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EFFECT OF MODIFIED ATMOSPHERE PACKAGE ON PHYSICO-CHEMICAL CHARACTERISTICS OF 'BALANAGAR' CUSTARD APPLE (*Annona squamosa* L.) FRUITS STORED AT 15 ±1˚C

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ABSTRACT
The present investigation was conducted to examine the effect of modified atmosphere package, MAP (fruits packed in polypropylene bags with 3% O_2 + 5% CO_2 or 3% O_2 + 10% CO_2 or 5% O_2 + 5% CO_2 or 5% O_2 +10% CO_2 or air) on physico-chemical characteristics of custard apple 'Balanagar' fruits when stored at 15 ±˚C. Various physico-chemical parameters like physiological loss in weight (PLW), firmness, spoilage, ripening, days taken for ripening, shelf life, total soluble solids (TSS) and ascorbic acid were estimated at an interval of 2 days during storage. Fruits in MAP with 3% O_2 +10% CO_2 recorded the lowest PLW whereas the highest firmness in MAP with 5% O_2 + 10% CO_2. The lowest ripening and the maximum days taken for ripening of fruits were recorded in MAP with 5% O_2 + 10% CO_2 or 5% O_2 + 5% CO_2 or 3% O_2 + 10% CO_2. Fruits in MAP with air or 3% O_2 + 5% CO_2 recorded lower spoilage and correspondingly increased the shelf life up to 12.28 and 12 days, respectively, whereas the unpacked fruits recorded a shelf life of 8.5 days only. Fruits in MAP with 3% O_2 + 5% CO_2 recorded lowest TSS than unpacked fruits. The highest ascorbic acid content of fruits was recorded in MAP irrespective of concentrations of O_2 + CO_2 or air. From this finding it can be concluded that the 'Balanagar' custard apple fruits packed in MAP with air or 3% O_2 + 5% CO_2 then stored at 15 ±1˚C recorded maximum shelf life.

KEY WORDS: physiological loss in weight, firmness, shelf life, ripening, ascorbic acid

INTRODUCTION
Custard apple (*Annona squamosa* L.) is an arid zone fruit crop grown in India. Out of 100 species of *Annona* only custard apple, cherimoya, soursop, bullock's heart and atemoya are of major commercial importance. Of these, custard apple (synonyms: Sugar apple, Sweetsop, *Sithaphal*, *Sharifa*) is the most popular and widely used dessert fruit having the maximum production efficiency. The plants are hardy, drought resistant and can thrive well on marginal and neglected soils with minimum inputs (Rajput, 1985). Custard apple is a delicious table fruit and is valued mainly for its sweet, mild flavored pulp. The fruit is botanically referred as syncarpium and aggregate of fruit lets, each pocessing edible fleshy mass of soft, juicy and granular textured pulp surrounding a non-edible black seed. It is a climacteric fruit, starts ripening soon after detachment from the tree and it is highly perishable fruit with short shelf life of 1 to 2 days after ripening (Wills *et al*., 2001). The normal ripening of custard apple was reported by Broughton and Tan (1979) at temperature ranging from 15 to 30˚C. Vishnu Prasanna *et al*. (2000) reported that the safe range of storage temperature of custard apple was found to be between 15 and 20˚C, with maximum shelf life at 15˚C.

Modified atmosphere package (MAP) is intended to create an appropriate gaseous atmosphere around a commodity packed in film packages to enhance shelf life and conserve the quality of packed produce. Active modified atmosphere can be done by pulling a slight vacuum and replacing the package atmosphere with the desirable gas mixture. Gas flushing establish modified atmosphere quickly and increases the shelf life and quality of fruits. MAP has been shown to extend the storage life of many fruits like mango, pineapple and guava (Ranganna *et al.,* 2009). MAP has been shown to delay fruit ripening, reduces respiration, ethylene production rates, ethylene sensitivity to delayed ripening, retarded softening and slows down various compositional changes associated with ripening (Kader, 1986). Hence, this investigation was carried out to study the modified atmosphere package for enhancing storage life of custard apple 'Balanagar' fruits stored at 15 ±1˚C.

MATERIALS & METHODS
The experiment on effect of modified atmosphere package on physico-chemical characteristics of custard apple 'Balanagar' fruits stored at 15 ±1˚C was carried out at Fruit Research Station, Sangareddy, Medak district, Telangana State, India. Custard apple 'Balanagar' fruits were harvested at the light green fruit colour, stage with yellowish white colour between the carpels and initiation of cracking of the skin between the carpels. Matured fruits of uniform size, firm, free from disease and injuries were directly picked from orchard and brought to the laboratory. The fruits were cleaned with running tap water to remove the adherent dirt material and then allowed to dry in shade. The fruits were surface disinfected with 0.1% (w/v) bavistin solution for 2 minutes. The fruits were then

packed in polypropylene bags with the following amount of CO_2 and O_2 gases was flushed with MAP machine: MAP with 3% O_2 + 5% CO_2, MAP with 3% O_2 + 10% CO_2, MAP with 5% O_2 + 5% CO_2, MAP with 5% O_2 +10% CO_2, MAP with air and unpacked (control) fruits. The packed fruits were then stored at 15 ±1˚C temperature in horizontal racks. The experiment was conducted in completely randomized design with factorial concept and each treatment was replicated thrice. Various physico-chemical parameters like physiological loss in weight (PLW), firmness, spoilage, ripening, days taken for ripening, shelf life, total soluble solids (TSS) and ascorbic acid were estimated at an interval of 2 days during storage. The weight of the fruits in each replication was recorded on every second day and subtracted from the initial weight. The loss of weight in relation to initial weight was calculated and expressed as percentage. A table top penetrometer was used to record the firmness of the fruits and obtained direct readings in $kgcm^{-2}$. Ripening was judged by the development of whitish yellow colour between the aereoles, light green colur of aereoles, softening and characteristic odour. The number of fruits ripened on each date of sampling was counted and ripening percentages were worked out. The days taken for ripening was determined by the stage wherein more than 50% of the stored fruits became ripen was considered as end of days taken for ripening. The spoilage of fruits was determined based on visual observations like shriveling, fungal infection and subsequent rotting, over ripening and subsequent splitting and browning and discolouration of fruits. The spoilage is recorded by the number of fruits spoiled in a replication was counted and expressed in percentage. The stage wherein more than 50% of the stored fruits became unfit for consumption was considered as end of storage life and expressed as mean number of days. The TSS of custard apple pulp recorded in ºBrix by using ERMA hand refractometer. Ascorbic acid content of custard apple pulp was determined by 2, 6-dichlorophenolindophenol titration method (Ranganna, 1986). The experiment was conducted in completely randomized design with factorial concept and each treatment replicated thrice. The data were subjected to statistical analysis as per the procedure out lined by Panse and Sukhatme (1985).

RESULTS & DISCUSSION

Physiological loss in weight (%)

There were significant differences among different treatments, days and interactions with the highest PLW (Table 1) in control (4.92%) fruits and the lowest in MAP with 3% O_2 + 10% CO_2 (3.22%), which is on par with MAP with 5% O_2 + 10% CO_2. The PLW of fruits in MAP with 3% O_2 + 5% CO_2 were at par with PP bags with 5% O_2 + 5% CO_2. The PLW of fruits increased from 2nd to 12th day and increase was more pronounced from 6th to 8th day of storage. This may have been resulted from restricted availability of O_2 and CO_2 accumulation and consequently reduction in respiration leading to less moisture loss (Heining, 1975). Polyethylene bagging extremely reduced weight loss from the 'Neang' sugar apple fruits stored at 13ºC and 95% RH (Chunprasert *et al*., 2006). Kadam and Karad (2007) also found that the local cultivar of custard apple fruits packed in 100 gauge polyethylene with 2% vent showed less weight loss than unpacked fruits. The custard apple fruits weight loss was slower in fruits stored in the cool chambers than under ambient conditions (Dilipbabu, 1994 and Vishnu Prasanna *et al*., 2000). Kramchote *et al*. (2008) also found that controlled atmosphere storage (3% O_2 + 5% CO_2) found to be most effective way to delay weight loss at 13˚C for 'Nam Dok Mai' mango. Berger *et al*. (1993) also found that cherimoya cv. Bronceada fruits were treated with wax and stored at 10ºC and 85 to 90% RH under various CO_2 and O_2 concentrations (normal atmospheric conditions or 5% O_2 + 0 (*i.e.* 0.03), 5 or 10% CO_2) reduced the dehydration of fruits. MAP with 3% O_2 + 10% CO_2 in the present study has similarly reduced the PLW.

TABLE 1. Effect of modified atmosphere package on PLW (%) of custard apple 'Balanagar' fruits stored at 15±1˚C

Treatments	Days after storage						
	2	4	6	8	10	12	Mean
MAP (3% O_2 + 5% CO_2)	0.26	1.76	2.45	4.24	4.64	6.84	3.36^d
MAP (3% O_2 + 10% CO_2)	0.23	1.35	2.38	4.14	4.49	6.74	3.22^c
MAP (5% O_2 + 5% CO_2)	0.27	1.77	2.46	4.25	4.64	6.85	3.37^d
MAP (5% O_2 + 10% CO_2)	0.22	1.34	2.37	4.17	4.52	6.76	3.23^c
MAP with air	0.30	1.81	2.64	4.52	5.21	6.91	3.56^b
Control	1.07	2.45	3.32	6.65	7.45	8.61	4.92^a
Mean	0.39^f	1.75^e	2.60^d	4.66^c	5.15^b	7.12^a	
CD at 5%	For days (D)		0.091				
	For treatments (T)		0.091				
	For D × T		0.223				

Figures with same alphabet did not differ significantly

Firmness (kg cm^{-2})

There were significant differences among different treatments, days and interactions with the highest firmness (Table 2) in MAP with 5% O_2 + 10% CO_2 (2.06 kg cm^{-2}), which is on par with MAP with 3% O_2 + 10% CO_2 and MAP with 5% O_2 + 5% CO_2, whereas the lowest firmness was recorded in control (1.22 kg cm^{-2}) fruits. The firmness of fruits decreased from 0 to 12th day and decrease was more pronounced from 6th to 8th day of storage. Similar results were obtained by Vishnu Prasanna *et al*. (2000) and Bolivar-Fernandez *et al*. (2009) that the firmness of ripe fruits of custard apple was the least in fruits stored at 25 and 20ºC as compared to those stored at 15 and 10ºC. The decrease in firmness might be due to less activity of enzymes at reduced temperatures which are responsible for degradation of cellulose and other pectic substances (Tsay and Wu 1989). Similar results were also reported in cherimoya fruit stored at 10ºC which retained its firmness throughout 6 days of storage and the decrease was slower when stored at 15ºC (Shen *et al*., 2009). Similar results obtained by Berger *et al*. (1993) during storage of cherimoya cv. Bronceada fruits were treated with wax and stored at 10ºC and 85-90% RH under 5% CO_2 + 10% O_2. Similar results also obtained in cherimoya cv. Fino de Jete in controlled atmospheres (10% O_2 combined with 10, 15 or 20% CO_2) at 8ºC for 9 days than air stored fruits (Sanchez *et al*., 1998). This may have been resulted from restricted availability of oxygen and CO_2 accumulation as reported by Alique (1995) in cherimoya under 10% O_2 in combination with 10, 15, 20 CO_2 at 8ºC up to 9 days and 'Nam Dok Mai' mango by Kramchote *et al*. (2008) under controlled atmosphere storage with 3% O_2 + 5% CO_2 at 13ºC.

TABLE 2. Effect of modified atmosphere package on firmness (kg cm^{-2}) of custard apple 'Balanagar' fruits stored at 15±1˚C

Treatments		Days after storage							
		0	2	4	6	8	10	12	Mean
MAP (3% O_2 + 5% CO_2)		2.85	2.60	2.30	2.51	1.60	1.10	0.55	1.93^b
MAP (3% O_2 + 10% CO_2)		2.85	2.75	2.65	2.00	2.00	1.30	0.80	2.05^a
MAP (5% O_2 + 5% CO_2)		2.85	2.75	2.55	2.00	2.00	1.30	0.75	2.02^a
MAP (5% O_2 + 10% CO_2)		2.85	2.75	2.65	2.00	2.00	1.40	0.80	2.06^a
MAP with air		2.85	2.50	2.25	1.85	0.90	0.50	0.10	1.56^c
Control		2.85	2.45	1.95	1.00	0.20	0.15	0.00	1.22^d
Mean		2.85^a	2.63^b	2.39^c	1.89^d	1.45^e	0.96^f	0.50^g	
CD at 5%	For days (D)			0.095					
	For treatments (T)			0.088					
	For D × T			0.234					

Figures with same alphabet did not differ significantly

Ripening (%)

There were significant differences among different treatments and days but not interactions with the highest ripening (Table 3) recorded in control (68.75%) fruits and the lowest (41.25%) in MAP with 5% O_2 + 10% CO_2 or 5% O_2 + 5% CO_2 or 3% O_2 + 10% CO_2. The ripening of fruits in MAP with 5% O_2 + 5% CO_2 were at par with MAP with 3% O_2 + 5% CO_2. The ripening increased from 6th to 12th day and increase was more pronounced from 8th to 10th day of storage. This may be due to a series of bio-chemical changes are initiated by the auto catalytic production of ethylene, marking the changes from growth to senescence and involving an increase in respiration leading to ripening of fruits (Mattoo and Modi, 1967). Lowering of storage temperature from 27-15ºC and treatment of fruits to fungicide, waxol or precooling markedly lowered the rate of deteriorative physiological, biological and biochemical activities in ripening of custard apple fruits (Kamble and Chavan, 2005). This might be due to reduced ethylene production and thereby retardation of ripening as reported by Tsay and Wu (1989) and Bolivar-Fernandez *et al*. (2009) in custard apple fruits. Yonemoto *et al*. (2002) also found that number of days required for cherimoya fruit ripening at 15ºC and 20ºC were 9-11 days and 8 days, respectively.

TABLE 3. Effect of modified atmosphere package on ripening (%) of custard apple 'Balanagar' fruits stored at 15±1˚C

Treatments		Days after storage				
		6	8	10	12	Mean
MAP (3% O_2 + 5% CO_2)		15.00	30.00	70.00	80.00	48.75^b
MAP (3% O_2 + 10% CO_2)		10.00	25.0	60.00	70.00	41.25^c
MAP (5% O_2 + 5% CO_2)		10.00	25.00	60.00	70.00	41.25^c
MAP (5% O_2 + 10% CO_2)		10.00	25.00	60.00	70.00	41.25^c
MAP with air		15.00	35.00	75.00	85.00	52.50^b
Control		30.00	55.00	90.00	100.00	68.75^a
Mean		15.00^d	32.50^c	69.17^b	79.17^a	
CD at 5%	For days (D)			4.93		
	For treatments (T)			6.04		
	For D × T			NS		

Figures with same alphabet did not differ significantly; NS-Not significant

Spoilage (%)

There were significant differences among different treatments, days and an interaction with the lowest (40.00%) spoilage (Table 4) of fruits was recorded in MAP either with 3% O_2 + 5% CO_2 or air. The spoilage increased from 8th to 14th day and increase in spoilage was more pronounced from 12th to 14th day of storage. The fruits in MAP with 5% O_2 + 10% CO_2 or 5% O_2 + 5% CO_2 or 3% O_2 + 10% CO_2 shows the dark brown spots on the skin is observed in present study due to very high concentration of CO_2 and too low concentration of O_2 (Berger *et al*., 1993). The percentage of rotting fruits was lower in high CO_2 combination with, 20:5 and 25:5 CO_2 and O_2 giving the best overall fruit appearance (Akbudak *et al*., 2008). Elevated CO_2 concentrations reduced the incidence of decay in many commodities, especially when the CO_2 levels were higher than 10 % (Wang and Vestrheim, 2002). Similar results were also reported in custard apple (Bhadra and Sen, 1999; Berger *et al*. 1993 and Chunprasert *et al*., 2006).

TABLE 4. Effect of modified atmosphere package on spoilage (%) of custard apple 'Balanagar' fruits stored at 15±1˚C

Treatments		Days after storage				
		8	10	12	14	Mean
MAP (3% O_2 + 5% CO_2)		0.00	35.00	50.00	75.00	40.00[b]
MAP (3% O_2 + 10% CO_2)		0.00	40.00	55.00	80.00	43.75[c]
MAP (5% O_2 + 5% CO_2)		0.00	40.00	55.00	80.00	43.75[c]
MAP (5% O_2 + 10% CO_2)		0.00	40.00	55.00	80.00	43.75[c]
MAP with air		5.00	30.00	45.00	80.00	40.00[b]
Control		35.00	70.00	95.00	100.00	75.00[a]
Mean		6.66[d]	43.33[c]	59.17[b]	82.50[a]	
CD at 5%	For days (D)			3.45		
	For treatments (T)			2.82		
	For D × T			6.91		

Figures with same alphabet did not differ significantly

Days taken for ripening

The days taken for ripening (Table 5) among different treatments differed significantly with maximum(10.43 days) in MAP with 5% O_2 + 10% or 5% O_2 + 5% CO_2 or 3% O_2 + 10% CO_2 and minimum in control (7.60 days) fruits. The days taken for ripening of fruits in MAP with 3% O_2 + 5% CO_2 were at par with PPB with air. This may be due to a series of bio-chemical changes which are initiated by the auto catalytic production of ethylene, marking the changes from growth to senescence and involving an increase in respiration leading to ripening of fruits (Mattoo and Modi, 1967). Lowering of storage temperature from 27-15˚C and treatment of fruits to fungicide or waxol lowered the rate of deteriorative physiological, biological and biochemical activities in ripening of custard apple fruits (Kamble and Chavan, 2005). This might be due to reduced ethylene production and thereby retardation of ripening as reported by Tsay and Wu (1989) and Bolivar-Fernandez *et al*. (2009) in custard apple fruits. Yonemoto *et al*. (2002) also found that number of days required for cherimoya fruit ripening at 15˚C and 20˚C were 9-11 days and 8 days, respectively.

Shelf life (days)

The shelf life (Table 5) differed significantly among different treatments with maximum shelf life of 12.28 days was recorded in MAP with air, which is on par with MAP with 3% O_2 + 5% CO_2 and minimum in control (8.50 days) fruits. The shelf life of 11.33 days was recorded in MAP with 5% O_2 + 10% CO_2 or 5% O_2 + 5% CO_2 or 3% O_2 + 10% CO_2. This may be attributed due to reduction in ethylene production and thereby delayed ripening process (De La Plaza *et al*., 1979; Berger *et al*., 1993 and Alique and Oliveira, 1994) in the packed fruits. The increase in shelf life of custard apple in present investigation might be due to small rise in respiration rates on storage of fruits at 15˚C (Vishnu Prasanna *et al*., 2000). This could be attributed to modified atmosphere created by accumulation of CO_2 and depletion of O_2 and maintenance of high humidity inside the polypropylene bags (Magdaline *et al.*, 2001). These results are in conformation with the findings of Tsay and Wu (1989).

TABLE 5. Effect of modified atmosphere package on days taken for ripening and shelf life (days) of custard apple 'Balanagar' fruits stored at 15±1˚C

Treatments	Days taken for ripening	Shelf life (days)
MAP (3% O_2 + 5% CO_2)	9.00[b]	12.00[a]
MAP (3% O_2 + 10% CO_2)	10.43[a]	11.33[c]
MAP (5% O_2 + 5% CO_2)	10.43[a]	11.33[c]
MAP (5% O_2 + 10% CO_2)	10.43[a]	11.33[c]
MAP with air	8.75[b]	12.28[a]
Control	7.60[c]	8.50[d]
CD at 5%	0.37	0.58

Figures with same alphabet did not differ significantly

TSS (ºBrix)

There were significant differences among different treatments, days and interactions with the highest TSS (Table 6) recorded in control (22.18 ºBrix) and the lowest in MAP with 3% O_2 + 10% CO_2 (19.70 ºBrix), which is on par with MAP with 5% O_2 + 5% CO_2 or 5% O_2 + 10% CO_2 or 3% O_2+5% CO_2. The TSS increased from 0 to 12th day and increase was more pronounced from 10th to 12th day of storage. The TSS of climacteric fruits increases with progressive of ripening (Kumbhar and Desai, 1986). The increase in TSS was gradual in custard apple fruits stored at 15˚C and 20˚C (Vishnu Prasanna *et al*., 2000). Soluble solids rise concomitantly with the respiratory increase in annonaceous fruits and reach a maximum after the onset of second respiratory rise (Wills *et al*., 1984; Tsay and Wu, 1989 and Martinez *et al*., 1993). The TSS contents of custard apple fruits slowly increased during storage are due to slowly increased ripening at low temperatures

(Vishnu Prasanna *et al*., 2000 and Bolivar-Fernandez *et al*., 2009). Similar result also observed by Alique (1995) cherimoya fruits were stored at 8°C under controlled atmosphere of 10% O_2 with 10, 15 or 20% CO_2 and 98% RH lower the TSS with no significant differences among the three atmospheres. Similar results were also reported in 'Neang' sugar apple fruit by Chunprasert *et al*. (2006) and in cherimoya by Martenz *et al*. (1993) and Sanchez *et al*. (1998) under controlled atmospheres.

TABLE 6. Effect of modified atmosphere package on TSS (°Brix) of custard apple 'Balanagar' fruits stored at 15±1°C

	Days after storage							
Treatments	0	2	4	6	8	10	12	Mean
MAP (3% O_2 + 5% CO_2)	18.50	18.70	18.75	19.40	20.20	20.30	23.30	19.87^c
MAP (3% O_2 + 10% CO_2)	18.50	18.65	18.65	19.10	19.70	20.30	23.10	19.70^c
MAP (5% O_2 + 5% CO_2)	18.50	18.65	18.65	19.20	19.60	20.35	23.20	19.72^c
MAP (5% O_2 + 10% CO_2)	18.50	18.65	18.65	19.30	19.50	20.40	23.10	19.73^c
MAP with air	18.50	18.85	19.40	20.80	21.70	22.95	23.20	20.90^b
Control	18.50	19.20	20.20	22.50	23.10	25.00	24.80	22.18^a
Mean	18.50^g	18.78^f	19.05^e	20.05^d	20.63^c	21.55^b	23.61^a	
CD at 5%	For days (D)		0.154					
	For treatments (T)		0.220					
	For D × T		0.378					

Figures with same alphabet did not differ significantly

TABLE 7. Effect of modified atmosphere package on ascorbic acid (mg 100 g^{-1}) of custard apple 'Balanagar' fruits stored at 15±1°C

	Days after storage							
Treatments	0	2	4	6	8	10	12	Mean
MAP (3% O_2 + 5% CO_2)	41.30	41.30	41.30	50.20	45.10	43.60	32.50	42.17^a
MAP (3% O_2 + 10% CO_2)	41.30	41.30	41.30	50.20	45.10	43.60	32.50	42.17^a
MAP (5% O_2 + 5% CO_2)	41.30	41.30	41.30	50.20	45.10	43.60	32.50	42.17^a
MAP (5% O_2 + 10% CO_2)	41.30	41.30	41.30	50.16	45.10	43.60	32.50	42.17^a
MAP with air	41.30	41.30	41.30	48.40	44.40	40.75	30.22	41.07^a
Control	41.30	41.30	41.50	47.20	42.25	38.55	28.66	40.10^b
Mean	41.30^c	41.30^c	41.33^c	49.39^a	44.50^b	42.28^c	31.48^d	
CD at 5%	For days (D)		1.65					
	For treatments (T)		1.35					
	For D × T		NS					

Figures with same alphabet did not differ significantly; NS-Not significant

Ascorbic acid (mg 100 g^{-1})

There were significant differences among different treatments and days but not interactions with the lowest ascorbic acid (Table 7) recorded in control (40.10 mg 100 g^{-1}) fruits and the highest (42.17 mg 100 g^{-1}) in MAP irrespective of concentrations of O_2 + CO_2 or air. The ascorbic acid increased from 0 to 6th day and then declined by 31.48 mg 100 g^{-1} on 12th day and decrease was more pronounced from 10th to 12th day of storage. Broughton and Tan (1979) also reported an increase in ascorbic acid of custard apple as the fruit ripened, reaching a maximum at the climacteric, after which the amount decreased. Paull (1982) also observed an increase in ascorbic acid during the ripening of soursop fruit. As the number of days required reaching the ripe stage increased with decrease in storage temperature, the ascorbic acid content was decreased in the ripe fruits (Vishnu Prasanna *et al*., 2000). The decline in ascorbic acid during storage may be attributed to conversion of ascorbic acid into dehydroascorbic acid (Guftason and Cooke, 1952). The highest ascorbic acid content was obtained from high CO_2 treatments (25 CO_2 : 5 O_2 or 20 CO_2 : 5 O_2) in '0900 Ziraat' sweet cherry fruits stored at 0±1°C (Akbudak *et al*., 2008). Tian *et al*. (2004) also found that 5% O_2 : 10% CO_2 had relatively retained higher ascorbic acid in sweet cherry.

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