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Effect of Modified Atmosphere on Bio-chemical Parameters and Shelf Life of Guava (*Psidium guajava* L.) cv. Hisar Safeda and L-49

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Abstract

An experiment was conducted to study the effect of different durations of modified atmosphere on bio-chemical parameters and shelf life of guava under ambient conditions. Fruits were packed in perforated polyethylene bags (LDPE) of thickness 300 gauge and then stored at 8ºC in BOD incubator for the periods 1, 2, 3 and 4 days. After respective durations of storage under MA at 8ºC, fruits were removed from MA and packed in CFB and stored at ambient temperature. Fruits were sampled at every day for various bio-chemical pigments of guava. Among different durations of MA storage, the maximum total sugars and reducing sugars was recorded in the fruits stored for 0, 1 and 2 days and minimum in the fruits stored in MA for 4 days. The fruits stored in MA for different durations maintained high phenol contents and recorded maximum phenol in the fruit stored in MA for 4 days and minimum in control fruits. Higher retention of chlorophyll was recorded in the fruits stored in MA for 4 days while lesser carotenoids were recorded in fruit stored in MA for 4 days. Carotenoids content increased and chlorophyll content decreased with the increase in storage period in both the cvs Hisar Safeda and L-49 (Sardar).

INTRODUCTION

Guava 'Apple of tropics' (*Psidium guajava* L.) is a popular fruit, grown successfully throughout tropical and sub-tropical regions. Guava is the fourth most important fruit crop after mango, banana, and citrus in India and occupies the area of 24.4 lakh ha and production 33.18 lakh MT with average productivity of 11.1 MT /ha (Indian Horticulture Database, 2013). It is considered as one of the exquisite, nutritionally valuable, and remunerative crop. Guava is one of the most common fruits which are liked by both the rich and the poor because of its high nutritive value, availability at moderate price. It is a rich source of vitamin C and pectin (Patel et al., 2005). Guava is normally consumed as fresh as desert fruit but it is also processed into several products in fruit processing industry. A number of delicious products like jam, jelly, cheese, and RTS beverages are being prepared from guava fruits. Guava fruit is a climacteric fruit. It exhibits a climacteric pattern of respiration and ethylene production. Usually the fruits are harvested at different stage of maturity depending on the situation.

After reaching the physiological maturity it ripens fast within 1or 2 days resulting in early senescence of the fruit (Chundawat et al., 1976). The ripening of the fruits corresponds to a series of physiological, biochemical, and structural changes, which make the fruit attractive for consumption, so bio-chemical changes during ripening of fruit is also the most important attribute because in addition to defining the quality of the fruit for consumption.

Being highly perishable and very short post-harvest shelf life, a result of the loss of all quality attributes, which limits transportation and storage period. Packing of fruits in sealed polybags is the simplest way to attain MA (Neeraj et al., 2003), however, it may not always enhance the shelf life (Mahadeviah, 2002). Thus there is a need to find out the suitable MA storage condition to enhance the shelf life and reduces the huge post harvest losses. Therefore, the present studies were carried out to find out the effect of various durations of MA on the subsequent shelf life quality and ripening behaviour of guava fruit cv. L-49 and Hisar Safeda.

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MATERIALS AND METHODS

The fruits of rainy season crop were harvested at green mature stage. The fully green matured and healthy fruits cv. Hisar Safeda and L-49 were procured from the orchard of the Department of Horticulture, CCS HAU, Hisar, Haryana. The fruits were packed in imperforated polyethylene bags of thickness 300 gauge and stored at 8°C for 1, 2 ,3 and 4 days. After respective durations of storage under MA at 8°C, fruits were removed from MA and packed in corrugated fiber board (CFB) and stored at ambient temperature. Control fruits packed directly in CFB boxes with newspaper lining and stored at ambient conditions until they become unmarketable. Each treatment was comprised of four replications under complete randomized design. Fruits were sampled at every day for various bio-chemical parameters. Sugars were estimated by the method of Hulme and Narain (1993).Total phenolic content was estimated by the method of Amorium et al. (1997). The chlorophyll and carotenoids were estimated by the method given by Wellburn (1994).

Table 1: Effect of modified atmosphere on total sugars (%) of different cvs. of guava fruits during storage

MA (Days)*	Period of storage (days)									Mean
	0	1	2	3	4	5	6	7	8	
Hisar Safeda										
0	5.44	6.20	7.13	7.54	7.65	6.53	6.10	5.53	4.92	6.33
1	**5.44**	5.40	6.05	6.91	7.22	7.53	6.74	5.94	5.75	6.33
2	**5.44**	**5.40**	5.37	6.07	6.71	7.14	7.58	6.91	6.33	6.33
3	**5.44**	**5.40**	5.37	5.57	5.88	6.02	6.11	5.79	5.15	5.63
4	**5.44**	**5.40**	**5.37**	**5.57**	5.16	5.33	5.46	5.53	5.40	5.40
Mean	5.44	5.56	5.85	6.33	6.52	6.51	6.40	5.94	5.51	
CD at 5% Treatments = 0.08 Storage = 0.11 Treatments x Storage = 0.24										
Lucknow-49										
0	5.99	6.97	8.18	8.18	6.85	6.28	5.64	5.26	4.96	6.48
1	5.99	5.83	6.72	7.98	8.20	6.95	5.91	5.77	5.51	6.54
2	**5.99**	**5.83**	5.86	6.74	7.58	7.62	7.50	6.46	6.32	6.66
3	5.99	**5.83**	**5.86**	5.43	5.88	6.28	5.48	5.54	5.02	5.70
4	5.99	5.83	5.86	**5.43**	4.95	5.36	5.83	5.26	4.79	5.48
Mean	5.99	6.06	6.49	6.75	6.69	6.50	6.07	5.66	5.32	

CD at 5% Treatments = 0.11 Storage = 0.14 Treatments x Storage = 0.32
Bold figures indicate assumed values, which are similar to the values of fruits from bags opened on that day * at 8°C

RESULTS & DISCUSSION

The total sugar and reducing sugars exhibited a much faster increase initially and then decrease towards the end of storage (Table 1 & 2). There was a significant increase in the total sugar up to 6 days and reducing sugar up to 5 days and thereafter, became decreased during storage in both the cvs. Hisar Safeda and L-49. With the advance in storage period, polysaccharides get hydrolyzed into mono and disaccharides which in turn may lead to an increase in sugars. Upon complete hydrolysis of polysaccharides, no further increase occurs and subsequently a decline in the parameters is predictable as they are the primary substrate for respiration. Such a gradual increase in reducing and total sugars contents in guava may be due to fast degradation of starch by α-amylase activity (Ramakrishna et al., 2003). The results obtained are in conformity with the report of Pandey et al. (2010). A steadier and slower increase in reducing and total sugars was observed under MA conditions, minimum increase in reducing and total sugars was observed in fruits stored for 4 days in MA in both the cvs Hisar Safeda and L-49.

Table 2: Effect of modified atmosphere on reducing sugar (%) of different cvs. of guava fruits during storage

MA (Days)*	Period of storage (days)									Mean
	0	1	2	3	4	5	6	7	8	
Hisar Safeda										
0	3.69	3.79	3.95	4.11	4.53	3.73	3.17	3.05	2.95	3.66
1	**3.69**	3.71	3.82	3.98	4.04	4.37	3.61	3.06	2.59	3.65
2	**3.69**	**3.71**	3.70	3.78	3.82	3.71	3.73	3.27	3.39	3.64
3	**3.69**	**3.71**	3.70	3.72	3.76	3.78	3.36	3.41	2.93	3.56
4	**3.69**	**3.71**	3.70	**3.72**	3.72	3.73	3.20	3.04	2.76	3.47
Mean	3.69	3.73	3.77	3.86	3.97	3.86	3.41	3.16	2.92	
CD at 5% Treatments = 0.09 Storage = 0.12 Treatments x Storage = 0.26										
Lucknow-49										
0	3.81	4.21	5.06	5.62	4.82	3.97	3.66	3.09	3.02	4.28
1	**3.81**	3.76	4.07	5.12	5.30	5.12	4.03	3.61	2.93	4.25
2	3.81	3.76	3.59	3.97	4.48	5.16	5.48	4.31	3.57	4.24
3	3.81	3.76	3.59	3.07	3.52	3.81	3.98	4.23	3.78	3.73
4	**3.81**	**3.76**	**3.59**	**3.07**	3.10	2.93	2.97	3.08	2.58	3.21
Mean	3.81	3.85	3.98	4.17	4.24	4.20	4.02	3.66	3.17	
CD at 5% Treatments = 0.09 Storage = 0.12 Treatments x Storage = 0.26										

Bold figures indicate assumed values, which are similar to the values of fruits from bags opened on that day * at 8°C

This might be due lesser degradation of starch by low α-amylase activity (Dhoot et al., 1984; Siddiqui et al., 2014). Salunkhe and Wu (1973) had also reported observed that the low oxygen atmosphere conditions inhibited starch degradation and subsequent sugar formation in fruits under MA. Such a gradual increase in total sugar under MA conditions was observed by other workers in guava (Venkatesh and Reddy, 1994) and in kiwifruit (Bhushanet al., 2002). Total phenols in the pulp of guava fruit decreased progressively with increase in storage period. Decrease in phenols during storage might be due to their hydrolysis of phenols into Sugars, acid and other compounds or it may be due their transformation from of soluble into insoluble form (Van Buren, 1970).

Similar decrease in total phenols with the advancement of ripening has also been reported in

guava (Gangwar, 1972). In the present investigation, the phenols content was recorded more in the fruits stored in MA for different durations (Table 3). This may be due to low activity of enzyme responsible for degradation of polyphenols. Among different durations of MA, the degradation of chlorophyll and biosynthesis of carotenoids decreased with the increase in duration of period (Table 4 & 5). This might be due to decreased metabolic processes responsible for chlorophyll degradation (Siddiqui et al., 2011) and biosynthesis of carotenoids pigments in the peel portion under elevated CO_2 reduced O_2 levels due to MA storage condition (Fang et al., 1998). Similar, minor changes in chlorophyll and carotenoids in peel of apples under MA have been reported by Yongjoon et al. (1995).

Table 3: Effect of modified atmosphere on total phenols (g/100g fruit pulp) guava fruits during storage

MA (Days)*	Period of storage (days) 0	1	2	3	4	5	6	7	8	Mean
Hisar Safeda										
0	0.79	0.74	0.64	0.60	0.55	0.49	0.43	0.40	0.34	0.55
1	0.79	0.76	0.70	0.62	0.58	0.54	0.49	0.44	0.39	0.59
2	0.79	0.76	0.76	0.71	0.66	0.61	0.56	0.50	0.43	0.64
3	0.79	0.76	0.76	0.75	0.71	0.68	0.64	0.59	0.57	0.69
4	0.79	0.76	0.76	0.75	0.71	0.68	0.67	0.63	0.61	0.70
Mean	0.79	0.76	0.72	0.68	0.64	0.60	0.56	0.51	0.47	
CD at 5% Treatments = 0.01 Storage = 0.01 Treatments x Storage = 0.02										
Lucknow-49										
0	0.69	0.67	0.62	0.58	0.55	0.51	0.48	0.45	0.42	0.55
1	0.69	0.67	0.65	0.62	0.60	0.57	0.53	0.50	0.46	0.59
2	0.69	0.67	0.65	0.64	0.59	0.58	0.55	0.53	0.48	0.60
3	0.69	0.67	0.65	0.66	0.64	0.61	0.58	0.54	0.49	0.61
4	0.69	0.67	0.65	0.66	0.62	0.62	0.61	0.59	0.57	0.63
Mean	0.69	0.67	0.65	0.63	0.60	0.58	0.55	0.52	0.48	

CD at 5% Treatments – 0.01 Storage – 0.01 Treatments x Storage – 0.02
Bold figures indicate assumed values, which are similar to the values of fruits from bags opened on that day * at 8°C

Table 4: Effect of modified atmosphere chlorophyll (mg/g of peel) of guava fruits during storage

MA (Days)*	Period of storage (days) 0	1	2	3	4	5	6	7	8	Mean
Hisar Safeda										
0	1.32	1.21	1.11	1.04	0.92	0.63	0.51	0.39	0.33	0.85
1	1.32	1.32	1.18	1.05	0.86	0.67	0.50	0.36	0.31	0.84
2	1.32	1.32	1.33	1.19	1.07	0.82	0.67	0.49	0.43	0.96
3	1.32	1.32	1.33	1.34	1.28	1.20	1.06	1.06	1.01	1.21
4	1.32	1.32	1.33	1.34	1.34	1.28	1.28	1.24	1.18	1.29
Mean	1.32	1.29	1.26	1.19	1.09	0.92	0.80	0.70	0.66	
CD at 5% Treatments = 0.02 Storage = 0.02 Treatments x Storage = 0.05										
Lucknow-49										
0	1.50	1.22	1.02	0.87	0.67	0.56	0.44	0.34	0.32	0.77
1	1.50	1.35	1.25	1.14	0.94	0.68	0.56	0.46	0.37	0.91
2	1.50	1.35	1.44	1.28	1.10	1.02	0.78	0.59	0.46	1.06
3	1.50	1.35	1.44	1.46	1.37	1.27	1.21	1.15	1.11	1.32
4	1.50	1.35	1.44	1.46	1.42	1.40	1.35	1.33	1.24	1.39
Mean	1.50	1.32	1.32	1.24	1.10	0.99	0.87	0.77	0.70	

CD at 5% Treatments = 0.02 Storage = 0.04 Treatments x Storage = 0.08
Bold figures indicate assumed values, which are similar to the values of fruits from bags opened on that day * at 8°C

Table 5: Effect of modified atmosphere on total carotenoids (mg/g of peel) of different cvs. of guava fruits during storage

MA (Days)*	Period of storage (days) 0	1	2	3	4	5	6	7	8	Mean
Hisar Safeda										
0	0.72	0.79	0.83	0.91	0.99	1.13	1.25	1.40	1.48	1.05
1	0.72	0.69	0.80	0.85	0.92	1.00	1.11	1.25	1.45	0.98
2	0.72	0.69	0.71	0.79	0.86	0.94	1.05	1.15	1.22	0.90
3	0.72	0.69	0.71	0.69	0.72	0.76	0.80	0.83	0.85	0.75
4	0.72	0.69	0.71	0.69	0.66	0.70	0.72	0.75	0.80	0.71
Mean	0.72	0.71	0.75	0.78	0.83	0.90	0.99	1.08	1.15	
CD at 5% Treatments = 0.01 Storage = 0.02 Treatments x Storage = 0.04										
Lucknow-49										
0	0.80	0.98	1.07	1.20	1.37	1.41	1.49	1.56	1.66	1.28
1	0.80	0.79	1.01	1.11	1.16	1.33	1.39	1.46	1.59	1.18
2	0.80	0.79	0.78	0.97	1.08	1.14	1.26	1.36	1.50	1.08
3	0.80	0.79	0.78	0.76	0.79	0.80	0.82	0.84	0.87	0.81
4	0.80	0.79	0.78	0.76	0.75	0.76	0.77	0.79	0.81	0.78
Mean	0.80	0.83	0.89	0.96	1.03	1.08	1.15	1.20	1.29	

CD at 5% Treatments = 0.01 Storage = 0.02 Treatments x Storage = 0.04
Bold figures indicate assumed values, which are similar to the values of fruits from bags opened on that day * at 8°C

CONCLUSION

The results obtained from the present investigation reveal that exposure of fruits for $\leq$ 2 days to MA resulted in enhanced shelf life of fruits up to 8 days whereas in fruits exposed to MA for more than 3 days, retained high phenol, high Chlorophyll and low carotenoid contents and retained green color, hard texture and did not ripen when further stored under ambient conditions.

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