Ann. Bangladesh Agric. (2012) 16 (2): 15-23 *ISSN 1025-482X*

CHEMICAL CHANGES IN DIFFERENT SIZES OF PUMMELO FRUITS DURING STORAGE

M. A. Hoque[1], M. M. Hossain1 and A. J. M.Karim[1]
[1]Dept. of Horticulture, Dept. of Soil Science, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur-1706

Abstract

An experiment was conducted at the Laboratory of Horticulture Department, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur with three varied fruit size of pummelo viz, large, medium and small to determine different chemical changes that occur during storage. It was observed from the experiment that ascorbic acid content decreased and ß-carotene content increased with the increase of storage period in all sizes of pummelo fruits. ß-carotene content increased steadily up to 30 days after storage and then increased rapidly. In large size fruits, TSS at fresh condition was 10.2% that increased to 11.9% after 60 days of storage. In medium and small size fruits, TSS was recorded at fresh condition as 8.4% and 10.1%, respectively, which after 60 days of storage increased to 9.9% and 12.6%, respectively. The highest dry matter was found to be increased in small sized (19.1%) fruits followed by large (18.5%) and medium (18.2%) sized fruits after 60 days of storage. Rotting was started after 30 days of storage in large and medium sized fruits and after 45 days in small sized fruits. Maximum rotting of fruits was recorded after 60 days of storage in all sized fruits.

Keywords: Pummelo storage; chemical change; *Citrus grandis*.

Introduction

Among the citrus fruits, pummelo is an important and promising fruit crop in Bangladesh that grows well throughout the country. The fruit is rich in vitamin C and its consumption can decrease the deficiency of vitamin C in our country. Besides, it is also a good source of vitamin A and B (Randhawa and Srivastava, 1986).

Storage of fruits aims at to protect the perishable from decomposition and keep them in a fresh condition, so that, it can be used by the consumers in future (Chattopadhyay, 1994). The pummelo fruits can be kept well for long periods because of the thick peel but if stored too long, they may become bitter (Morton, 2006). Pummelos and other citrus fruits are non-climacteric in nature and they do not show climacteric peak during post-harvest storage. Most of the biochemical change takes place on the tree itself. Coorg mandarins when stored at room temperature; vitamin C and acid contents in the juice decreases and total soluble solids increases (Dalal et al. 1962). Darjeeling mandarins when stored; vitamin-C and

acidity decreases and carotenoides increases (Dutt et al. 1960). Ramana et al. (1979) observed decrease in total acidity, chlorophyll and an increase in TSS, total sugar and carotenoids during storage at room temperature in coorg mandarin.

During storage of pummelo, chemical changes vary with fruit size (Krishnamurthy, 1993). Different citrus fruits after 19 days of storage at room temperature; juice content, titrable acidity and ascorbic acid decreases and total soluble solids, reducing and reducing sugars increases. Chemical changes that occur during storage of pummelo fruits have not yet been observed in our country. Hence, the present investigation have been undertaken to determine different chemical changes in pummelo with varied fruit size during storage.

Materials and Methods

The experiment was conducted at the Laboratory of Horticulture Department, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur. Pummelo fruits were collected from the pummelo orchard of Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Akbarpur, Moulvibazar. Three different sizes of fruits viz. large, medium and small were collected from the accession CG-185, CG-143 and CG-1, respectively. The fruits were divided into different sizes by weight and also by length and breadth. Fruit weight above 1000g with above 13.5cm length/breadth was considered as large, fruit weight between 600-1000g with 11.5-13.5cm length/breadth was considered as medium and fruit weight below 600g with below 11.5cm length/breadth was considered as small fruits. A total of 90 fruits were stored at room temperature on October 15, in which 30 fruits were from each size. Mature and ripe fruits were selected for storing. This experiment was laid out in Completely Randomized Design with three replications.

Collection of data

Data were collected at fresh condition and then 15 days intervals upto 60 days. Data from three fruits in each size were collected. Each fruit represented a single replication. Following data were recorded during the storage period.

a. Ascorbic acid (mg/100g)

The ascorbic acid content was determined as per the procedure described by Pleshkov (1976).

Preparation of the extract and determination of ascorbic acid

Hundred grams of sample was weighed and taken in a warring blender. The sample was homogenized with warring blender by adding 100ml distilled water. The homogenized solution was transferred into a 500 ml volumetric flask and volume up to the mark and then centrifuged at 0°C for 20 minutes at the speed of 4,000 rpm. The supernatant liquid was collected in the 500 ml volumetric flask again. This was the extract solution for the determination of ascorbic acid.

Ten ml of the extract was passed through cation exchange resin (CG-IR-120).The extract was collected in a 50 ml conical flask. The column was washed repeatedly to collect all the extract. Then 5 ml of 5% KI, 2 ml of 2% starch solution, 2 ml of 100% glacial acetic acid were added to it. Total ascorbic acid estimated by titrating that aqueous extract solution against 0.001N of KIO3 solution. The total ascorbic acid content was quantified by using the following formula.

Ascorbic acid (mg/100g) = (T.F.V.100)/v.W

Where, T = Titrated value of KIO3 in ml

F = 0.088 mg of ascorbic acid per ml of 0.001N of KIO3

V = Total volume of the sample extracted (ml)

v = Volume of the extract (ml) taken

W = Weight of the sample taken (g)

b. ß-carotene (mg/100g)

Amount of ß-carotene in 100 g pummelo during storage and at 15 days intervals was estimated as follows-

One gram of pummelo pulp was crushed thoroughly and mixed with 10 ml acetone: hexane (4:6) solution. This sample was centrifuged and optical density of the supernatant was measured by spectrophotometer (Model 200-20, Hitachi, Japan) at 663 nm, 645 nm, 505 nm and 453 nm. Calculation was done by the following formula (Nagata et al. 1992).

ß-Carotene (mg/100g) = $0.216(OD_{663}) + 0.452(OD_{453}) - 1.22(OD_{645}) - 304(OD_{505})$

Where, bold figure indicates optical density

c. Brix (%)

Percentage of brix was measured by an Abbe's Refractometer and recorded.

d. pH

pH of juice was estimated by a hand pH meter and recorded.

e. Dry matter (%)

One hundred grams of fresh pulp was measured and kept in an oven and the

temperature was set to 650C. The pulp was dried for at least 24 hours up to a constant weight. The final weight of the sample was taken by an electrical balance. Finally, dry matter (%) was calculated using the following formula-

$$\% \text{ Dry matter} = \frac{\text{Dry weight (g)}}{\text{Fresh weight (g)}} \times 100$$

f. Number of rotten fruit

Number of rotten fruit was recorded in different dates after storage and percentage was calculated from total (30) number of fruits.

Results and Discussion

The results of this experiment and discussion have been presented under the following heads.

Ascorbic acid

Ascorbic acid content in the stored pummelo fruits was found to be decreased. The rate of decreasing ascorbic acid content was increased with the increase of storage period in all sized fruits. Ascorbic acid content was decreased rapidly up to 45 days after storage and then decreased slowly (Table 1). Highest percentage of decrease after 30 days of storage was recorded in large sized fruits (32.5%) followed by small (23.6%) and medium (21.0%) sized fruits. The percentage of decrease in ascorbic acid content after 45 and 60 days of storage was more or less similar in all sized fruits (Fig. 1). The decrease in ascorbic acid content with increasing storage period was attributed to the conversion of ascorbic acids to sucrose, fructose and glucose during respiration. Other reason might be the storage temperature, because ascorbic acid is highly thermo-sensitive and degradation of ascorbic acid might be occurred for high storage temperature. Moreover, ascorbic acid content might be reduced by oxidation. Loss of ascorbic acid in stored Coorg mandarins was reported by Dalal et al. (1962), in Darjeeling mandarin by Dutt et al. (1960) and in other citrus fruits by Krisnamurthy (1993) and Zhao (1997).

Table 1. Changes in ascorbic acid content in pummelo after different days of storage

Size	Ascorbic acid content (mg/100g pulp)				
	Fresh	15 DAS	30 DAS	45 DAS	60 DAS
Large	55.3	45.0	37.3	35.2	33.6
Medium	58.5	51.4	46.2	39.0	37.4
Small	61.1	52.2	46.7	41.4	38.8

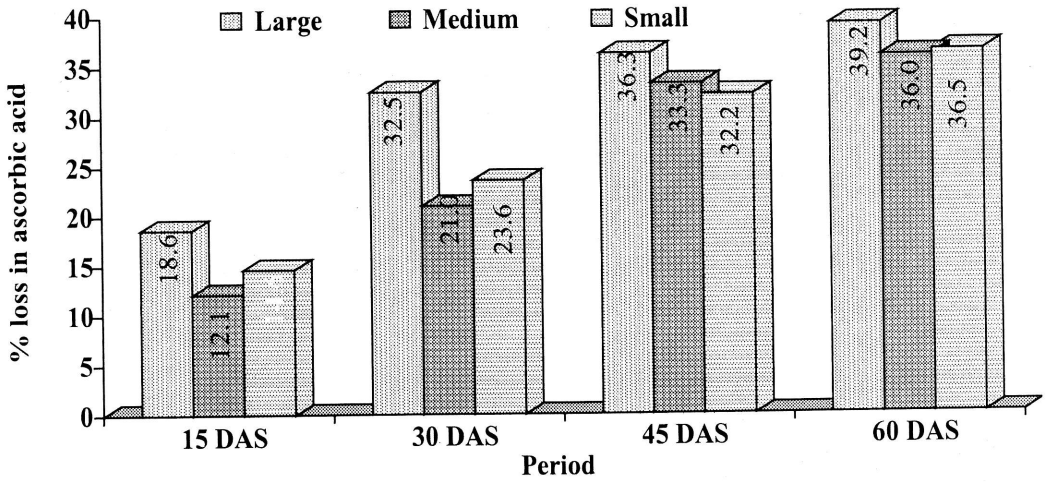

Fig. 1. Percentage of loss in ascorbic acid content at different DAS in pummelo.

ß-carotene content

ß-carotene content in stored pummelo fruits was increased with the increase of storage period in all sizes. ß-carotene content was increased steadily up to 30 days after storage in large and medium sized fruits and then increased rapidly. After 45 days of storage carotene content was further increased steadily (Table 2). In small sized fruits, the increase of carotene was more or less similar after different days of storage. Highest percentage of carotene was increased in small sized fruits followed by medium and large sized in all storage periods (Fig. 2). The increased ß-carotene content in stored pummelo was attributed for formation of carotenoid pigments. Ramana et al. (1979) reported to have increased carotene content with increased storage period in coorg mandarin.

Table 2. Changes in ß-carotene content in pummelo after different days of storage

Size	ß-carotene content (mg/100g pulp)				
	Fresh	15 DAS	30 DAS	45 DAS	60 DAS
Large	103.0	108.7	113.0	121.2	126.5
Medium	109.0	112.4	124.1	140.6	149.2
Small	115.1	126.0	144.6	169.2	194.8

Total Soluble Solids (TSS)

Total soluble solids in different size of pummelo fruits varied with storage period. An increasing trend was observed in all sizes with the increase of storage period. In large size fruits, 10.2% TSS was recorded at fresh condition and after 60 days of storage, the TSS increased steadily to 11.9%. In medium size fruits, 8.4% TSS was recorded at fresh condition and after 60 days of storage, the TSS increased to 9.9% while in small size fruits, 10.1% TSS was recorded at fresh condition and after 60 days of storage, the TSS increased to 12.6% (Table 3). The increase in the TSS content with the increase of time might be attributed to the increase of sucrose, glucose and fructose from the conversion of starch and organic acids during storage. Similar observation of increased TSS with increased storage period was recorded by Ramana et al. (1979) in coorg mandarin, Krishnamurthy (1993) in different citrus, Dalal et al. (1962) and Doijode (1997) in coorg mandarin and Zhao (1997) in orange.

Table 3. Changes in TSS in different size of pummelo after storage

Size	TSS (%)				
	Fresh	15 days	30 days	45 days	60 days
Large	10.2	10.5	10.9	11.4	11.9
Medium	8.4	8.7	9.0	9.5	9.9
Small	10.1	10.7	11.5	12.1	12.6

Changes in pH

During storage of pummelo fruits, it was observed that pH of the fruit was increased gradually with the increase of storage period. The large sized fruits were less responsive than medium and small regarding change in pH (Table 4). The increase in pH with the increase of storing time was attributed to decrease of organic acids in the fruits. Because, with the advancement of period, organic acids were converted to sugar during respiration and total amount of acids were decreased resulting an increased pH value. Similar observation of increased pH due to decreased acidity during storage was reported by Ramana et al. (1979), Krisnamurthy (1993), Doijode (1997), Tzur et al. (1998), Peng and Rabe (1997) and Ye et al. (1997) in different citrus fruits.

Table 4. Changes in pH in different sizes of pummelo after different days of storage

Size	pH				
	Fresh	15 DAS	30 DAS	45 DAS	60 DAS
Large	3.8	3.8	4.0	4.2	4.2
Medium	3.7	3.8	4.0	4.1	4.2
Small	3.8	4.0	4.2	4.3	4.4

Dry matter content

Dry matter content in the stored pummelo fruits was found to be increased with increased storage periods in all sizes. The highest dry matter was found to be increased in small sized (19.1%) fruits followed by large (18.5%) and medium (18.2%) sized fruits after 60 days of storage (Table 5). The increased dry matter with increased storage period was might be due to loss of water from the fruits through transpiration and other bio-chemical processes during storage. TSS that increases in fruits with the increase of storage period might be another reason of increased dry matter content in fruits.

Table 5. Changes in dry matter content in pummelo after different days of storage

Size	Dry matter content (%)				
	Fresh	15 DAS	30 DAS	45 DAS	60 DAS
Large	12.7	13.6	15.3	17.8	18.5
Medium	12.7	13.5	15.5	17.7	18.2
Small	12.8	14.1	16.1	18.3	19.1

Number of rotten fruit

No fruits in either size were found to be rotten up to 15 days after storage. Rotting started after 30 days of storage in large and medium sized fruits. In small size, rotting started with 1 fruit (3.3%) after 45 days of storage. Maximum rotting in all size fruits was recorded after 60 days of storage compared to other dates. At this time, rotting was highest (26.7%) in large fruits followed by medium (20.0%) and small sized (10.0%) fruits (Table 6). This result indicated that small fruits might be stored well than large and medium sized fruits for comparatively longer time.

Table 6. Number of rotten fruits in pummelo after different days of storage

Size	No. of fruit rotten				
	Fresh	15 DAS	30 DAS	45 DAS	60 DAS
Large	0.0	0.0	1.0* (3.3)	2.0 (6.7)	8.0 (26.7)
Medium	0.0	0.0	1.0 (3.3)	2.0 (6.7)	6.0 (20.0)
Small	0.0	0.0	0.0	1.0 (3.3)	3.0 (10.0)

*Figures in the parentheses indicate the percentage of rotting.

Conclusions

On the basis of obtained results, it may be concluded that small sized (<600g weight and <11.5cm length/breadth) pummelo fruits stored well for 60 days, while medium (600-1000g weight and 11.5-13.5cm length/breadth) and large (>1000g weight and >13.5cm length/breadth) sized fruits stored well for 45 days in an ambient condition without much changes in nutritional properties. TSS, dry matter (%), pH, carotene content increased during storage and ascorbic acid content decreased with increased storage period.

References

Chattopadhyay, T. K. 1994. Storage of fruits. In: A textbook on pomology. Vol. I. Fundamentals and fruit growing. Kalyani Publishers, New Delhi-110002, India. pp- 209-222.

Dalal, V. B., H. Subramanyam and H. C. Srivastava. 1962. Studies on the effect of repeated wax coatings on the storage behaviour of Coorg orange (Citrus reticulata). Food Sci., 11: 240-241.

Doijode, S. D. 1997. Seed quality and seed storage in fruit for short-term conservation of germplasm in Coorg mandarin (Citrus reticulata Blanco). Plant Genetic Resources Newsletter. 111: 82-83.

Dutt, S. C., K. P. Sarkar and A. N. Bose. 1960. Storage of mandarin oranges. Indian J. Hort. 17: 60-68.

Krishnamurthy, S. 1993. Harvesting, handling and storage of fruits. In: Advances in Horticulture. Volume 4. Fruit Crops. Part-4. K.L. Chadha and O.P. Pareek [eds.]. Malhotra Publishing House, New Delhi-110064, India. pp:1743-1774.

Morton, J. 2006. Pummelo. In: Fruits of warm climates. Morton, J.F and F.L. Miami (eds). P. 147-151. [Collected from browsing web site- http://www.hort.purdue.edu/newcrop/ morton/ index.html].

Nagata. M., K. Dan and I. Yamashita. 1992. Simple method for simultaneous determination of chlorophyll and carotenoiods in tomato. J. Japan. Soc. Hort. Sci. 61(2): 686-687. (Supplementary issue).

Peng, Y. H. and E. Rabe. 1997. Postharvest storage behaviour, respiration rate and ethylene evolution of fruit from deficit and normal irrigation in 'Mihowase satsuma' trees. J. Southern African Soc. Hort. Sci. 7(2): 44-47.

Pleshkov, B. P. 1976. Practical works on plant biochemistry. Moscow, Kolos. pp. 236-238.

Ramana, K. V. R., G. R. Setty, N. V. N. Murthy, S. Saroja and A. M. Nanjundaswamy. 1979. Effect of ethephone, benomyl, thiobendazole and wax wrapping on colour and shelf-life of Coorg mandarins (Citrus reticulata). Trop. Sci. 21: 265-272.

Randhawa, G. S. and K. C. Srivastava. 1986. Citriculture in India. Hindustan Publishing Corporation (India), Delhi-110007. p: 501.

Tzur, A., R. Goren and U. Zehavi. 1998. Changes in fruit quality of different citrus cultivars during ripening period. Alon-Hanotea. 52(3): 132-139.

Ye, M. Z., D. C. Ye and W. R. Xu. 1997. Some physiological changes in tangerines during storage. Plant Physiology Communications. 33(2):115-117.

Zhao, M. T. 1997. Experiment of improving the keeping quality of Valencia orange in storage. South China Fruits. 26(2): 16-17.