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Improving post harvest quality of custard apple using modified atmospheric packaging and storage temperature

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Abstract

Investigation on ‘Effect of modified atmospheric packaging and storage temperature on shelf life of custard apple cv. Balanagar’ was carried out with 14 treatment combinations. The uniform sized fully matured fruits of custard apple cv. Balanagar at colour turning stage were packed in medium density polyethylene bags (50μ density) with mixture of different gaseous composition and stored in different storage temperatures. Two concentration of O_2 (5% and 10%), three concentration of CO_2 (10%, 15% and 20%) and one control (environmental gaseous composition with 21% O_2 and 0.03% CO_2) were used in packages. Fruits were stored at ambient and 12ºC temperatures. Higher TSS and total sugar, retention of ascorbic acid, acidity, phenols and highest scores for overall organoleptic attributes were found in low concentration of O_2 and CO_2 in MAP and low temperatures storage. Finally this study indicated that custard apple fruit could be stored at 12ºC for 10 days with MAP (5% O2 and 10% CO2) allowed conservation of fruits with highest quality parameters. It also indicate that stored custard apple fruit can be marketed for extended period and used for making various products.

Key word: Modified atmosphere packaging, storage temperature, shelf life

Introduction

Custard apple (*Annona squamosa* L.) popularly known as sitaphal, sugar apple, sweetsop, sharifa, and noi-na”, is one of the most important underutilized finest fruit gifted to India by Tropical America and belongs to the family Annonaceae. In India area under custard apple is reported to be 53,000 ha. Custard apple is mainly grown in the states of Andhra Pradesh, Maharashtra, Madhya Pradesh, Uttar Pradesh and Rajasthan. Custard apple has wide adaptability to soil and climatic conditions, tolerant to drought and salinity and resistance against pests and diseases due to its hardy nature and escape from animal damage. Among the *Annona* fruits, sugar apple pulp is considered as sweetest with a good flavour and low acidity (FAO,8). The 100g pulp contains 70.5 g moisture, 23.5 g carbohydrate, 1.6 g protein, 0.9 g minerals, 1.5 mg iron, 17 mg calcium, 47 mg phosphorus, 105 I.U. calorific value and 37 mg vit. C (Dashora *et al.,* 6). *Annonas* are climacteric fruits (Biale and Barcus, 5). Custard apple fruits are perishable, ripening of *Annona* fruits are characterized by high respiration and high ethylene production rates which makes it highly perishable (Pareek *et al*., 11), so under ordinary conditions, fruits can be kept well only for 3-4 days after harvest. Rapid softening of fruits during transportation and at retail stores is the biggest ongoing problem. The use of several techniques including the use of modified atmosphere packing (MAP) and cold storage has proved to be useful in maintaining the quality of custard apple and increasing its shelf life. MAP is the replacement of air in a pack with a single gas or mixture of gases and proportion of each component is fixed when the mixture is introduced. The basic principle of MAP is to match the respiration of the product with the O_2 and CO_2 concentration and permeability of packages in order to modify the O_2 and CO_2 concentrations of the atmosphere to desired levels within the package (Beaudry and Lakakul, 4). Therefore, keeping the above factors in view the present study “Effect of modified atmospheric packaging and storage temperature on shelf life of custard apple cv. Balanagar” was conducted in Post Harvest Technology Laboratory, Department of Horticulture, Rajasthan College of Agriculture, Udaipur during 2013-14.

Materials and methods

The uniform sized fully matured fruits of custard apple cv. Balanagar were obtained from Instructional Farm of KVK, Chittorgarh under Maharana Pratap University of Agriculture and Technology, Udaipur and brought to the

Post Harvest Technology Laboratory of the Department of horticulture on the same day. Custard apple fruits were inspected thoroughly for any damage and spoilage. The uniform sized fully matured fruits of custard apple cv. Balanagar at colour turning stage were packed in medium density polyethylene bags (50μ density) with mixture of different gaseous composition and stored in ambient and 12˚C temperatures. The modified atmospheres were created by using a gas mixture. The experiment was consisting of 14 treatment combination comprising: G_1T_1= control (21% O_2 & 0.03% CO_2) + ambient storage temperature; G_1T_2= control (21% O_2 & 0.03% CO_2) + 12˚C storage temperature; G_2T_1= 5% O_2 & 10% CO_2 + ambient storage temperature; G_2T_2= 5% O_2 & 10% CO_2 +12˚C storage temperature; G_3-T_1= 5% O_2 & 15% CO_2 + ambient storage temperature; G_3T_2= 5% O_2 & 15% CO_2 +12˚C storage temperature; G_4T_1= 5% O_2 & 20% CO_2 + ambient storage temperature; G_4T_2= 5% O_2 & 20% CO_2 +12˚C storage temperature; G_5T_1= 10% O_2 & 10% CO_2 + ambient storage temperature; G_5T_2= 10% O_2 & 10% CO_2 +12˚C storage temperature; G_6T_1= 10% O_2 & 15% CO_2 + ambient storage temperature; G_6T_2= 10% O_2 & 15% CO_2 +12˚C storage temperature; G_7T_1= 10% O_2 & 20% CO_2 + ambient storage temperature; G_7T_2= 10% O_2 & 20% CO_2 +12˚C storage temperature, and sampled periodically for analysis of various, biochemical and sensory parameters after every 48 hours. The whole experiment was conducted using a factorial completely randomized design with three replications.

Observation were recorded on biochemical attributes including TSS (˚B), acidity (%), ascorbic acid (mg $100g^{-1}$), pH, reducing sugar (%), total sugar (%) and phenols (%); and overall organoleptic scores. TSS of the Pulp was determined by using "Zeiss" Hand Refractometer, pH of fruit pulp was directly determined by sensor based digital pH mete, reducing sugars content was measured by using dinitrosaliccylic acid, total phenol content of the fruit was determined by Folin- ciocalteau reagent. All other quality parameters of fruits were analyzed as per standards methods given in (A.O.A.C., 1).

Results and discussion

The TSS contents of sugar apple fruits increased during storage at different temperatures (Bolivar-Fernandez *et al.,* 2005; Prasanna *et al.,*13). Present study showed that the TSS (°B) of custard apple fruits increased with the advancement of storage period up to climacteric rise and thereafter decreased and the maximum TSS at the termination of the experiment was found in G_2 gaseous composition and T_2 storage temperature, also depicted in Fig. 1, might be due to starch gets hydrolyzed into mono and disaccharides which in turn may lead to an increase in total soluble solids and similar results were also reported by Yang *et al*., 14; Mohsen, 8. It is evident from the data presented in Fig. 2, on 8th day of storage, the lowest total sugar was observed in G_5T_2 (18.66%) and highest in G_1T_1 (20.90%). Further, on 10th day of storage, the minimum total sugar was observed in G_3T_2 (12.00%) and maximum in G_2T_2 (14.46%) treatment combinations. A general decrease in sucrose content in bayberry fruit stored at different temperatures was observed, while there was a marked increase in fructose and glucose contents during the initial period of storage, and then their values declined (Yang *et al*., 14). The increase in fructose and glucose contents could be due to hydrolysis of sucrose, yielding glucose and fructose (Ding *et al.,* 7; Patel *et al*., 12). It is clear from the data presented in Table 1, that at the end of the experiment, maximum ascorbic acid was observed in G_2T_2 (27.06 mg 100^{-1}) while minimum in G_1T_1 (23.69 mg 100^{-1}) and G_2T_2 was found at par with G_3T_2 and G_7T_2. The ascorbic acid content of fruits decreased with the advancement of storage period. The decrease in ascorbic acid during storage is probably due to the process of oxidation of ascorbic acid forming dehydro ascorbic acid by enzyme ascorbinase. The pH of custard apple fruits increased during storage and their values were significantly lowered by lower storage temperature. The values of pH stored at ambient and 12°C were around 4.75 and 4.61 respectively as presented in the Table 1, that the pH of bayberry fruit juice increased during storage, corresponding to a decreased in acidity at all storage temperatures (Yang *et al*., 2010). The phenol content of custard apple fruits decreased with the advancement of storage time during the entire period of experiment and the rate of decrease was significantly affected by different gaseous composition during storage as presented in Fig 3. The total phenol content declined with advancement of storage and this loss of astringency is probably connected with increased polymerization of tannins. The results are in agreement with the findings of Mahajan (9) in apples.

On 8th day of storage, minimum overall organoleptic score was recorded in G_1T_1 and G_1T_2 (6.33) treatment combinations and maximum in G_2T_2 (8.33). But on 10th day of storage, all the treatment combinations were found non-significantly different with each other. Minimum score of overall acceptability of sapota fruit was observed in 40 μ LDPE bags that could be attributed to insufficient O_2 within package (anaerobic respiration) due to low permeability of 40 μ LDPE film was reported by Antala *et al*., (2). These results support the present investigation in custard apple fruit.

Based on the above findings, it could be recommended that custard apple can be stored at 12˚C for 10 days with MAP (5% O2 & 10% CO2) with highest quality parameters .This standardized storage technology has promising future for technology utilization by small, medium and large scale processor and entrepreneurs. The stored fruit can be marketed for extended period and used for making various products.

Table 1. Interaction effect of gas composition in package and storage temperature on ascorbic acid (mg/100g) and pH during storage

Treatment combinations	Ascorbic acid (mg/100g)					pH				
Storage day	2	4	6	8	10	2	4	6	8	10
G_1T_1	47.08	40.32	31.16	26.02	23.69	4.00	4.71	5.03	5.35	5.67
G_1T_2	47.32	39.56	31.86	27.04	25.17	3.64	4.14	4.64	5.14	5.65
G_2T_1	47.32	40.56	33.35	27.14	25.10	2.43	2.73	3.13	3.63	4.23
G_2T_2	52.08	48.32	37.16	30.12	27.06	1.90	2.40	2.90	3.40	3.90
G_3T_1	48.08	40.32	32.56	28.06	24.02	3.65	4.15	4.65	5.15	5.65
G_3T_2	52.84	47.48	40.32	32.38	26.98	3.37	3.87	4.37	4.87	5.37
G_4T_1	47.08	40.32	33.32	27.80	24.03	3.63	4.13	4.63	5.13	5.67
G_4T_2	53.94	47.18	36.56	28.06	25.06	3.31	3.81	4.31	4.81	5.31
G_5T_1	52.08	40.32	33.32	27.18	24.01	2.90	3.40	3.90	4.40	4.90
G_5T_2	55.14	48.28	37.46	29.16	24.10	3.14	3.64	4.14	4.64	5.14
G_6T_1	53.28	47.32	35.16	28.03	24.48	3.30	3.80	4.30	4.80	5.30
G_6T_2	52.84	49.08	37.32	29.80	24.70	3.16	3.66	4.16	4.66	5.61
G_7T_1	52.08	46.12	37.96	28.26	25.20	3.29	3.79	4.29	4.79	5.29
G_7T_2	52.08	46.02	38.51	29.16	26.14	2.80	3.70	4.22	4.75	4.69
SEm±	0.78	0.68	0.54	0.44	0.40	0.02	0.03	0.03	0.03	0.06
CD (P=0.05)	2.26	1.94	1.55	1.28	1.15	0.07	0.09	0.09	0.09	0.17

*Significance at 5 % level of significance.

G_1T_1=control (21% O_2&0.03% CO_2)+ambient storage temperature; G_1T_2=control (21% O_2&0.03% CO_2)+12˚C storage temperature; G_2T_1=5% O_2&10% CO_2+ambient storage temperature; G_2T_2=5% O_2&10% CO_2+12˚C storage temperature; G_3-T_1= 5% O_2&15% CO_2+ambient storage temperature; G_3T_2= 5% O_2&15% CO_2+12˚C storage temperature; G_4T_1=5% O_2&20% CO_2+ambient storage temperature; G_4T_2=5% O_2&20% CO_2+12˚C storage temperature; G_5T_1=10% O_2&10% CO_2+ambient storage temperature; G_5T_2= 10% O_2 & 10% CO_2+12˚C storage temperature; G_6T_1= 10% O_2&15% CO_2+ambient storage temperature; G_6T_2= 10% O_2&15% CO_2+12˚C storage temperature; G_7T_1=10% O_2&20% CO_2+ambient storage temperature; G_7T_2= 10% O_2 & 20% CO_2+12˚C storage temperature.

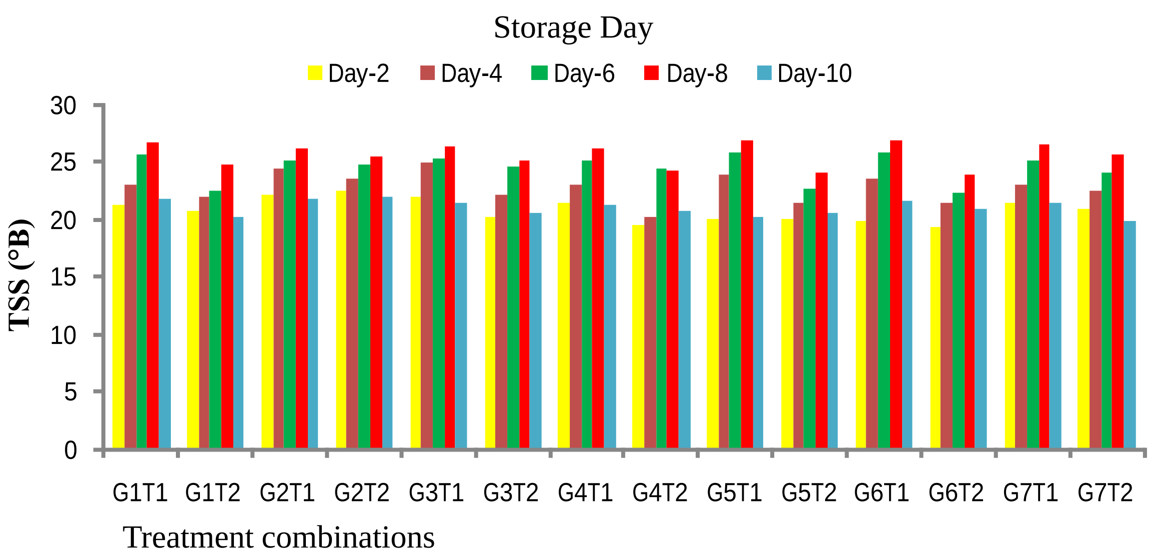

Fig 1. Interaction effect of gas composition in package and storage temperature on TSS (˚B) during storage

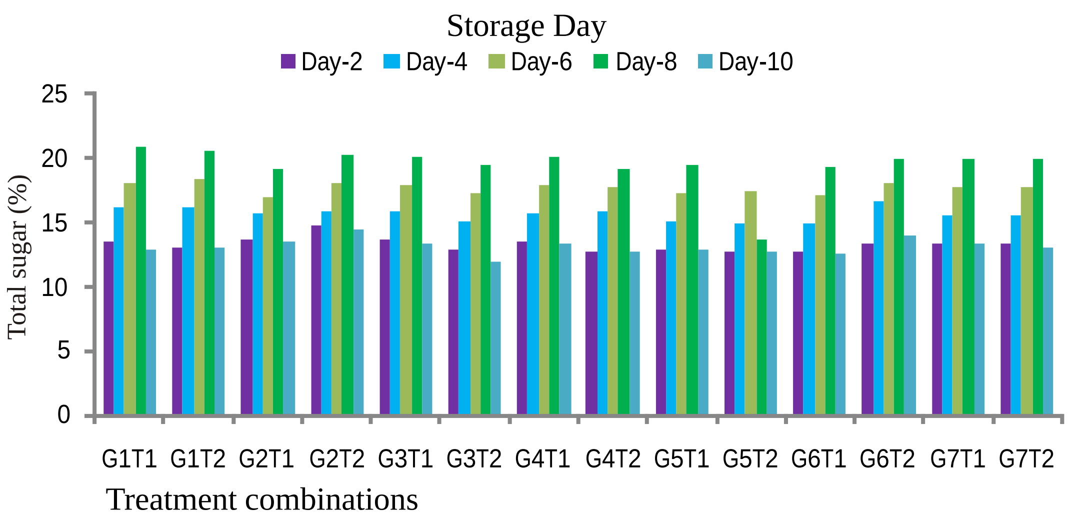

Fig 2**.** Interaction effect of gas composition in package and storage temperature on total sugar (%) during storage

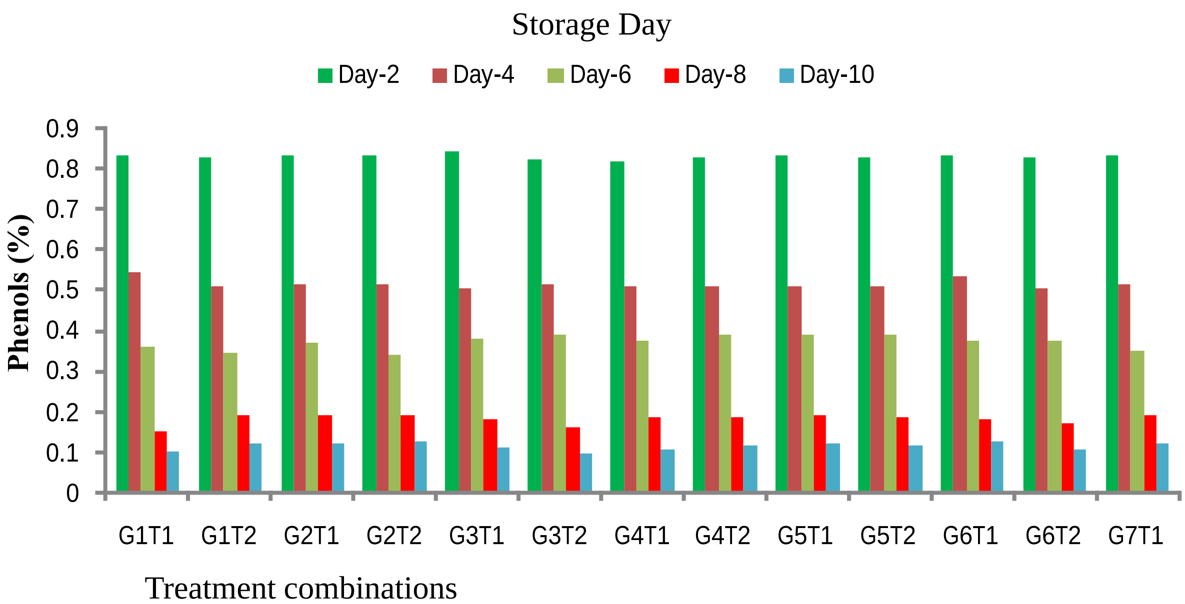

Fig 3**.** Interaction effect of gas composition in package and storage temperature on phenols (%) during storage

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