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Post-harvest life of selected grapes like Anab-e-shahi and Thompson seedless through modified atmosphere packaging and storage

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Abstract
Fresh fruits and vegetables are high in water, low in protein and fat. They are important source of both digestible and indigestible carbohydrates, minerals and vitamins especially vitamin A and C. The post-harvest losses of both fresh and freshly processed Agricultural produce have been estimated to be as high as 25 to 40 per cent of the total production. To counteract post-harvest losses, the use of modified atmosphere storage has increased for bulk storage and also for consumer sized packages. Moreover Modified Atmosphere Packaging complies with recent trends in the use of healthy convenient foods. The main objectives of this study was to asses the impact of refrigerated modified atmosphere storage conditions on the chemical, nutritional, microbiological and organoleptic qualities of minimally processed Grape like Ana-b-shahi and Thompson seedless. A slightly modified version of modified atmosphere packaging unit was fabricated and erected. The grapes were minimally processed in the pretreated in one per cent citric acid, potassium metabisulphite and salt for 30 seconds. The pretreated grapes were under modified atmospheres (oxygen, carbon dioxide and nitrogen in 500ml bottles at refrigeration temperature. 12 degree centigrade. During storage period The grapes (Anab-e-shahi) had 73.60 g of moisture, 2.10 gm of acidity,15.80 degree brix of total soluble solids,14.15 mg of ascorbic acid, 56.90 and 94.19 g per cent of reducing and total sugars. The Thompson seedless grapes had 69.00 g of moisture, 1.10 gm of acidity,22.55degree brix of total soluble solids,5.36 mg of ascorbic acid, 9.80 and 15.17 g per cent of reducing and total sugars Organoleptic evaluation showed that the treated Anab-e-shahi and Thompson seedless was as good as fresh. The production costs of minimally processed grapes were 50.00. The shelf life of the grapes came up to 45 days in T2, T3 and T4 treated samples under modified atmosphere packaging whereas the control samples kept good for only 15 days. From this study it was observed that minimally processed grapes could be successfully stored under modified atmosphere packaging

Keywords: Modified Atmosphere Packaging, Anab-e-shahi and Thompson seedless.

1. Introduction
The unit comprised of carbon dioxide, oxygen and nitrogen cylinders, pressure gauge, pressure regulator, shut off valves, mixing tank, rubber tubes, inlet and outlet distribution manifold and sample bottles (Fig 3). The inlet distribution manifolds consist of 9.32 mm inside diameter copper pipes (30cm length and 0.5cm breadth) were soldered on a board (90cm length and 60cm breadth) and connected to a mixing tank which is attached to a pressure regulator and shut—off valves. The shut—off valves were connected to the cylinders through rubber tubes. The outlet distribution manifolds 10.82mm thickness (also soldered on the board) consist of conduct pipes were connected to the sample bottles The carbon dioxide, oxygen and nitrogen gases were passed through separate rubber Pubes (17.3 inches length and 11.81mm thickness) to mixing tank through Copper pipes via pressure regulator. The pressurized gases were maintained by Pressure gauge. From the mixing tank the mixture of gases passed to outlet distribution manifold. When the outlet distribution manifold is opened the gas mixture comes in contact with sample bottles. The shut-off valves act as a control measure for unit. The primary guardians of this value added are low temperature and Modified Atmosphere Packaging (MAP). Traditionally only sterile and / or processed foods could be delivered to distant markets during off seasons. With the globalization of food markets and increased consumer desire for fresh foods year around, lucrative markets have been opened to those able to present fresh foods without chemical additives. To this end novel packaging approaches to

the preservation to avoid deterioration have emerged under the name of "extended shelf life packaging". The majority of these packages rely on a combination of modified atmosphere and rigorous refrigeration to forestall microbial and chemical deterioration (Thompson, l999) [12]. To standardize the optimum Modified Atmosphere Packaging (MAP) and storage for extended post-harvest life of Grapes - Thompson seedless and Anab-e-shahi. To study the physico-chemical characteristics of the Grapes - during storage and to study the consumer acceptability.

Materials and Methods

Raw materials: Grapes- Anab-e-Shahi and Thompson seedless.

Packaging materials: Gas tight glass bottle of 500 ml capacity with rubber cork was purchased from local market.

Chemicals: The chemicals like citric acid and potassium metabisulphite, used were food grade and other chemicals and reagents used in this study were either AR, LR, or GR grade.

Equipments: Designing and erection of Modified Atmosphere Packaging unit (MAP),Gas chromatograph, Klett summer son photoelectric colorimeter, Braun balance, ripple beam balance, Refrigerator, Hand Refractometer, Ph meter, Hot air oven, centrifuge, Muffle furnace and photo electric colorimeter.

Pretreatments: The minimally processed grapes were pretreated by soaking them in the following solution for 30 seconds. Potassium metabisulphite, citric acid and salt were 1.0 percent.

Packaging: The bottles were flushed with gas mixtures for two minutes. Then the pretreated minimally processed grapes were filled into bottles and packed under modified atmosphere packaging with standardized gas mixtures. Anab-e-Shahi and Thompson seedless oxygen-13.0, corbondioxide-7.0 and nitrogen80.0 were stored at refrigeration temperature maintained at 10+-2.c and 80+-5 per cent relative humidity.

Storage studies: Chemical analysis were done in stored vegetables at periodical intervals (once in a 15 days. as per the procedures given below. Moisture content, Titrable acidity, Reducing sugar, Total sugar, Microbial examination and Ascorbic acid were followed by (Ranganna, 1995) [10]. The data on chemical characteristics of the samples were statistically analyzed by factorial completely randomized design as per method described by (Gomez and Gomez, 1984)[3].

Result and Discussion

Changes in the moisture content of (g %) Anab-e-Shahi and Thompson seedless during storage.

The initial moisture content of Anab-e-shahi was 78.42 g per cent. From Table 1 it was observed that the moisture content decreased during storage. The Anab-e-shabi had moisture content of 73.00 in T_1 (control), 76.21 in T_2 (MAP), 76.51 in T_3 (MAP + citric acid), 75.30 in T_4 (MAP) + potassium Meta bisulphate) and 75.00 g per cent in T_5 (MAP + salt) respectively after 15 days of storage. After 30 days there was further reduction in moisture content and ranged between 73.35 and 74.35 g per cent (T_2 to T_5) and the control was spoiled. After 45 days storage a decrease in moisture content was observed in T_2 (73.60), T_3 (73.62) and T_4 (73.80) whereas T_5 became unsuitable. Naik *et al.*, (1997) [6] have indicated that there was rapid decrease in moisture within 14 days of storage in control samples and other treatments had loss in moisture after 42 days. Similar results were observed in this study. The initial value of moisture content in Thompson seedless was 77.68 g percent. From Table 16, it was observed that the moisture content decreased during storage. After 15 days of storage, Thompson seedless was found to have 74.30, 72.30, 72.40, 73.25 and 71.35 g per cent moisture respectively in control (T_1), MAP (T_2), MAP + citric acid (T_3), MAP + potassium metabisulphite (T_4) and MAP + salt (T_5). After 30 days the moisture respectively content was found to be 70.10 to 70.15 g per cent in T_2 to T_5 samples whereas the control (T_1) sample was spoiled. After 45 days the T_2, T_3 and T_4 had 69.20, 69.10 and 69.00 g per cent and T_5 sample was spoiled. Adsule and Tandon (1983) [1] revealed that moisture content of the guava fruits increased in control compared to the fruits stored in low density polyethylene bags similar results was observed.

Table 1: Changes in the moisture content of (g %) Anab-e-Shahi and Thompson seedless during storage

Anab-e-Shahi						Thompson seedless				
Storage period(days)	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
0	78.42	78.42	78.42	78.42	78.42	77.68	77.68	77.68	77.68	77.68
15	73.00	76.21	76.51	75.30	75.00	74.30	72.30	72.40	73.25	71.35
30	-	73.50	73.35	74.00	74.35		70.10	70.00	70.15	70.15
45	-	73.60	73.62	73.80	-		69.20	69.10	69.00	-

Changes in the acid content of (g %) Anab-e-Shahi and Thompson seedless during storage

The acidity increased during storage and was observed from Table 2. The initial acidity was 2.32 g per cent. The increase in the acidity was found to be 2.26 control (T_1) 2.29 in MAP 2.29 m MAP + citric acid (T_3), 228 m MAP + potassium meta bisulphite (T_4) and 2.29 g per cent in MAP+ salt (T_5) in Anab-e-shahi after 15 days of storage After 30 days of storage it decreased to 2.13 to 2.16 g per cent in T_2 to T_5 samples whereas the control sample was spoiled After 45 days T_2, T_3 and T_4 had the acid contents of 210, 2.9 and 2.10 g per cent respectively and T_5 samples were spoiled. Park and Youn (1999) [8] noted that CA stored apples appeared to retain the acidity of the juice. The decrease in acidity was minimum due to the effect of treatments and storage temperature in which the ripening process was delayed. The acidity decreased during storage and was observed from Table 2. The initial acidity was 1.27 g per cent. During storage, the decrease in the acidity was found to be 1.21 in control (T_1), 1.19 in MAP (T_2), MAP + citric acid (p3), MAP + potassium metabisulphite (0 and 120 g per cent in MAP + salt (T_5) in Thompson seedless grapes respectively after 15 days of storage After 30 days of storage it decreased to 1.10 and 1.13, 1.10 and 1.12 (T_3, T_4 and t_5) g per cent whereas the control sample was spoiled. After 45 days T_2, T_3 and T_4 had the acid content of 1.08, 1.10 and 1.12 g per cent and T_5 sample was spoiled. Statistical analysis of the data revealed that the days of storage and treatment (T) and their interactions were highly and significantly different from each other. The treatments (T_1), T_2 was the best followed by T_3, T_4, T_5 and T_1. Among the treatment T_3 and T_4 were on par with each other and different from others.

Table 2: Changes in the acid content of (g %) Anab-e-Shahi and Thompson seedless during storage

	Anab-e-Shahi					Thompson seedless				
Storage period(days)	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
0	2.32	2.32	2.32	2.32	2.32	1.27	1.27	1.27	1.27	1.27
15	2.26	2.29	2.29	2.28	2.29	1.21	1.19	1.19	1.19	1.20
30	-	2.16	2.13	2.16	2.16		1.10	1.13	1.10	1.12
45	-	2.10	2.9	2.10	-		1.08	1.10	1.12	

Changes in the Total soluble solids (° brix) Anab-e-Shahi and Thompson seedless during storage

The initial TSS value of grapes (Anab-e-shahi) was found to be 15.6° Brix. During storage there was a slight increase in TSS Table 3.After 15 days of storage, the TSS was found to be 15.65° Brix, in control (T_1), MAP (T_2), MAP + citric acid (T_3), MAP + potassium meta bisulphate (T_4) and MAP + salt (T_5) samples respectively. After 30 days it was. 15.700 Brix in all the samples and the control was spoiled. After 45 days 45 was found to be 15.8 in T_2, T_3 and T_4 samples and the other was spoiled. Gupta *et al*., (1992) [4] studied about the controlled environment storage for pears. He found that the total soluble solids were increased with an increase in the storage period. Narayana *et al.* (1996) [7] found that the total soluble solids of guavas stored in cold storage were found to increase gradually up to two weeks and thereafter the rise was faster. The findings of the present study are in agreement with this study. The initial TSS value of Thompson seedless was found to be 22.50° Brix. During storage a slight increase in TSS was observed Table 4.After 15 days of storage, TSS was found to be 22.55° Brix in control (T_1), MAP T_2), MAP + citric acid (T_3), MAP + potassium metabisulphite (1_4) and MAP + salt (T_5) samples for the Thompson seedless. After 30 days it was 22.55° Brix in T_2 to T_5 samples and the control was spoiled After 45 days TSS was found to be 22.55 in T_2, T_3 and T_4 samples and the other was spoiled. Statistical analysis of the data revealed that there was no difference in TSS of Thompson seedless grapes during storage The treatment T_2 (MAP) was the best followed by T_3 and T_4 Among them T_2, T_3 and T_4 were on par with each other and significantly different from T_5 and T_1 According to Bhullar and Farmahan (1980) [2] total soluble solids increased and reached the maximum at eating stage The similar was observed in this study.

Table 3: Changes in the Total soluble solids (° brix) Anab-e-Shahi and Thompson seedless during storage

	Anab-e-Shahi					Thompson seedless				
Storage period(days)	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
0	15.60	15.60	15.60	15.60	15.60	22.50	22.50	22.50	22.50	22.50
15	15.65	15.65	15.65	15.65	15.65	22.55	22.55	22.55	22.55	22.55
30	-	15.70	15.70	15.70	15.70	-	22.55	22.51	22.55	22.55
45	-	15.80	15.80	15.80	-	-	22.55	22.55	22.55	-

Ascorbic acid

The initial ascorbic acid content was 14.46 mg per cent. During storage it was reduced and observed from Table 4. During storage of Anab-e-shahi, it was reduced to 14.38, 1436, 14.35, 1437 and 14.30 mg per cent respectively in control (T_1), MAP (T_2), MAP + citric acid (F_3), MAP ÷ potassium meta-bisulphate (T_4) and MAP + salt (T_5) samples; after 15 days. Alter 30 days it was further decreased from 14.46 to 14.26 mg per cent in T_2 to T_5 samples. Whereas the control (T_1) was spoiled. After 45 days T_2, T_3 and T_4 had the ascorbic acid contents 14.19, 14.18 and 14.15mg per cent and the other was spoiled. In Thompson seedless the initial ascorbic acid content was 5.60 mg per cent during storage it was reduced as observed from Table 4.During storage it reduced to 5.51, 5.50, 5.52, 5. 53 and 5.54 mg per cent in control (T_1), MAP (T_2), MAP + citric acid (T_3), MAP + potassium metabisulphite (T_4) and MAP + salt (T_5) samples, after 15 days of storage in Thompson seedless After 30 days it was decreased from 548 to 5.46 and 5.43 to 5.42 mg per cent in T_2 to T_5 samples whereas the control (T_1) sample was spoiled. Alter 45 days T_2, T_3 and T^4 had the ascorbic acid contents of 5.39, 5.37 and 5.36mg per cent and T_5 was spoiled. Raju (1998) [9] concluded that the pretreatments and MAP could reduce the vitamin C loss during storage besides causing retention of sensory quality in shredded cabbage.

Table 4: Changes in the ascorbic acid content of (mg %) Anab-e-Shahi and Thompsan seedless during storage

	Anab-e-Shahi					Thompson seedless				
Storage period(days)	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
0	14.46	14.46	14.46	14.46	14.46	5.60	5.60	5.60	5.60	5.60
15	14.38	14.36	14.35	14.37	14.30	5.51	5.50	5.52	5.53	5.54
30	-	14.26	14.26	14.26	14.26	-	5.48	5.46	5.43	5.42
45	-	14.19	14.18	14.15	-	-	5.39	5.37	5.36	-

Reducing sugar

In Anab-e-Shahi the reducing sugar content increased from its initial value during storage as observed from Table 5. The initial reducing sugar content was 56.71 g per cent. After 15 days of storage it increased to 56.79 gin MAP (T_2), 56.71 g in MAP + citric acid (T_3), 56.80 g in MAP + potassium metabisulphite (T_1) and 56.75 gin MAP + salt (T_5) treated samples in Anab-e-shahi. After 30 days the control (T_1) sample was spoiled and samples T_2, T_5 and T_3-T_4 were on par for the reducing content ranging from 56.85 to 56.89 g per cent After 45 days T_2, T_3 and T_4 had 6.90, 56.91 and 56.92 g per cent respectively and the other was spoiled. According to Maini *et al*., (1985) [5] reducing sugar content of apples was increased with the storage period. The results of the present investigations are in line with this finding. Thompson seedless the reducing sugar content increased from its initial value during storage as observed from Table 5. The initial reducing sugar content was 962 g per cent. After 15 days of storage it

increased to 969 g in control (T_1), 9.70 g m MAP Cr2), 972 in MAP + citric acid (T_3), 969 in MAP + potassium metabisulphite (T_4) and MAP + salt (T_5) treated samples in Thompson seedless grapes After 30 days the control (T_1) sample was spoiled and T_2 to T_4 samples had the reducing sugar content in the range from 9.76 to 9.79 g per cent in T_3 and T_5. After 45 days, T_2, T_3 and T_4 had 9.80, 9.81, and 9.81 g per cent and were on par, whereas the T_1 and T_5 samples were spoiled. Statistical analysis of the data revealed that highly significant difference was observed in reducing sugar content In the treatments MAP T_2) was the best followed by T_3, T_4, T_5 and T_1 The treatments and their interactions were highly significant. According to Sing *et al.*, (1984) [11] there was higher gain in the buildup of reducing sugar in the fruits during storage as observed in this study.

Table 5: Changes in the Reducing sugar content of (mg %) Anab-e-Shahi and Thompsan seedless during storage

	Anab-e-Shahi					Thompson seedless				
Storage period(days)	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
0	56.71	56.71	56.71	56.71	56.71	9.62	9.62	9.62	9.62	9.62
15	56.71	56.79	56.71	56.80	56.75	9.69	9.70	9.72	9.69	9.6
30	-	56.85	56.89	56.89	56.85	-	9.76	9.79	9.76	9.79
45	-	56.90	56.91	56.92	-	-	9.80	9.81	9.81	-

Total sugar

Anab-e-Shahi The initial total sugar content was 94.44 g per cent. During storage it was decreased from its initial value as shown in Table 6.The Anab-e-shahi had total sugar content of 94.31 g in control (T_1), 94.37 g in MAP (T_2), 94.35 g in MAP + citric acid (T_3), 94.35 g in MAY + potassium metabisulphite (T_4) and 94.26 g per cent in MAY + salt (T_5) after 15 days of storage. Alter 30 days the control (T_1) was spoiled and from T_2 to T_5 the total sugar content ranged between 94.25 and 94.29 g per cent. After 45 days, T_2, T_3 and T_4 had the total sugar content of 94.19, 94.16 and 94.10 g per cent and the other was spoiled. The treatments MAP + citric acid (T_3) prevented the loss compared to others (T_4, T_2, T_5 and T_1) Singh and Singh (1996) observed that the total sugars remained more or less constant in known mandarin fruits during storage in MAP for 140 days. The initial total sugar content was 15.43 g per cent. During storage it was decreased from its initial value as observed and presented in Table 6. Thompson seedless grapes had 15.29 g in control (T_1) 15.26 g in MAP (T_2), 15.24 g MAP + citric acid (T_3), 15.22 g in MAP + potassium metabisulphite (T_1) and 15.20 g per cent in MAP + salt (T_5) after 15 days of storage. After 30 days the control (T_1) was spoiled and T_2 toT_5 the total sugar content ranged between 15.16 and 15.20 g percent. After 45 days, T_2, T_3 and T_4 had the total sugar content of 15.l7, 15.l4 and 15.13 g percent and T_5 spoiled. Statistical analysis of the data revealed that there was a significant difference between treatments (T), days of storage and their interactions were found in total sugar content. Storing grapes in MAP had a significant effect on total sugar content when compared to other treatments. Gupta (1992) [4] found that there was a decrease in the sugars of peaches in modified atmosphere. This was in support for the present study.

Table 6: Changes in the total sugar content of (mg %) Anab-e-Shahi and Thompson seedless during storage

	Anab-e-Shahi					Thompson seedless				
Storage period(days)	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
0	94.44	94.44	94.44	94.44	94.44	15.43	15.43	15.43	15.43	15.43
15	94.31	94.37	94.35	94.35	94.26	15.29	15.26	15.24	15.22	15.20
30	-	94.25	94.29	94.29	94.25	-	15.20	15.19	15.18	15.16
45	-	94.19	94.16	94.10	-	-	15.17	15.14	15.13	-

Organoleptic evaluation of Anab-e-shahi and Thompson seedless

Organoleptic characteristics such as appearance, colour, flavor, texture, taste, and overall acceptability scored high in all treatments after 30 days of storage Table 7 With respect to appearance all the treatments scored high and ranged between 3.30 and .98. In case of colour ft. varied from 3.30 to 3.98. In the case of flavor the samples score ranged between 3.30 and 3.98. Taste and texture was as good as control in T_2 followed by all other treatments. Overall acceptability also ranged between 2.77 and 3.98. Treatment (T) at m minimum bacterial load was found in control grapes (T_1) followed by T_2, T_3, T_4 and T5 samples. In the case of treatments (T) T_2, T_3 and T_4 were on par with other and significantly different from T_5 sample. Thompson seedless Grape was organoleptically evaluated using 4 point hedonic scale rating and the results revealed the character such as appearance, colour, flavor, texture, taste, and overall acceptability scored high in all treatments after 30 days of storage Table7. In appearance all the treatments scored between 3.38 and 3.98. In case of color it varied from 3.38 to 3.98. In the case of flavor the samples score ranged between 2.92 and 3.98. Taste and texture was as good as control in all other treatments. Overall acceptability also ranged between 2.79 and 3.98.In the present study taste of the Thompson seedless was good in all treatments except in MAP + salt and MAP + potassium metabisulphite.

Table 7: Organoleptic Evaluation of Anab-e-Shahi and Thompson seedless during storage

	Anab-e-Shahi					Thompson seedless				
Quality Attributes	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
Appearance	3.98	3.98	3.60	3.46	3.60	3.98	3.98	3.70	3.46	3.38
Colour	3.98	3.84	3.53	3.30	3.53	3.98	3.84	3.55	3.40	3.38
Flavour	3.98	3.98	3.30	3.38	3.30	3.98	3.98	3.40	3.38	3.92
Texture	3.98	3.76	3.60	3.38	3.92	3.98	3.98	3.60	3.38	3.46
Taste	3.98	3.84	3.38	3.40	3.46	3.98	3.85	3.40	3.39	2.69
Over all Acceptability	3.98	3.93	3.46	3.38	2.77	3.98	3.98	3.50	3.39	2.79

Bacterial load x io4 cfu/g Anab-e-shahi Thompson seedless during storage

The initial bacterial counts were 10.00, 5.00, 4.00, 6.00 and 4.00 x 10^{-6} cfu/g for control (T_1) MAP (T_2) MAP +citric acid (T_3), MAP + potassium metabisulphite (T_4) and MAP + salt (T_5) respectively. During storage the microbial counts increased Table 8.In the Anab-e-shahi the bacterial count was found to be 12.00 (T_1), 6.00(T_2), 7.00 (T_3), 8.00 (T_4) and 7.00 x 10 cfu/g (T_5) respectively after 15 days storage. After 30 days the control sample was spoiled and it increased to 9.00, 10.00 and 9.00 x l0 cfu/g in T_2, T_3 and T_4 respectively. After 45 days 12.00 in T_2 and cfu/g and 11.00 x 10^{-6} cfu/g in T_4 counts were found whereas T_5 sample was completely spoiled.

Thompson seedless: The initial bacterial counts were 10.00, 5.00, 4.00, 6.00 and 4.00 x 10^{-6} cfu/g for control (T_1) MAP (T_2) MAP +citric acid (T_3), MAP + potassium metabisulphite (T_4) and MAY + salt (T_5) respectively. During storage the microbial counts increased Table 8.In the Thompson seedless the bacterial count was found to be 12.00 (T_1), (T_2), 7.00 (T_3), 8.00 (T_4) and 7.00 x 10 cfu/g (T_5) respectively after 15 days storage. Alter 30 days the control sample was spoiled and it increased to 9.00, 10.00 and 9.00 x l0 cfu/g in T_2, T_3 and T_4 respectively. After 45 days 12.00 in T_2 and cfu/g and 11.00 x 10^{-6} cfu/g in T_4 counts were found whereas T_5 sample was completely spoiled.

Table 8: Bacterial load x io4 cfu/g Anab-e-shahi and Thompson seedless

	Anab-e-Shahi					Thompson seedless				
Storage period(days)	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
0	10.00	5.00	4.00	6.00	4.00	10.00	5.00	4.00	6.00	4.00
15	12.00	6.00	7.00	8.00	7.00	12.00	6.00	7.00	8.00	7.00
30	-	9.00	10.00	9.00	-	-	9.00	10.00	9.00	-
45	-	12.00	12.00	11.00	-	-	12.00	12.00	11.00	-

Enumeration of fungi x io4 cfu/g Anab-e-shahi and Thompson seedless

The initial fungal counts were 4.00, 3.00, 3.00, 3.00 and 3.00 x 103 cfiu/g in T_1 to T_5 samples. From the Table 9 T_3 it was observed that fungal count increased during storage. After 15 days of storage the counts were 6.00,4.00,3.00,4.00 and 3.50x $l0^3$ cfu/g in control (EU1) MAP [2] MAP+ citric acid (T3), MAP ± potassium metabisulphite (T_1) and MAP + salt (T_5) samples of Anab-e-shahi respectively. After 30 days it ranged between 4.00 and 5.00 x 10^{-3} cfu/g in T_2 to T_4 and the control was spoiled. After 45 days the counts were 6.00, 6.00 and 5.00 x 10^{-3} cfu/g in T_2, T_3 and T_4 respectively whereas T_5 sample was spoiled the initial fungal counts were 400 for control (T_1) and 300 x 10^{-3} cfu/g for T_2 to T_5 samples: From the Table 9 it was observed that fungal count increased during storage. After 15 days of storage the counts were 7.00, 4.00, 3.00,4.00 and 350 x 10^{-3} in control (T_1) MAP (T_2) MAP+ citric acid (T_3), MAP + potassium metabisulphite (T_5) and MAP + salt fl's) samples of grapes respectively. After 30 days between 4.00 and 5.00 x 1W3 cfu/g in T2 to T_4 and control, T_5 were spoiled. After 45 days the counts were 6.00, 6.00 and 5.00 x 10^{-3} cfu/g m T_2, T_3 and T_4 respectively whereas T_5 sample was spoiled.

Table 9: Enumeration of fungi x io4 cfu/g Anab-e-shahi and Thompson seedless

	Anab-e-Shahi					Thompson seedless				
Storage period(days)	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
0	4.00	3.00	3.00	3.00	3.00	4.00	3.00	3.00	3.00	3.00
15	6.00	4.00	3.00	4.00	4.00	7.00	4.00	3.00	4.00	3.50
30	-	4.00	5.00	4.00	-	-	4.00	5.00	4.00	-
45	-	6.00	6.00	5.00	-	-	6.00	6.00	5.00	-

Statistical analysis of the data revealed that Thompson seedless days of storage and treatments (1) and their maturations were highly significant In the grapes treatment minimum bacterial load was found m grapes stored m MAP followed by each and T_5 samples In the case of treatments (1) T_2, T_3 and T_4 were on par with each other and significantly different from T_5 sample.

Conclusions

The results obtained from the experiments carried out to increase the post-harvest life of selected grapes like Anab-e-shahi and Thompson seedless through modified atmosphere packaging and storage (MAP) is given below Data on the changes m chemical constituents, microbial population and organoleptic evaluation of stored products have been summarized. Valid conclusions drawn from the results of the study have been discussed. Modified atmosphere packaging unit was fabricated and erected. The minimally processed fruits and vegetables were stored in a modified atmosphere using standardized gas mixtures (7.0, 13.0 and 80.0; 7.0, 13.0 and 80; 13.0, 7.0 and 80.0; 130, 70 and 80, 20.0, 10.0 and 8.00, and 2.00, 1.00 and 800percentofoxygen, carbon dioxide and nitrogen respectively) for grapes (Thompson seedless and Anab-e-shahi), at refrigeration temperature (12 °C).

Anab-e-shahi

A gradual decrease in the moisture content was recorded throughout the storage period. The final moisture content was 73.60 for MAP (T2), 73.62 for MAP + citric acid (T_3) and 73.80 g per cent for MAP + potassium metabisulphite (T_4) in grapes which had the initial moisture content of 78.42 g per cent. In the acidity was noted throughout the study period. The maximum increase was found in T_2, T_3 and T_4 (2.10, 2.9 and 2.10 g per cent) of grapes). Among the pretreatments given T_2, T_3 and T_4 had retained the TSS in grapes during the storage. The TSS was 15.80, 15.80 and 15.80 for Anab-e-shahi grapes. A decreasing trend in the ascorbic acid content was noticed in the samples. The ascorbic acid in MAP (T_2), MAP + citric acid (T_3) and MAP + potassium metabisulphite (T_4) were 14.19, 14.18 and 14.15 tug per cent respectively. The reducing sugar content was observed during the study period. The initial reducing sugar was 56.71 g per cent. The percentage reduction was maximum in 56.90, followed by T_3 and T_4 as 56.91 and 56.92 g per cent at the end of the storage period. A gradual reduction in the total sugar content was recorded in the Anab-e-shahi grapes throughout the study period. After 45 days of

storage T_2 (MAP), T_3 (MAP+ citric acid) and MAP + potassium metabisulphite (T_4) decreased and the values were 94.19, 94.16 and 94.10 g per cent in grapes respectively.

Thompson seedless

A gradual decrease in the moisture content was recorded throughout the storage period The final moisture content was 6920 for (MAP) T_2 69.10 for MAP citric acid (T_3) and 69.00 g per cent for MAP + potassium metabisulphite (T_4) Thompson seedless grapes which had the initial moisture of 7768 g per cent) and increase the acidity was noted throughout the study period The maximum increase was found in T_2 1 08, T_3 1.10 and T_4 1.12 g per cent for grapes. Among the pretreatments given T_2, T_3 and T_4 had retained the TSS in grapes during the storage. (The TSS was 22.5, 22.5 and 22.5 °brix for grapes. A decreasing trend in the ascorbic acid content was noticed in the samples. The ascorbic acid in (MAP) T_2, MAP+ citric acid (T_3) and MAP + potassium metabisulphite (T_4) were 5.30, 5.37 and 5.36 mg per cent respective. A steady increase in the reducing sugar content was observed during the study period. The initial reducing sugar was 9.62 g per cent. The percentage reduction was maximum in 9.80, 9.81 and 9.81 g per cent in T_2, 1.73 and T_4 respectively at the end of the storage period a gradual reduction in the total sugar content was recorded in the Thompson seedless- grapes throughout the study period. At the end (45 days) of the storage T2. MAP+ citric acid) and MAP + potassium metabolites (T_4) had decreased to 15.17, 15.14 and 15.13 g per cent in grapes respectively. The quality attributes like appearance, color, flavor, texture, taste and overall acceptability of grapes showed that higher values were scored in control (T_1) followed by T_2, T_3 and T_4 and T_5 respectively. A gradual increase in the bacterial load was noted in grapes as the storage period increased. The increase was higher in control sample (T_1) and the values were 12.00, 12.00 and 11.00 x 10 cfu/g in T_5 compared to others, like T_2, T_3 and T_4 after 45 days of storage. A gradual increase sin fungi was observed throughout the study period. After 45 days, the count was found in T_2, T_3 and T_4 were 6.00, 6.00 and 5.00 x 10^{-3} cfu/g respectively.

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