, Karnataka, Tripura, Meghalaya and Nagaland. The area under pineapple cultivation in India is about 121.09 thousand ha and it produces around 2038.44 thousand MT pineapple in the year 2016-17 (Horticultural statistics at a glance 2017). The post-harvest loss of fruits varies from farmer field to consumer level is nearly 21 % and sometimes it goes upto 40-50% (Kabir *et al.*, 2010). Fresh pineapple fruit is consumed as desserts and salad. It can be processed into juice, canned flesh, fruit cocktail, crushed pineapple, fruit punch, frozen pineapple, yoghurt, pineapple powder, freeze-dried pineapple, wines, sauces, jams, marmalades and confectionery product. Pineapple fruits are considered as good source of carbohydrates, dietary fiber and minerals such as calcium, iron, phosphorus, sodium and potassium (Hossain and Bepary, 2015). Pineapple fruit also contains some vitamins including A, thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, folate and ascorbic acid (Ancos *et al.*, 2017). The fruit is also rich in bromelin and it has pharmacological as well as meat tenderizing properties (Lobo and Siddiq, 2017; Rekha *et al.*, 2013). The important cultivar grown in India is Cayenne, Mauritius, Vazhakulam

pineapple, Amritha, Kew, Giant Kew Queen and MD-2 (http://prsvkm.kau.in/book/variety). The quality of pineapple fruit changes rapidly during storage and hence it influences the acceptability of the consumer (Shamsudin *et al.,* 2007; Jha *et al.,* 2012). Pineapple is a non- climacteric fruit (Ding and Syazwani, 2016) and fruit does not continue to ripen or sweeten significantly after harvest. Therefore, fruit must be harvested until it reaches to the matured green stage. Pineapple fruit is perishable in nature and postharvest loss of the fruit varies from 5 to 20% (http://www.nistads.res.in/indiasnt2008/t6rural /t6rur14.htm). Postharvest loss is depend on the fruit production area, mode of transportation, road condition and market distance. The variation in postharvest storage life and quality of pineapple fruit during storage in the different cultivar have been reported by Ali *et al.,* (2015a). Therefore, the study was carried out to access the change in physico-chemical attributes and quality parameters during storage at ambient temperature in the ambient condition.

Materials and Methods

Pineapple fruit were harvested from the farm of Central institute of Horticulture, Medziphema and brought to the Laboratory for physico-chemical and organoleptic studies during storage at ambient temperature (33±5 °C) and R.H (85±6 %). A total 12 number of mature green pineapple fruits of each variety were used in the experiments. The experiments were performed in a completely randomized design with 3 replication and physico-chemical properties were analyzed at 3 days interval during storage.

Physiological weight loss percentage (PLW)

Physiological weight losses were determined as described by Dhar *et al.,* 2008, using the following formula;

$$PLW\ (\%) = \frac{\text{Initial fruit weight (g)} - \text{Final fruit weight (g)}}{\text{Initial fruit weight (g)}} \times 100$$

Fruit Firmness ($kgcm^{-2}$)

Fruits firmness of peeled tissue was measured with penetrometer (FT 327, Made in Italy) fitted with a probe of 15 mm diameter.

Chemical analysis

The total soluble solids were measured with the help of Digital refractometer (ATAGO PAL-3, Made in Japan).

Total titrable acidity was determined by titrating a known weight of juice with 0.1N NaOH solution using phenolphthalein as an indicator.

The results were expressed as percent anhydrous citric acid (w/w) (Ranganna, 1994).

Vitamin C was analyzed as described by AOAC method. Reducing and non-reducing sugars are measured by using Lane and Eynon Method (Ranganna, 1994).

Sensory analysis

Sensory evaluation was done based on 9-point hedonic scale and score were recorded based on these parameters (Liked extremely=9, Liked very much=8, Liked moderately=7, Liked slightly=6, neither liked nor disliked=5, Disliked slightly=4, Disliked moderately=3, Disliked very much=2, Disliked extremely=1). A piece of peeled and cored pineapple fruits was subjected to sensory evaluation by 10 semi-trained panelists from the institute.

Statistical analysis

The collected data from the experiment were statistically analyzed as one way ANOVA by using Graph pad Prism 7.0 trial version.

Results and Discussion

PLW Percentage

The physiological weight loss (PLW) plays major role to determine the post-harvest life and quality of the pineapple fruit. PLW was studies in the two cultivar of pineapple viz., kew and MD-2 and results were expressed in the Figure 1.

From Figure, it indicates that PLW was high in case of MD-2 cultivar whereas in Kew cultivar the PLW was low. The PLW percentage varies from 0 to 9.16±0.31% in Kew variety and in the MD-2, it varies from 0 to 0 9.62±0.65% during storage period from 0 to 9 days and there were significant difference ($p \leq 0.05$) in the PLW in both the variety. From the graph of Figure 1 shows that PLW varies with storage time and it increases with increase in number of storage day and it is also reported by Al- Obeed and Harhash (2006).

The loss in moisture and subsequent reduction PLW depends on the water content present in the fruit. Hence, the PLW is more in MD-2 cultivar than Kew may be due to presence of higher amount of water content than Kew cultivar.

Fruit firmness

Fruit firmness is important parameter which helps to determine the shelf life and quality of the fruit. The firmness of pineapple fruit was highest (in Kew, 5.8±0.23 kg cm^{-2}; in MD-2, 5.8±0.75 $kgcm^{-2}$) when harvested at mature green stage where as the firmness was found to be lowest on the 9^{th} days after harvest and it was 2.36±0.20 $kgcm^{-2}$ in Kew and 2.86±0.56 $kgcm^{-2}$ in MD-2 cultivar and there was significant difference ($p \leq 0.05$) in the firmness fruit during storage. From the experiment, it was observed that in both the varieties of pineapple the firmness decreases with increase in the storage period and it is given in Figure 2. It was also observed that the firmness of pineapple fruit of MD-2 variety was better than Kew during storage. As firmness of the fruit decreases the post-harvest storage life of pineapple fruit also decreases and it may be due to deteriorative changes associated with the senescence (Cordenunsi *et al.,* 2003). The decomposition of cell wall structure such primary cell wall and middle lamella causes the reduction in mechanical strength as result the firmness of the fruit decreases.

Total soluble solids

Total soluble solids (TSS) indicate the maturity stage and quality of the fruit. The TSS of pineapple in cultivar Kew was 14.36±1.18 °B and in MD-2 was 12.30±0.29 °B, when harvested at matured green stage. In case of Kew variety the TSS changes from 14.36±1.18 °B to 18.18±0.32 °B, whereas in case of MD-2 variety the TSS changes from 12.30±0.29 °B to 15.60±0.31 °B during storage.

From the observation it was found that in both the cases there was significant difference ($p \leq 0.05$) in the TSS during storage of fruits. Figure 3 shows the variation in TSS during storage of pineapple fruits and it also indicates that TSS is increases with increase in the storage time and similar results were also reported by Kamol *et al.,* (2014) and Ali *et al.,* (2015a). The increase in TSS may be due to conversion of starch into the sugar. Soluble solid percentage is a function of dissolved solid and water content present in the fruit (Farooq *et al.,* 2012).

Thus, increase in TSS might also be due to presence of low moisture content in the fruit or concentration of dissolved solid due to loss of moisture content during storage.

Fig.1 Change in PLW (%) during storage of pineapple cultivar Kew and MD-2

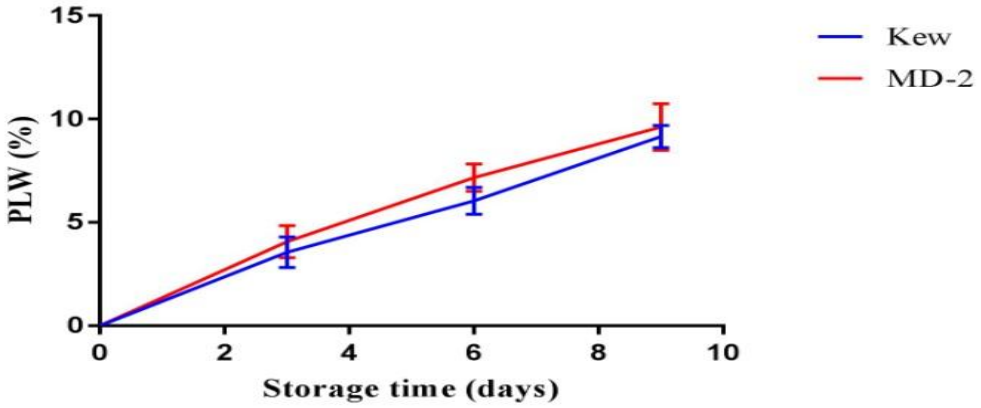


Fig.2 Change in texture ($kgcm^{-2}$) during storage of pineapple cultivar Kew and MD-2

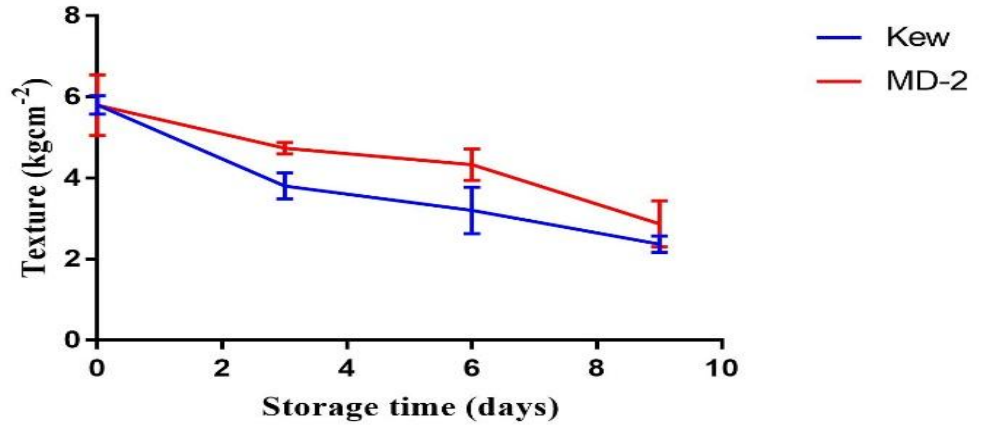


Fig.3 Change in TSS °B during storage of pineapple cultivar Kew and MD-2

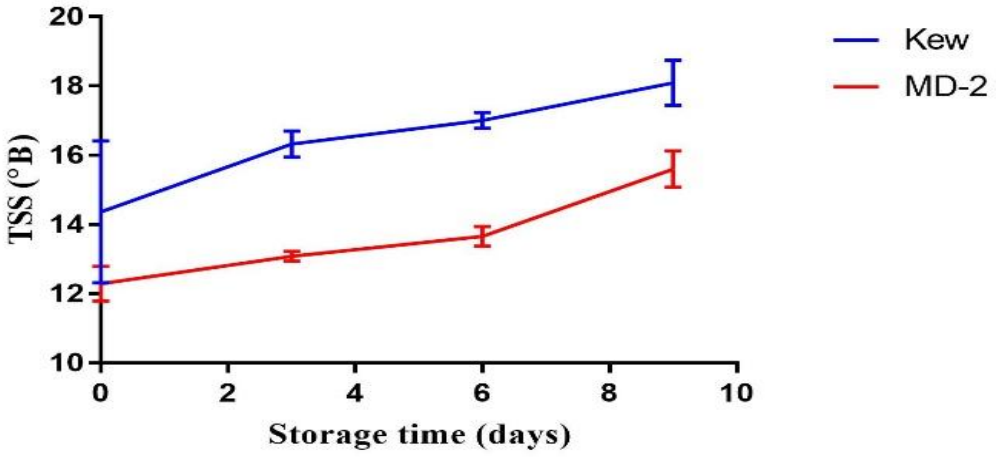


Fig.4 Change in acidity (%) during storage of pineapple cultivar Kew and MD-2

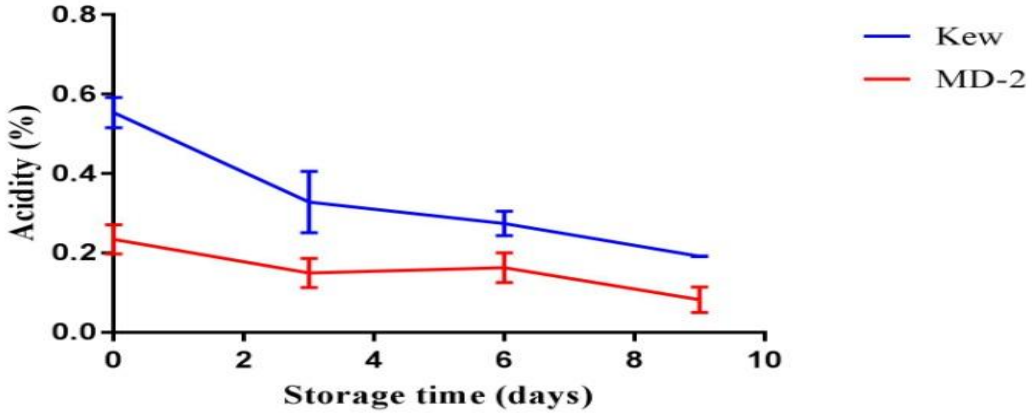


Fig.5 Change in Vitamin C during storage of pineapple cultivar Kew and MD-2

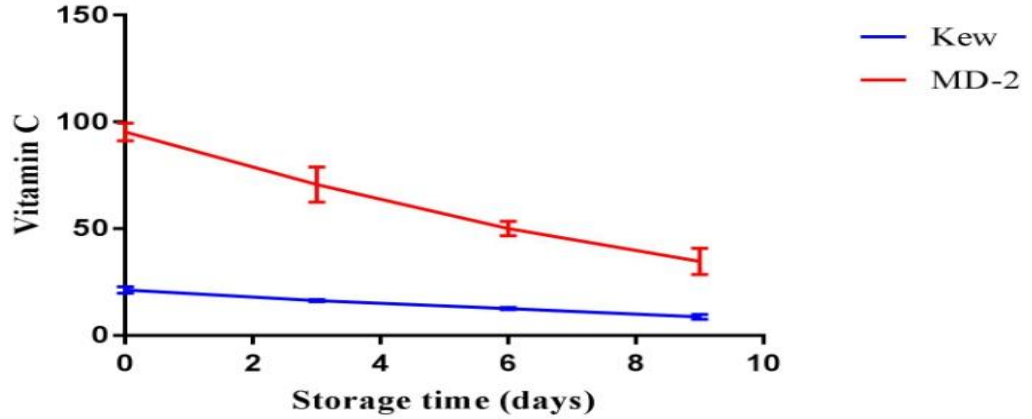


Fig.6 Change in reducing sugar during storage of pineapple cultivar Kew and MD-2

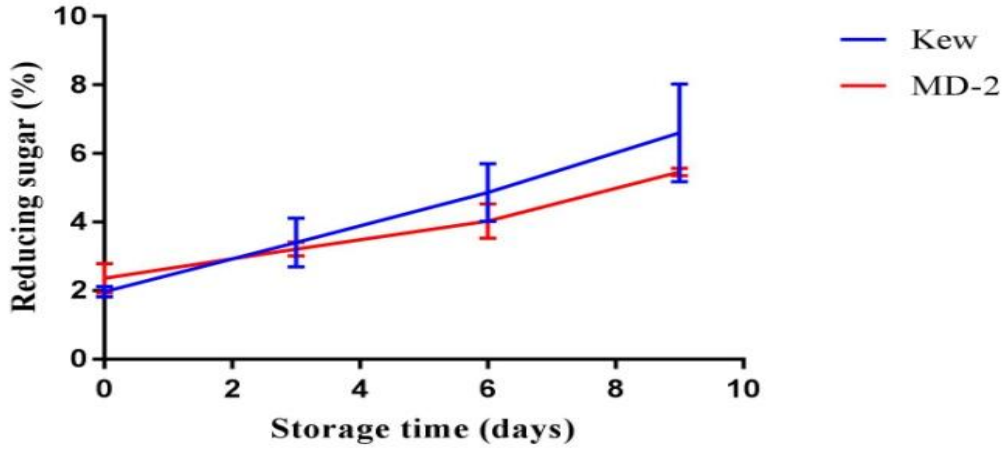


Fig.7 Change in non-reducing sugar during storage of pineapple cultivar Kew and MD-2

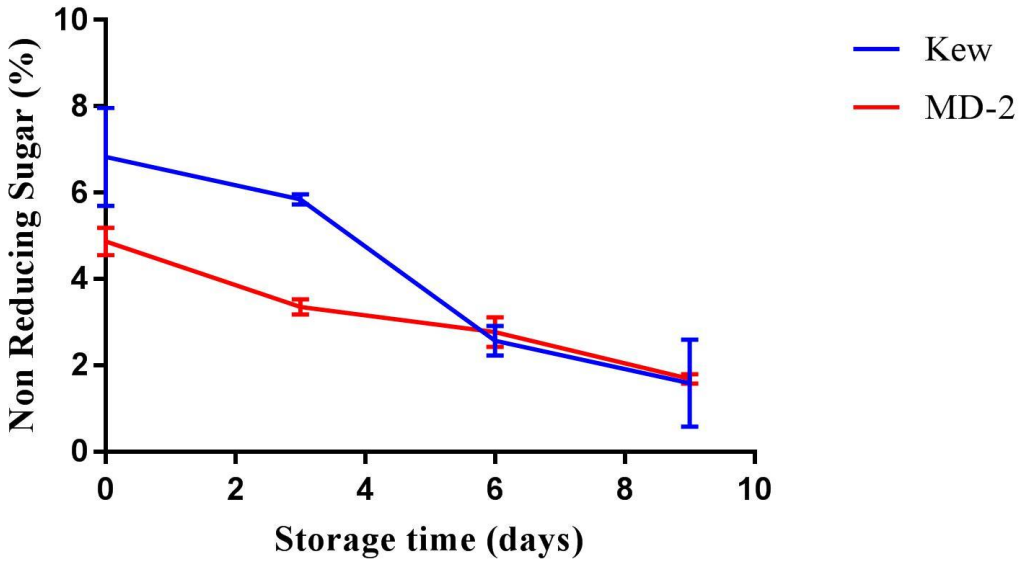
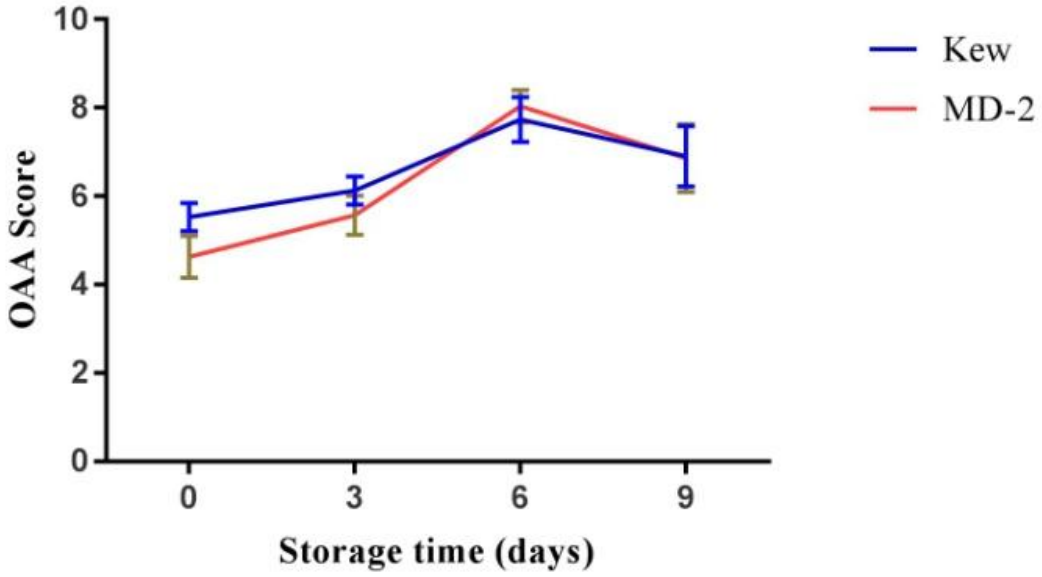


Fig.8 Change in overall acceptability (OAA) score during storage of pineapple cultivar Kew and MD-2



Titrable acidity

From the experiment it was found that the acidity percentage in Kew variety was 0.55±0.02, 0.32±0.04, 0.27±0.18 and 0.19; whereas in MD-2 variety was 0.23±0.02, 0.15±0.02, 0.16±0.02 and 0.08±0.01 during storage on 0 day, 3rd days, 6th days and 9th days respectively. The Figure 4 shows that acidity percentage decreases with increase in

the storage time and similar finding was reported by Ali *et al.,* (2015b), during storage of pineapple fruit.

Vitamin C

Vitamin C is act as an antioxidant and may play the important role to improve the storage life of fruits. The vitamin C content were 21.33±0.88, 16.33±0.33, 12.50±0.28 and 8.66±0.66 present in Kew and 95.33±2.40, 70.66±4.80, 50.00±2.00 and 34.66±3.53 in MD-2 variety during storage on 0 day, 3rd days, 6th days and 9th days respectively. From the Figure 5 it is observed that the vitamin C content in both the cultivar of pineapple fruit is decreases with increase in the storage time and similar finding was also reported by Kabir *et al.,* (2010), Hong *et al.,* (2013) and Ali *et al.,* (2015b).

In case of MD-2 variety it is observed that vitamin C decreases sharply with the increase in the storage period whereas in case of Kew variety the Vitamin C decreases gradually with storage time.

Reducing sugar

In Kew variety reducing sugar percentage changes from 1.96±0.08 to 6.60±0.82 and in MD-2 variety it changes from 2.36±0.24 to 5.46±0.06 during storage period and in both the cultivar, reducing sugar changes significantly ($p \leq 0.05$). Figure 6 shows that reducing sugar of the fruit increases with increase in the storage period in both the cultivar and similar finding was reported by Farooq *et al.,* (2012).

It has been also observed that in Kew there was slightly more increase in the reducing sugar than MD-2. During storage of pineapple fruit the conversion of starch into sugar was continued as result, there was increase in the reducing sugar.

Non-reducing sugar

Figure 7 shows that non-reducing sugar significantly differ at ($p \leq 0.05$) during storage in both the cultivar. The non-reducing sugar percentage were 6.83±0.65, 5.84±0.06, 2.57±0.19 and 1.58±0.58 recorded in Kew variety whereas in MD-2 the reducing sugar were 4.87±0.18, 3.35±0.10, 2.76±0.20 and 1.68±0.06 recorded during storage on 0 day, 3rd days, 6th days and 9th days respectively. Non-reducing sugar decreases with increase in the storage duration as given in Figure 7 and it is supported by the finding of Dhar *et al.,* (2008).

Overall acceptability

The statistical analysis for overall acceptability showed that there is significance difference at ($p \leq 0.05$). The highest score was observed in MD-2 (8.033±0.11) and in Kew (7.73 ±0.16) on 6th days after storage. Over all acceptability of pineapple fruit harvested at mature green stage are increases with increase in the storage time at a certain period and again it decreases as storage time prolonged. The pineapple stored at ambient temperature continued to respire and hence it reduced the quality of fruit (Fig. 8).

Loss in moisture content, firmness and biochemical changes affects the texture, flavor and visual quality of fruit as the storage period increases.

Post-harvest weight loss of pineapple fruits increases with increase in the storage period. Firmness of fruit, Titrable acidity and vitamin C were decreases with increase in storage period. Total soluble solid, reducing, non-reducing sugar of the fruit increases with increase in the storage duration. Highest overall acceptability (OAA) score of pineapple fruit was recorded on 6th day after storage.

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