Research Article

Effect of Various Chemical Additives on Storage Stability of Muskmelon Jam at Ambient Temperature

Zahid Mehmood*, Alam Zeb and Muhammad Ayub

Department of Food Science & Technology, The University of Agriculture, Peshawar, KPK, Pakistan

Abstract | The research was carried out to standardize and investigate the effect of different chemical preservatives (potassium metabisulphite, potassium sorbate and sodium benzoate) on the storage stability of muskmelon jam. The treatments included M_{J1} (Muskmelon + Sucrose + no preservatives), M_{J2} (Muskmelon + Sucrose + 0.1% sodium benzoate), M_{J3} (Muskmelon + Sucrose + 0.1% potassium sorbate), M_{J4} (Muskmelon + Sucrose + 0.01% potassium metabislulphite), M_{J5} (Muskmelon + Sucrose + 0.05% sodium benzoate + 0.05% potassium sorbate), M_{J6} (Muskmelon + Sucrose + 0.05% sodium benzoate + 0.01% potassium metabisulphite), M_{J7} (Muskmelon + Sucrose + 0.05% potassium sorbate + 0.01% potassium metabisulphite) and M_{J8} (Muskmelon + Sucrose + 0.033% sodium benzoate + 0.01 potassium metabisulphite + 0.033% potassium sorbate) and stored at ambient temperature (22-32^{0}C). The jam was studied for physicochemical attributes (TSS, pH, titratable acidity, total phenolic compounds, antioxidant activity, ascorbic acid) and organoleptic characteristics (flavor, color, texture and overall acceptability). The results revealed decrease ($P<0.05$) in pH, ascorbic acid, total phenolic content, antioxidant activity while increase in acidity, total soluble solids during six months storage. Decrease in score of organoleptic attributes was recorded during the storage. The results revealed that ($P<0.05$) the treatment Muskmelon + Sucrose + 0.033% Sodium benzoate + 0.033% Potassium sorbate + 0.01 potassium metabisulphite showed comparatively better results for physicochemical parameters as well as for organoleptic evaluation.

Received | August 10, 2017; **Accepted** | September 29, 2017; **Published** | October 28, 2017
***Correspondence** | Zahid Mehmood, The University of Agriculture, Peshawar, KPK, Pakistan; **Email:** zahidnifa@gmail.com
Citation | Mehmood, Z., A. Zeb and M. Ayub. 2017. Effect of various chemical additives on storage stability of muskmelon jam at ambient temperature. *Sarhad Journal of Agriculture*, 33(4): 573-581.
DOI | http://dx.doi.org/10.17582/journal.sja/2017/33.4.573.581
Keywords | Muskmelon, Preservatives, Physico-chemical properties, Shelf life

Introduction

Melon fruit belongs to Cucurbitaceae family. The most important genera of melon, *cucumuis* (muskmelon) and *citrullus* (water melon), are also known as sweet melons or dessert (Lester, 1997). Melon is one of the most widely used fruits and stands the stands at 4th in ranking of mostly consumed fruits in the world as source of food (Egbebi, 2014). Recent growth in economy and change in life styles have increased the importance of production and utilization of fruit and vegetables. Food security, poverty alleviation and sustainable agriculture are the main goals in food and vegetable sector. Due to absence of appropriate storage and trade expertness, producers are enforced to dispose their harvest at minimal rate leading to diminishing returns (Omolo et al., 2011).

It is reported that in developing countries producers lose more than 35 percent or 32-40 billion annually, after the crop is ready to harvest and before it is consumed (Parveen et al., 2014). Fruits, because of their high moisture content and nutrients availability and favorable pH are more vulnerable to the infestation of pathogenic fungi, which in addition to fungal rots, makes the fruits unsound for human utilization

(Philips, 1984; Stinson et al., 1981; Moss, 2002). In order to give maximum returns to farmers and to curtail post harvest losses during glut season, there is dire need for value addition of the produce. Value addition is practice that enhances the commodities value by different methods. It may be the conversion of original produce to different products e.g. fruit leather, jams, pickles, jellies and juices etc. The main theory behind food processing is to enhance the storage period of horticultural produce beyond the period when the commodity is flooded in its peak season (Parveen et al., 2014).

As muskmelon fruit contain important phenolic phytochemicals and other essential nutrients and preserving its pulp will meet the demand of market throughout the year. Stored pulp and its products will also facilitate food industry. The preservation will not only be helpful in lowering the post harvest losses but will enhance the livelihood of fruit growers, commerce and the economy of the nation.

Materials and Methods

Muskmelon fruit jam was prepared as desribed by Awan and Rehman (1999). Stainless steel kettles were used for jam preparation. The Muskmelon pulp was taken separately for each treatment. Citric acid (0.2%) was added to maintain the acidity of jam. Commercial grade pectin (0.5%) was dissolved with sucrose. Chemical additives of potassium metabisulphite (KMS), potassium sorbate (PS) and sodium benzoate (SB) were added in combination and alone at the end of cooking. Chemical preservatives were added according to Codex General Standard for Food Additives (Codex Stan 192-1995). Treatments of jam were MJ1 (Muskmelon + Sucrose + no preservatives), MJ20 (Muskmelon + Sucrose + 0.1% SB), MJ3 (Muskmelon + Sucrose + 0.1% PS), MJ4 (Muskmelon + Sucrose + 0.01% KMS), MJ5 (Muskmelon + Sucrose + 0.05% SB + 0.05% PS), MJ6 (Muskmelon + Sucrose + 0.05% SB + 0.01% KMS), MJ7 (Muskmelon + Sucrose + 0.05% PS + 0.01% KMS) and MJ8 (Muskmelon + Sucrose + 0.033% SB + 0.033% PS + 0.01 KMS). The jams was packed in 350gm glass jars and kept at ambient storage.

Physico-chemical analysis

Total soluble solids (TSS)

TSS in muskmelon jam was measured with hand refractometer at ambient temperature by the recommended method of AOAC (2012).

pH

Hanna Digital pH meter 720 was used to measure the pH of the different muskmelon jam samples.

Ascorbic acid (mg/100g)

It was analyzed according to the standard procedure of AOAC (2012).

Titratable acidity (%)

The regular method of AOAC (2012) was used for its determination in muskmelon jam samples

Total phenolic compounds

Phenolics content in the jam was measured according to procedure given by Mazumdar and Majumder (2003). The samples (5g) were extracted in of water (100 ml). Took 0.04mL of the extracted solution with 3.16 ml of distilled water in test tube and shaken for 10 seconds. Then added 0.2 ml Folin-Ciocalteau's phenol reagent followed by vigorous shaken for 10 seconds each test tube. After 6 min of reaction added 0.6 ml of sodium carbonate solution to the mixture and shaken for 10 seconds. After incubation for 2 hours in the dark place the absorbance at 765nm was measured using spectophotometer. The measurements were plotted against the gallic acid curve and were depicted as mg of gallic acid equivalents by gram of solution.

Antioxidant activity (%)

It was measured in terms of DPPH free radical scavenging activity as described by Brand- Williams et al. (1995). Antioxidant activity in the muskmelon jam samples was indicated by TE/100g.

Sensory Evaluation

Organoleptic analysis for different jam samples was done by using 9 point Hedonic Scale as stated by Larmond (1977). Trained panel of nine graded the color, taste and overall acceptability.

Statistical Analysis

All the results were analyzed by SPSS. The effect of different variables were carried out by completely randomized design with two factors. Means were separated according to the method depicted by Steel et al. (1997) by employing least significant difference.

Results and Discussion

pH and % Acidity

pH of muskmelon jam samples decreased during storage. Decrease in mean values was observed from 3.91 to 3.58 during six-month storage at ambient temperature. Decrease in pH values recorded for MJ1 (Figure 1 A and B) was 3.91 to 3.33, MJ2 was from 3.92 to 3.64, MJ3 it was noted from 3.92 to 3.59 while for MJ4 the values were from 3.92 to 3.54 during six months storage. Similarly values observed for MJ5 decreased from 3.93 to 3.66, MJ6 from 3.90 to 3.63, MJ7 from 3.89 to 3.62 and for MJ8 decrease was observed from 3.90 to 3.67. Maximum percent decrease in the jam samples was recorded in MJ1 (14.85%) seconded by MJ4 (9.69%) while minimum decrease in muskmelon jam samples was recorded in MJ8 (5.78%) followed by MJ5 (6.87%). The values for pH for muskmelon jam were significantly different at ($p < 0.05$).

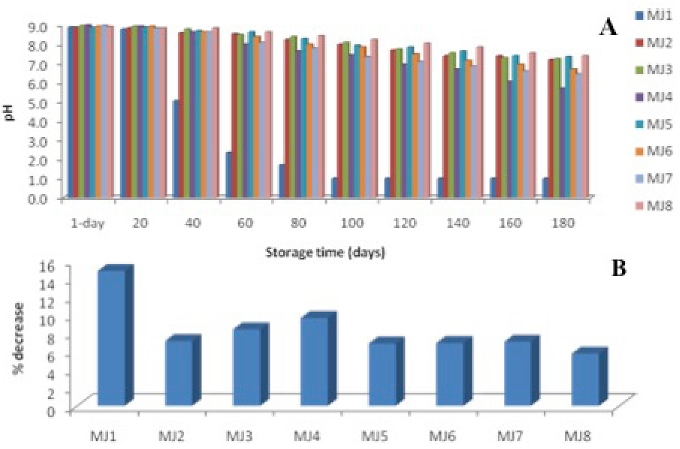

Figure 1: *Effect of various chemical preservatives (A) on the pH (B) percent decrease in PH of muskmelon jam stored at ambient temperature (22-32˚C).*

pH plays double task in the fruit jam by performing as preservative and also improving the flavour. A lot of authors have reported decrease in pH of various products in response to raise in acidity (Bajwa et al., 2003; Hussain et al., 2008). Titratable acidity increased in muskmelon jam throughout ambient storage of six months. Increase in mean values was observed (Figure 2 A and B) from 0.65 to 0.74 during six month storage at ambient temperature. Increase in titratable acidity recorded for MJ1 was 0.66 to 0.83 while similar values for MJ2 values were 0.66 to 0.74 and for MJ3 values recorded were 0.65 to 0.72, where as for MJ4 the values were from 0.64 to 0.75 during six months storage. Similarly values observed for MJ5 increased from 0.64 to 0.71, MJ6 from 0.66 to 0.73, MJ7 from 0.65 to 0.75 and for MJ8 increase was noted from 0.66 to 0.72. Maximum percent increase in the titratable acidity of muskmelon jam samples was observed in MJ1(25.95%) followed by MJ4 (16.41%) while minimum decrease in muskmelon jam samples was recorded in MJ8 (9.16%) followed by MJ6 (10.69%). All the values for titratable acidity for muskmelon jam were significantly different at ($p < 0.05$).

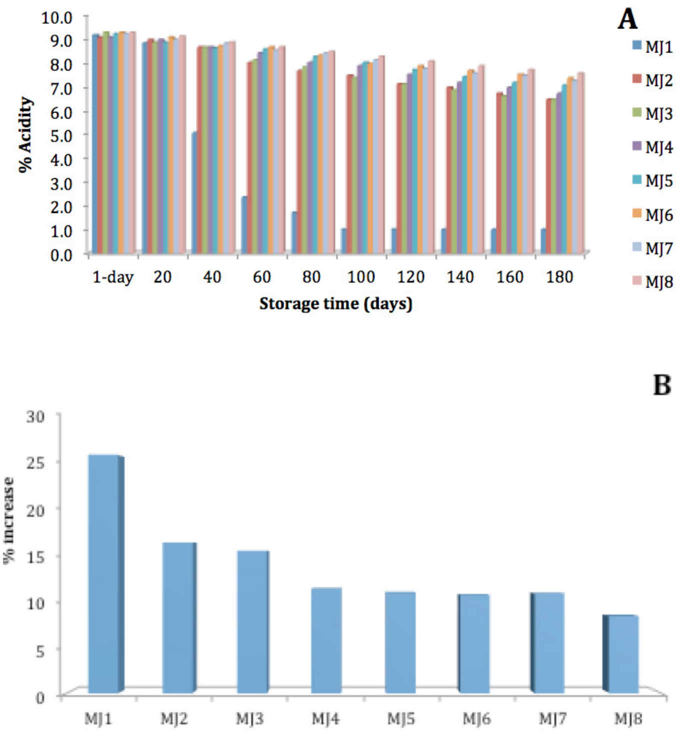

Figure 2: *Effect of various chemical preservatives (A) on the % acidity (B) percent increase of acidity of muskmelon jam stored at ambient temperature (22-32˚C).*

Findings are in concurrence with Ehsan et al. (2002) who expressed raise in acidity while studying storage stability of jam. Our results are in agreement with Rababah et al. (2011) who researched the effect of processing and storage on pH in different jams. It was depicted that during storage the pH decreased in fig, apricot and orange jam. The decrease in pH values might be owing to creation of hydroxy methyl furfural by water absorption by sugar in processing and storage guiding to change of hydroxy methyl furfural into levulinic and formic acid. The findings depicted that titratable acidity raised from 0.68 to 0.86 % at ambient storage of muskmelon jam. Similarly the facts are in line with the findings of Khan et al. (2012) who studied the standardization and storage of strawberry jam and found increase in the acidity and decline in pH in two months storage. Wisal et al. (2013) also obtained similar results while working on the influence of preservatives on strawberry juice.

Total Soluble Solids (TSS)

There was slight increase in total soluble solids of muskmelon jam during storage period of six months. Increase in mean values was observed from 68.47 to 69.50 during six month storage at ambient temperature. Increase in total soluble solids recorded (Figure 3 A and B) for MJ1 was 68.45 to 70.65 while values observed for MJ2 were from 68.30 to 69.45 and MJ3 were 68.55 to 69.25, where as for MJ4 the values were from 68.45 to 69.50 during six months storage. Similarly values observed for MJ5 increased from 68.45 to 69.25, MJ6 from 68.50 to 69.30, MJ7 from 68.45 to 69.45 and for MJ8 increase in TSS was noted from 68.60 to 69.15. Maximum percent increase in the total soluble solids of muskmelon jam samples was observed in MJ1(3.21%) followed by MJ2 (1.68%) while minimum decrease in muskmelon jam samples was recorded in MJ8 (0.80%) followed by MJ3 (1.02%). All the values of TSS for muskmelon jam were significantly different at ($p < 0.05$).

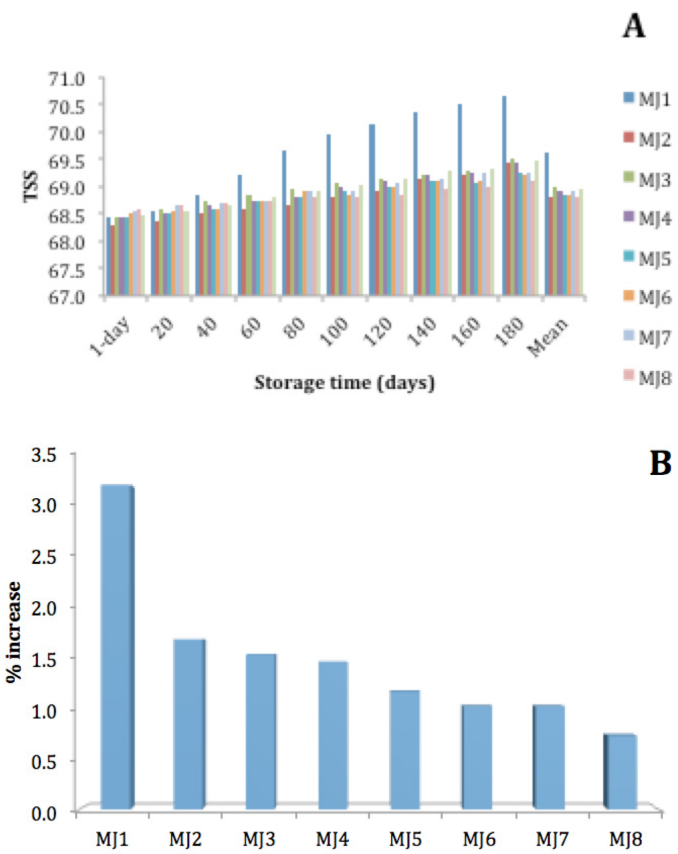

Figure 3: *Effect of various chemical preservatives (A) on the TSS (B) percent increase of TSS of muskmelon jam stored at ambient temperature (22-32°C).*

These findings are in agreement with Tremazi (1967) who found out that during storage total soluble solids raised in canned peach fruit. Ehsan et al. (2002, 2003) worked on watermelon and lemon jam and found the increase in TSS from 68.60 to 68.90 while in the grape fruit apple marmalade increase in total soluble solids was recorded from 70.0 to 70.8 after two months of storage period. Similarly the findings are in agreement with Khan et al., (2012) who worked on the standardization and shelf life of strawberry jam and found that total soluble solids increased during the storage period of two months. Increase in TSS might be due to conversion or solubilization of compounds other than carbohydrates. TSS could have also increase due to hydrolysis of cell wall constituents or increase in galacturonic acid by polygalacturanase (Davidson et al, 2005).

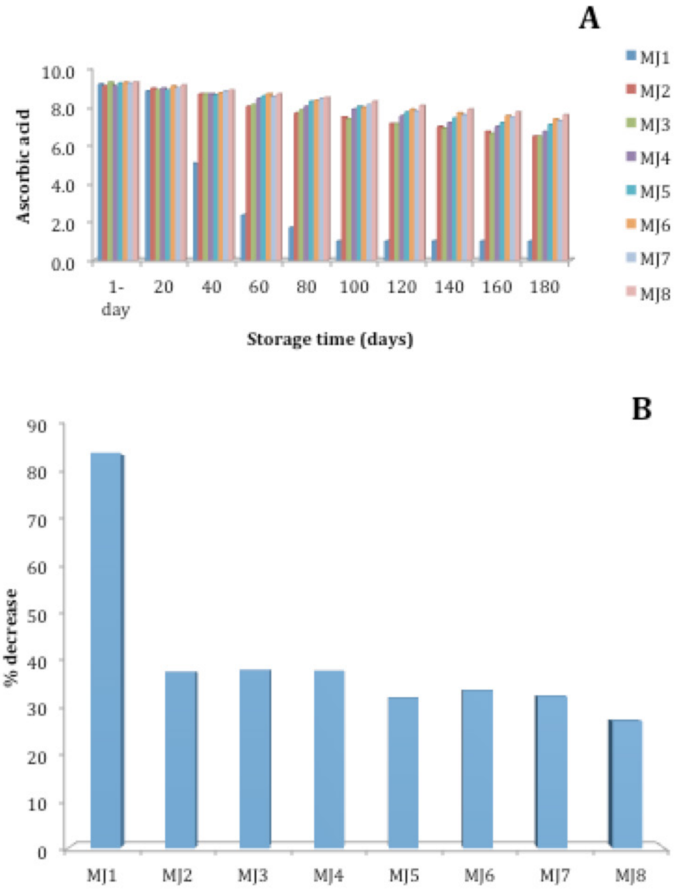

Figure 4: *Effect of various chemical preservatives (A) on the ascorbic acid (B) percent decrease of ascorbic acid of muskmelon jam stored at ambient temperature (22-32°C).*

Ascorbic acid

Ascorbic acid (Vit. C) is an important nutritional factor in any fruit product. Ascorbic acid decreased in muskmelon jam samples during storage period of six months at ambient temperature. Decrease in mean values (Figure 4 A and B) was recorded from 8.99 to

5.28 during storage of muskmelon jam. Decrease in ascorbic acid recorded for MJ1 was 9.0 to 1.4, MJ2 was from 9.1 to 6.15, MJ3 it was noted from 9.05 to 6.00 while for MJ4 the values were from 8.85 to 4.95 during six months storage. Similarly ascorbic acid values observed for MJ5 decreased from 9.05 to 6.05, MJ6 from 8.95 to 5.55, MJ7 from 8.90 to 5.55 and for MJ8 decrease in vitamin C was observed from 9.0 to 6.55. Maximum percent decrease for ascorbic acid in the muskmelon jam samples was observed in MJ1(84.44%) followed by MJ4 (44.07%) while minimum decrease in muskmelon jam samples was recorded in MJ8 (27.22%) followed by MJ2 (32.42%). All the values for ascorbic acid for muskmelon jam were significantly different at ($p< 0.05$).

Results are in agreement with Damiani et al. (2012) who worked on the antioxidant potential of Brazilian Savannah jam during storage and reported that ascorbic acid decreased during storage period of twelve months. A decline in ascorbic acid content was also recorded during the storage of three months in guava jam, as reported by Jawaheer et al. (2003). He said that there was a 62.50% decline in the processing, getting over 70%, owing to storage conditions and existence of residual oxygen. Ascorbic acid is degraded to furfural anaerobically after utilizing all the oxygen. In addition another reason is low water content and also its utilization in the Maillard reaction (Giannakourou and Taoukis 2003). Decrease also might be due to oxidation of ascorbic acid to dihydroascorbic acid (Mehmood et al., 2008).

Antioxidant activity

Antioxidant activity decreased in muskmelon jam samples during storage period of six months at ambient temperature. Decrease in mean values was recorded (Figure 5 A and B) from 18.26 to 10.14 during storage of muskmelon jam. Decrease in antioxidant activity recorded for MJ1 was 18.23 to 1.01, MJ2 was from 18.43 to 12.45, MJ3 it was noted from 18.28 to 12.12 while for MJ4 the values were from 18.01 to 7.16 during six months storage. Similarly antioxidant activity observed for MJ5 decreased from 18.51 to 12.92, MJ6 from 18.07 to 11.27, MJ7 from 18.08 to 11.21 and for MJ8 decrease in antioxidant activity was observed from 18.45 to 13.00. Maximum percent decrease for antioxidant activity in the muskmelon jam samples was observed in MJ1(94.49%) followed by MJ4 (60.27%) while minimum decrease in muskmelon jam samples was recorded in MJ8 (29.57%) followed by MJ5 (30.22%). All the values of antioxidant activity for muskmelon jam were significantly different at ($p< 0.05$).

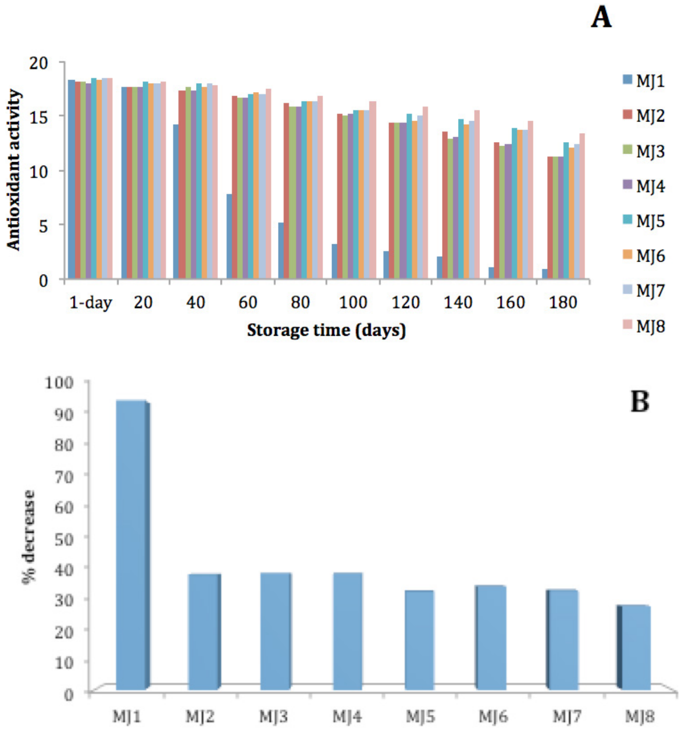

Figure 5: *Effect of various chemical preservatives (A) on the antioxidant activity (B) percent decrease of antioxidant activity of muskmelon jam stored at ambient temperature (22-32°C).*

The findings were in agreement with the results reported earlier by Kim and Zakour (2004) who confirmed that the antioxidant capacity of raspberry, plum and cherry reduced after jam processing. The data of antioxidant activity contracted with those of Wicklund et al. (2005) who stated that there was a decrease in anthocyanins and antioxidant activity during processing of strawberry jam. According to Ismail et al. (2004) it could be due to oxygen and free radicals (to protect the juice from oxidation these compounds itself reacts with oxygen and become oxidise). Results are in concurrence with those of Rababah et al. (2011) who studied the effect of processing and storage on antioxidant activity in different jams. It was revealed that during storage the antioxidant activity decreased in fig, apricot and orange jam.

Total phenolic compound

Total phenolic compound is an important nutritional factor in any fruit product. Total phenolic compound (mg gallic acid equivalents/100g) decreased in muskmelon jam samples during storage period of six months at ambient temperature. Decrease in mean values (Figure 6 A and B) was recorded from 2.97 to 1.73 during storage of muskmelon jam. Decrease in total phenolic compound recorded for MJ1 was 2.99 to 0.46, MJ2 was from 2.94 to 1.83, MJ3 it was noted from 2.96 to 1.84 while for MJ4 the values were from 2.93 to 1.50 during six months storage. Similarly total phenolic compound observed for MJ5 decreased from 2.99 to 2.11, MJ6 from 3.00 to 1.99, MJ7 from 3.01 to 1.99 and for MJ8 decrease in total phenolic compound was observed from 2.98 to 2.14. Maximum percent decrease for total phenolic compound in the muskmelon jam samples observed in MJ1 (84.44%) followed by MJ4 (48.90%) while minimum decrease in muskmelon jam samples was recorded in MJ8 (28.36%) followed by MJ5 (29.64%). All the values for total phenolic compound for muskmelon jam were significantly different at ($p < 0.05$).

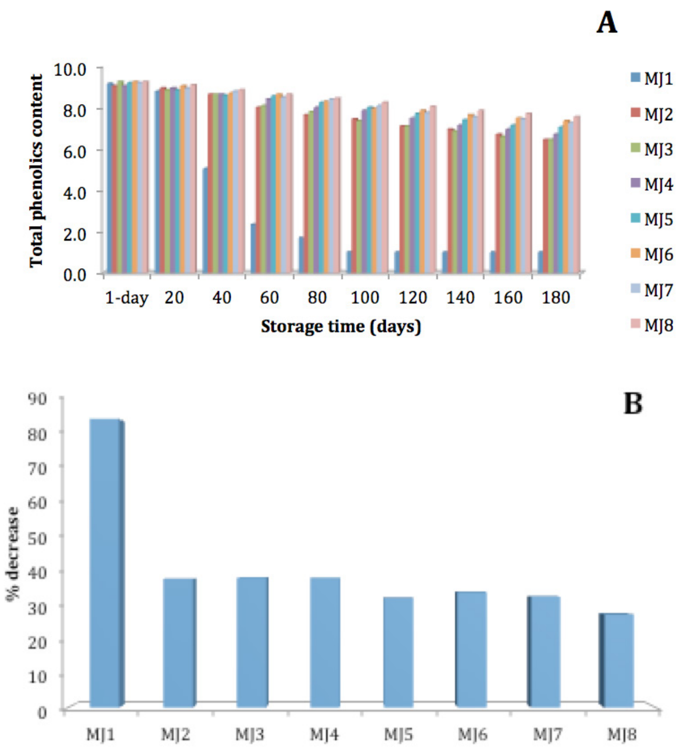

Figure 6: *Effect of various chemical preservatives (A) on the total phenolic content (B) percent decrease of total phenolic content of muskmelon jam stored at ambient temperature (22-32°C).*

The decrease during jam processing and storage in total phenolics might be due a decline in total ellagic acid (Hakkinen et al., 2000) or may be owing to disruptions in cell structure during the processing of fruit (Patras etal., 2009). These findings are also in line with Kim and Padilla-zakour (2004) who revealed that significant decrease in the total phenolics from 9% and 27% in two types of cherry after processing of jam. Results are in concurrence with those of Rababah et al. (2011) who studied the effect of processing and storage on total phenolics in different jams. It was revealed that during storage the total phenolics decreased in fig, apricot and orange jam.

Sensory evaluation

Nine point hedonic scale was used by the panel of judges for the sensory evaluation of muskmelon jam during storage. Score for color decreased in muskmelon jam samples during storage period of six months at ambient temperature. Decrease in mean values (Figure 7 A and B) was recorded from 8.90 to 6.04 during the storage of muskmelon jam. Decrease in score for color recorded for MJ1 was 8.85 to 1.00, MJ2 was from 9.00 to 7.15, MJ3 it was noted from 8.95 to 7.00 while for MJ4 the values were from 8.90 to 5.70 during six months storage. Similarly score obtained by MJ5 decreased from 8.85 to 7.25, MJ6 from 8.85 to 6.55, MJ7 from 8.90 to 6.35 and for MJ8 decrease in score for appearance was observed from 8.90 to 7.35. Maximum percent decrease for score in color of the muskmelon jam samples was observed in MJ1 (88.70%) followed by MJ4 (35.96%) while minimum decrease in muskmelon jam samples was recorded in MJ8 (17.42%) followed by MJ5 (18.08%). All the values for appearance of muskmelon jam were significantly different at ($p < 0.05$).

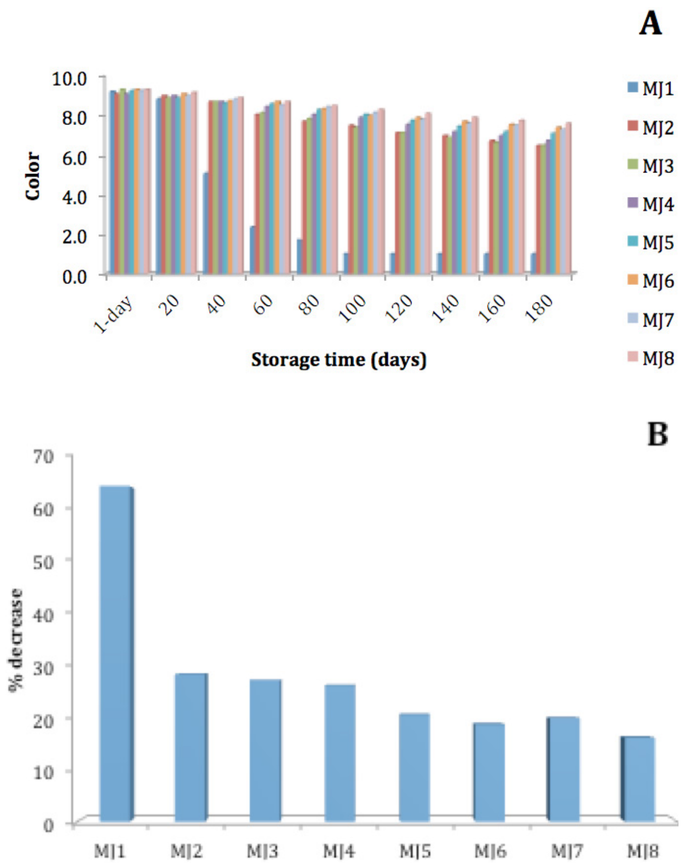

Figure 7: *Effect of various chemical preservatives (A) on the color score (B) percent decrease of color score of muskmelon jam stored at ambient temperature (22-32°C).*

Score for flavor also decreased in muskmelon jam samples during storage period of six months at room temperature. Decrease in mean values was recorded (Figure 8 A and B) from 8.9 to 6.04 during the storage of muskmelon jam. Decrease in score for flavor observed for MJ1 was 8.85 to 1.0, MJ2 was from 9.0 to 7.20, MJ3 it was noted from 8.95 to 7.15 while for MJ4 the values were from 8.90 to 5.70 during six months storage. Similarly score obtained by MJ5 decreased from 8.85 to 7.15, MJ6 from 8.85 to 6.55, MJ7 from 8.90 to 6.35 and for MJ8 decrease in score for flavor was observed from 8.90 to 7.25. Maximum percent decrease for score in flavor of the muskmelon jam samples was observed in MJ1(88.70%) followed by MJ4 (35.96%) while minimum decrease in muskmelon jam samples was recorded in MJ8 (18.54%) followed by MJ6 (19.21%). All the values for flavor of muskmelon jam were significantly different at ($p<$ 0.05).

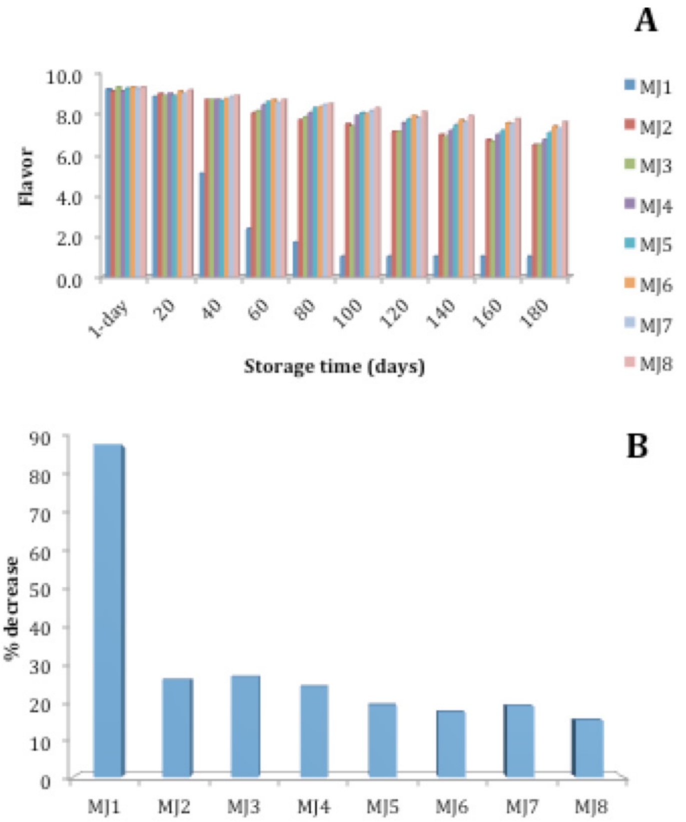

Figure 8: *Effect of various chemical preservatives (A) on the flavor score (B) percent decrease of flavor score of muskmelon jam stored at ambient temperature (22-32°C).*

Overall acceptability of any food product is of primary importance in product development. Score for overall acceptability also decreased in muskmelon jam samples during storage period of six months at room temperature. Decrease in mean values was recorded (Figure 9 A and B) from 8.94 to 6.13 during the storage of muskmelon jam. Decrease in score for overall acceptability observed for MJ1 was 8.90 to 1.0, MJ2 was from 8.89 to 7.20, MJ3 it was noted from 8.98 to 7.25 while for MJ4 the values were from 9.00 to 5.70 during six months storage. Similarly score obtained by MJ5 decreased from 8.89 to 7.35, MJ6 from 8.95 to 6.70, MJ7 from 8.99 to 6.45 and for MJ8 decrease in score for flavor was observed from 8.93 to 7.40. Maximum percent decrease for score in overall acceptability of the muskmelon jam samples was observed in MJ1(88.76%) followed by MJ4 (36.67%) while minimum decrease in muskmelon jam samples was recorded in MJ8 (17.09%) followed by MJ5 (17.30%). All the values for overall acceptability of muskmelon jam were significantly different at ($p<$ 0.05).

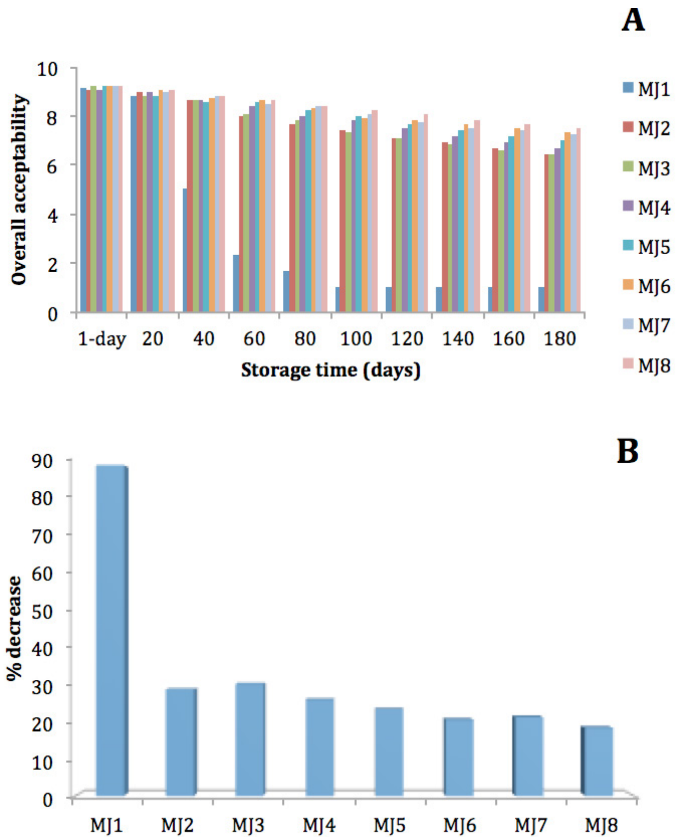

Figure 9: *Effect of various chemical preservatives (A) on the overall acceptability score (B) percent decrease of overall acceptability score of muskmelon jam stored at ambient temperature (22-32°C).*

These finding are in agreement with Ramayya et al. (2012) who stated that taste and flavor of Alphonso mangoes depicted considerably diminishing trend after fifteen days of storage period. Results are also in agreement with Mehmood et al. (2008) who while revealed decrease in the score for organoleptic values during the storage of three months at ambient temperature. Similarly the results are in line with the findings of Khan et al. (2012) who worked on the standardization and storage stability of strawberry jam and found that score for organoleptic attributes decreased during the storage period of two months. Results are in agreement with Wisal et al. (2013) who reported decrease in organoleptic values during storage of strawberry juice.

Conclusions

The overall findings of physicochemical analysis and organoleptic depicted that the treatment MJ8 of jam samples (Muskmelon + Sucrose + 0.033% Sodium benzoate + 0.033% Potassium sorbate + 0.01 potassium metabisulphite) comparatively showed better results for physicochemical parameters as well as for organoleptic evaluation during six months of storage. Furthermore, it was confered from the data that combination of chemical preservatives performs better as compared to alone doses. The results suggest that combination of preservatives may be used in low quantity to get better results as compared to high dose of single preservative.

Author's Contributions

Zahid Mehmood conceived the basic idea, did data collection, data entry and analysis and write-up of manuscript. Alam Zeb Supervised the research and improved manuscript. Muhammad Ayub provided technical input at every step of research.

References

A.O.A.C. 2012. Association of official and analytical chemists. 19th Ed (Helrich, K.). Arlington, Virgina, USA.

Awan, J. and S. Rehman. 1999. Food Preservation manual unitech.com. Faisalabad. Pak. 50p.

Bajwa, E.E., Z. Naeem, J. Anjum and A. Nazir. 2003. Development, standardization and storage studies on watermelon-lemon. Pak. J. Food Sci. 12: 21-24.

Brand-Williams, W., M.E. Cuvelier and C. Berset. 1995. Use of free radical method to evaluate antioxidant activity. Lebensm. Wiss. Technology 28: 25–30. https://doi.org/10.1016/S0023-6438(95)80008-5

Damiani C., F.A Silva, E.R. Asquieri, M.E. Lage and E.V.B.V. Boas. 2012. Antioxidant potential of psidium guinnensis sw. jam during storage. Pesq. Agropec. Trop., Goiânia, v. 42(1): 90-98.

Davidson P.M., J.N. Sofos and A.L. Branen. 2005. Antimicrobials in food. Third Edition. CRC Press Taylor & Francis Group 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742.

Egbebi, A.O. 2014. Comparative studies on the three different species melon seed; (*Citrulus vulgaries, Cucumeropsis manni* and *Leganaria siceraria*). Sky J. Food Sci. Vol. 3(1): 1-4.

Ehsan E.B., G.A. Naeem and M.S. Bahtti. 2002. Development, standardization and storage studies on watermelon lemon jam. Pak. J. Food Sci. 12: 21-24.

Ehsan E.B., Z.P. Naeem., A. Javed and A. Nazir. 2003. Development, standardization and storage studies on grape fruit apple marmalade. Pak. J. Food Sci. 13: 11-15.

Giannakourou, M.C. and P.S. Taoukis. 2003. Kinetic modeling of vitamin C loss in frozen green vegetables under variable storage conditions. J. Food Chem. 83: 33-41. https://doi.org/10.1016/S0308-8146(03)00033-5

Hakkinen, S.H., S.O. Arenlampi, H.M. Mykk¨anen and A.R. Torronen. 2000. Influence of domestic processing and storage on flavonol contents in berries. J. Agric Food Chem. 48:2960–2965. https://doi.org/10.1021/jf991274c

Hussain, I., A. Zeb, I. Shakir and A.S. Shah. 2008. Combined effect of potassium sorbate and sodium benzoate on individual and blended juices of apricot and apple fruits grown in Azad Jammu and Kashmir. Pak. J. Nutr. 7(1): 181-185. https://doi.org/10.3923/pjn.2008.181.185

Ismail, A., M.M. Zamaliah and W.F. Chin. 2004. Total antioxidant activity and phenolic content in selected vegetable. J. Food Chem. 87: 581-586. https://doi.org/10.1016/j.foodchem.2004.01.010

Jawaheer B., D. Goburdhun and A. Rugoo. 2003. Effect of processing and storage of guava into jam and juice on the ascorbic acid content, Plant Food Hum Nutr. 58: 1-12. https://doi.org/10.1023/B:QUAL.0000041161.05123.66

Khan R.U., S.R. Afridi., M. Ilyas., M. Sohail and H. Abid. 2012. Development of strawberry jam and its quality evaluation during storage. Pak. J. Biochem. Mol. Biol. 45(1): 23-25.

Kim, D.O. and O.I. Padilla-Zakour. 2004. Jam processing effect on total phenolics and antioxidant activity capacity in anthocyanin-rich fruits: Cherry, plum, and raspberry, sensory and nutritive qualities of food. J. Food Sci. 69:395–400. https://doi.org/10.1111/j.1365-2621.2004.tb09956.x

Kim, D.O and O.I. Padilla-Zakour. 2004. Jam processing effect on phenolics and antioxidant capacity in anthocyanin-rich fruits: cherry, plum and raspberry. J. Food Sci. 69: S395–S400.

Larmond. 1977. Laboratory method of sensory evaluation of food. Publication 1977, Canada, DEptt: Agri. Ottawa.

Lester, G.E. 1997. Melon (*Cucumis melo* L.) fruit nutritional quality and health functionality. Hort. Technol. 7: 222–227.

Mazumdar, B.C. and K. Majumder. 2003. Methods on physico-chemical analysis of fruits. Daya Publishing House, Delhi-110035, pp.162-163

Mehmood, Z., A. Zeb, M. Ayub, N. Bibi, A. Badshah and Ihsanullah. 2008. Effect of pasteurization and chemical preservatives on the quality and shelf stability of apple juice. Am. J. Food Tech. 3(2): 147-153. https://doi.org/10.3923/ajft.2008.147.153

Moss, M. O. 2002. Mycotoxin review. 1. *Aspergillus* and *Penicillium*. Mycologist 16: 116-119.

Omolo, P., P. Tana., C. Mutebi., E. Okwach., H. Onyango and K.O. Okach. 2011. Analysis of avocado marketing in Trans-Nzoia district, Kenya. J. Develop. Agric. Econ. 3(7): 312-317.

Parveen S., I. Bushra., K. Humaira., S. Shazia and M.A. Azhar. 2014. Value addition: A tool to minimize the post-harvest losses in horticultural crops. Green. J. Agric. Sci. 4(5):195-198.

Patras, A., N.P. Brunton and B.K. Tiwari. 2009. Stability and degradation kinetics of bioactive compounds and color in strawberry jam during storage. Food Bioproc. Technol. https://doi.org/10.1007/s11947-009-0226-7

Phillips, D.J. 1984. Mycotoxins as a post-harvest problem.. In: pp. 50-54. H.E. Moline (Ed.), Post-harvest pathology of fruits and vegetables: Post-harvest losses in Perishable crops. Agricultural Experimental Station, University of California, Berkeley Publications, NE.

Rababah, T.M., M.A. Al-Mahasneh., I. Kilani., W. Yang., M.N. Alhamad, K. Ereifeja and M. Al-U'datt. 2011. Effect of jam processing and storage on total phenolics, antioxidant activity, and anthocyanins of different fruits. J. Sci. Food Agric. 91:1096–1102. https://doi.org/10.1002/jsfa.4289

Ramayya, N., K. Niranjan and E. Duncan. 2012. Effects of modified atmosphere packaging on quality of 'Alphonso' Mangoes. J. Food Sci. Technol. 49(6): 721–728. https://doi.org/10.1007/s13197-010-0215-x

Steel, R.G.D., J.H. Torrie and D.A. Dickey. 1997. Principles and procedures of statistics: A biometrical approach. 3rd Ed., McGraw Hill Book Co., New York, USA.

Stinson, E.E., S.F. Osman, E.G. Heisler, J. Siciliano and D.D. Bills. 1981. Mycotoxin production in whole tomatoes, apples, oranges and lemons, J. Agric. Food Chem. 29: 790-792. https://doi.org/10.1021/jf00106a025

Tremazi, S.A. 1967. Canning of Pakistani peaches. Pak. J. Sci. Res. 19: 18-23.

Wicklund, T., H.J. Rosenfeld, B.K Martinsen, M.W Sundfor, P. Lea and T. Bruun. 2005. Antioxidant activity capacity and colour of strawberry jam as influenced by cultivar and storage conditions. J. Food Sci. Technol. 38:387–391.

Wisal S., J. Ullah, A. Zeb and M.Z. Khan. 2013. Effect of refrigeration temperature, sugar concentrations and different chemicals preservatives on the storage stability of strawberry juice. Int. J. Engg. Tech. 13: 160.