Journal of Food Processing & Technology
ISSN: 2157-7110
Hussain et al., J Food Process Technol 2019, 10:4
DOI: 10.4172/2157-7110.1000786

Research Article Open Access

Quality Assessment of Sweet Cherry (*Prunus avium*) Juice Treated with Different Chemical Preservatives

Sajid Hussain[1], Aysha Riaz[1], Murtaza Ali[2], Naeem Ullah[3]* and Nisar Hussain[2]

[1]*Department of Food Science and Technology, The University of Agriculture, Peshawar, Pakistan*
[2]*School of Food Science and Engineering, South China University of Technology, Guangzhou, P.R. China*
[3]*Department of Nutrition and Food Hygiene, School of Public Health, Jilin University, Changchun, Jilin, P.R. China*

Abstract

This research was conducted to assess the quality of sweet cherry juice treated with sodium benzoate and potassium sorbate. The samples were packed in 1000 ml PET bottles and stored at ambient temperature. The treatments were observed for different physiochemical and sensory properties at 30 days interval for 90 days. Results showed a significant increase in Total soluble solids (14.73 to 15.17obrix); titratable acidity (0.85% to 1.15%), and Reducing sugar (10.38% to 11.25%); while a significant decrease in pH (4.38 to 3.32); ascorbic acid (8.66 mg/100 g to 5.10 mg/100 g); sugar acid ratio (17.42 to 13.37), and non-reducing sugar (1.52% to 1.29%). Throughout storage interval, it was observed that Treatment CJ3 (0.1% sodium benzoate+0.1% citric acid) was acceptable physicochemical and we recommend it for commercial use.

Keywords: Cherry; Juices; Chemical preservative; Fruit

Introduction

Cherry fruit can be eaten as fresh, dried, pickled and processed into in jam, marmalades, and juices or canned product. The cherry fruits are grown in more than 40 countries throughout the world [1,2]. Worldwide there are many species are grown such as sweet cherry (*Prunus avium*), sour cherry (*Prunus cerasus*), black cherry (*Prunus serotina*) and West Indian cherry (*Prunus myrtifolia*) [2]. Worldwide total cherry productions were calculated as 2,185,881 metric tons [3]. Swat, Chitral, Quetta, and Gilgit Baltistan are the leading cherry producing areas of Pakistan. According to statistical data, the production and area under cultivation of cherry fruits were estimated at 1,065 thousand hectares and 1,981 thousand tons respectively [4]. In Gilgit Baltistan area under cultivation and production of cherry, fruits were estimated at 1302 hectares and 2,384 tons respectively [5].

The values of pH, titratable acidity and total soluble solids in sweet cherry are ranged from 3.72 to 4.62,0.5 to 1.35 and 13.53 to 22.73 respectively [6,7]. In sweet cherry fruit, the sugar and organic acid found in ranged between 125-265 and 3.67 g/kg to 8.66 g/kg of fresh weight [8]. Fruit juices play a vital role because they are a rich source of nutrients and energy, and provide necessary nutrients such as fructose, glucose, ascorbic acids, folic acid, other vitamins, minerals, antioxidant, polyphenol, and organic acids [9,10]. Despite having the vital role of juice in maintaining human health, soft drinks canned at low temperature had more water activity which causes microbial growth that can be prevented by addition of preservatives [11]. The most commonly used preservatives in soft drink industries are sodium benzoate and sorbate. Mostly at low pH, the efficiency of Sorbic acid attained its peck against yeasts and molds growth but sometimes it also works at pH of 6.5 [12]. Sorbates are safe, efficient, flexible, tasteless, odorless and non-toxic chemical additives, just because of these reasons they are using in the wide range of foods such as juices, jams, cakes, bread cheese, yogurt and many more types of food products [13]. By observation the above different feature, this research was carried out to minimize the post-harvest loses of cherry fruits grown in Gilgit Baltistan.

Materials and Methods

The cherry fruit was bought from the local orchard and was brought PCSIR (Pakistan Council of Scientific and Industrial Research), Skardu Gilgit Baltistan.

Preparation of the samples

The sweet cherry fruits were washed, graded and sorted after that juice was extracted by using fruit pulper. Sodium benzoate and Potassium sorbate preservatives were added to the cherry juice and each sample was packed in PET (Polyethylene terephthalate) bottles of the volume 1000 ml.

Treatments

Following are the treatments:

CJ_0=Cherry juice without preservatives

CJ_1=Cherry juice+0.05% sodium benzoate+0.1% citric acid

CJ_2=Cherry juice+0.05% potassium sorbate+0.1% citric acid

CJ_3=Cherry juice+0.1% sodium benzoate+0.1% citric acid

CJ_4=Cherry juice+0.1% potassium sorbate+0.1% citric acid

Storage

The samples were stored at ambient temperature for 90 days. The physicochemical analysis was conducted at 30 days interval during storage.

Physico-chemical analysis

The pH, Ascorbic acid, Total Soluble Solids (TSS), Titratable acidity, Sugar acid ratio, Reducing sugars, and Non-reducing sugars were determined by the standard method of AOAC [14].

***Corresponding author:** Naeem Ullah, Department of Nutrition and Food Hygiene, School of Public Health, Jilin University, Changchun, Jilin, P.R. China, Tel: 008613154350438; 00924329611612; E-mail: naeemullahswati@gmail.com

Received December 04, 2018; **Accepted** February 04, 2019; **Published** February 08, 2019

Citation: Hussain S, Riaz A, Ali M, Ullah N, Hussain N (2019) Quality Assessment of Sweet Cherry (*Prunus avium*) Juice Treated with Different Chemical Preservatives. J Food Process Technol 10: 786. doi: 10.4172/2157-7110.1000786

Copyright: © 2019 Hussain S, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Statistical analysis

All analytical parameters were tested in triplicates and the obtained data were calculated statistically by using Complete Randomized Design (CRD) two-factor factorial experiment and means were compared by LSD test as followed by Steel and Torrie [15].

Results and Discussions

The sweet cherry juice sample was analyzed for ascorbic acid content. The result demonstrated that the mean value of ascorbic acid content of sweet cherry juice was reduced significantly (p<0.05) from 8.66 mg/100 g to 5.10 mg/100 g during storage. The highest mean was observed in treatment CJ_3 (7.81) followed by CJ_1 (6.97) mg/100 g, while the minimum mean was observed in treatment CJ_0 (6.17) followed by CJ_4 (6.20). Maximum percentage reduction in ascorbic acid was examined in CJ_0 (54.02%) followed by CJ_4 (53.40%) and the minimum decrease was recorded in treatment CJ_3 (27.68%) followed by CJ_1 (33.52%) (Table 1). The ascorbic acid content of sweet cherry juice was significantly affected by the treatment applied and the storage time. Ayub et al. [16] checked the effect of potassium sorbate and sodium benzoate on ascorbic acid content and concluded the reduction of ascorbic acid from 49.9 mg to 32.8 mg. Ascorbic acid is nominal stable vitamin since it is responsive and ruined as the temperature boost and affected by light during storage. The outcome of this research study is excellent conformity with the termination of Muhammad et al. [17]; they inspected that the ascorbic acid decreased (18.96 mg to 12.93 mg) in citrus through the passage of time. Durrani et al. [18] also stated the humiliation of the ascorbic acid content (25.98 mg/100 g to 21.45 mg/100 g) during the preservation of apple pulp. Sabina et al. [19] work are also evidenced by the reduction of ascorbic acid (48.1 to 35.9).

The pH of sweet cherry juice was analyzed at every 30 days interval during three months of storage result indicated that pH was declined. Reduction in mean value of pH occurred significantly (p<0.005) from 4.38 to 3.32. Highest fall off was noted in treatment CJ_2 (3.99) followed by CJ_3 (3.66). On another hand lowest fall off was recorded in CJ_0 (3.46) contrast to CJ_1 (3.62). Reduction in term of percentage, the highest was found in CJ_0 (29.09%) followed by CJ_4 (26.66) while at the same time minimum was a note in CJ_3 (20.85%) go after CJ_1 (21.68) (Table 2). The tenure of storage and applied treatments had significant (p<0.05) effect on the pH of sweet cherry juice. The cause of reduction of pH was pectin conversion in pectic acid which was explored by Imran et al. [20]. Ali [21] research work was also evidence that the acidity in juice raised when the pH declined during storage. Hussain et al. [22] also concluded that as acidity was enhanced after that pH (4.30 to 2.90) were decreased. During apple pulp preservation Durrani et al. [18] also confirmed that pH was declined from (3.71 to 3.65).

During three month of storage, the sweet cherry juice was examined at every 30 days interval for total soluble solids content. The mean value increased significantly (p<0.05) from 14.73 to 15.17. The highest mean value was reported in CJ_0 (15.37°Brix) followed by CJ_4 (15.05°Brix) at the same time lowest value was obtained in CJ_2 (14.82°Brix) nearby CJ_3 (14.83°Brix). In term of percentage increment highest was noted in CJ_0 (7.21%) go after CJ_4 (5.62%) although the smallest increment was noted in sample CJ_3 (1.80%) next with CJ_1 (1.90%) (Table 3). The percentage increased in total soluble solids of cherry juice may be that the sucrose content is upturned in fructose and glucose because of temperature. The conclusion of Ayub et al. [16] is a harmony with our outcome that they found increment in TSS (16.5°C to 17.4°C). Rab et al. [23] preserved orange with heat treatments concluded that enrichment in TSS. Durrani et al. [18] during apple pulp preservation also reported that increment in TSS (9.71°C to 11.36°C). Muhammad et al. [24] et al. reported that an increment occurred in TSS (9.75°C to 11.39°C) in apple pulp during the period of storage.

The sweet cherry juice samples were analyzed at every 30 days of interval, results indicated that the titratable acidity was increased significantly (p<0.05) during 3 months of storage statistically. Mean value increased from 0.80 to 1.15. Treatment CJ_3 (1.04) contained highest % acidity nearby CJ_1 (1.02), on the other hand, CJ_0 (0.95) indicated minimum mean value nearby CJ_4 (0.98). The peak enhance was verified in treatment CJ_0 (27.27%) next with CJ_4 (26.54%) as well lowest increment was found in CJ_3 (25.21%) go after CJ_1 (25.64%) (Table 4). Titratable acidity of cherry juice was affected significantly

Treatments	Storage Interval (30 days)				%Decrease	Means
	Initial	30	60	90		
CJ_0	8.7	6.4	5.6	4	54.02	6.17c
CJ_1	8.5	7.5	6.25	5.65	33.52	6.97b
CJ_2	8.6	6.9	5.35	4.38	49.06	6.30bc
CJ_3	8.85	8.55	7.45	6.4	27.68	7.81a
CJ_4	8.8	6.4	5.5	4.1	53.4	6.20c
Means	8.66a	7.33b	6.16c	5.10d		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 1: Effect of chemical preservatives and storage period on ascorbic acid content (mg/100 g) of sweet cherry juice.

Treatments	Storage Interval (30 days)				%Decrease	Means
	Initial	30	60	90		
CJ_0	4.33	3.28	3.18	3.07	29.09	3.46c
CJ_1	4.15	3.63	3.45	3.25	21.68	3.62bc
CJ_2	4.82	3.81	3.7	3.65	24.27	3.99a
CJ_3	4.22	3.65	3.39	3.34	20.85	3.66b
CJ_4	4.5	3.45	3.35	3.3	26.66	3.65b
Means	4.38a	3.59b	3.43bc	3.32c		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 2: Effect of chemical preservatives and storage period on pH of sweet cherry juice.

Treatments	Storage Interval (30 days)				%Decrease	Means
	Initial	30	60	90		
CJ_0	14.8	14.85	15.9	15.95	7.21	15.37a
CJ_1	14.75	14.8	14.85	15.05	1.99	14.86b
CJ_2	14.7	14.75	14.84	15	2	14.84b
CJ_3	14.73	14.77	14.82	15	1.8	14.83b
CJ_4	14.77	14.8	15.01	15.65	5.62	15.05ab
Means	14.73b	14.87b	14.88ab	15.17a		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 3: Effect of chemical preservatives and storage period on TSS of sweet cherry juice.

Treatments	Storage Interval (30 days)%				%Increase	Means
	Initial	30	60	90		
CJ_0	0.8	0.9	1	1.1	27.27	0.95bc
CJ_1	0.87	0.97	1.07	1.17	25.64	1.02a
CJ_2	0.85	0.95	1.05	1.15	26.08	1.00c
CJ_3	0.89	0.99	1.09	1.19	25.21	1.04c
CJ_4	0.83	0.93	1.03	1.13	26.54	0.98ab
Means	0.85c	0.94c	1.04b	1.15a		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 4: Effect of chemical preservatives and storage period on the acidity of sweet cherry juice.

($p<0.05$) by storage time and treatment applied. Nunes et al. [25] worked on strawberry is the witness of our study they investigated that % acidity increased significantly due to treatments applied and storage time. The main reason for increment in acidity may be due to the effect of sugar content and temperature. The work of Clyesdale et al. [26] is a proof that they concluded that the breakdown of pectin into pectic acid increased the acidity. This research was also in accordance with Iqbal et al. [27]. During the period of preservation of strawberry juice, Sabina et al. [19] also found upgrading in % acidity (1.31 to 2.09).

When the sweet cherry juice samples were analyzed at every 30 days of the interval during storage, reduction in sugar acid ratio was found. Table 5 contained significantly ($p<0.05$) degraded mean value from 17.42 to 13.37. The greatest mean value of sugar acid ratio hold by treatment CJ_0 (16.35) followed by CJ_4 (15.53) at the same time treatment CJ_3 (14.41) enclosed minimum value next with CJ_1 (14.73). Reduction in term of percentage, highest was observed in CJ_0 (24.57%) go after CJ_4 (24.12%) at the same time as treatment CJ_3 (21.62%) and CJ_1 (22.17%) illustrated the minimum fall off in sugar acid ratio (Table 5). This research work exposed that the storage intervals and applied treatments had significant ($p<0.05$) impact on the sugar-acid ratio of sweet cherry juice. Reduction in sugar acid ratio (14.31 to 13.81) also experienced in apple pulp preservation using various chemical preservatives by Durrani et al. [18]. Muhammad et al. [24] described that drop off in sugar acid ratio (29.14 to 28.13) during preservation of mashed variety of apple.

In all the products which based on fruits, the sugars are a crucial constituent because it worked as flavor contributor and natural preservatives. The mean values of Reducing sugar were enhanced significantly ($p<0.05$) from 10.37 to 11.25. The maximum mean value was found in treatment CJ_1 (11.00) go after CJ_3 (10.77) at the same time the lowest mean value was found CJ_2 (10.40) nearby CJ_0 (10.62). Increment in term of percentage, highest was found in treatment CJ_0 (12.78%) compared to CJ_4 (9.21%) while CJ_3 (3.18%) showed minimum increment followed to CJ_1 (6.11%) (Table 6) The treatment applied and duration of storage had significant ($p<0.05$) impact no reducing sugar content of sweet cherry juice. Kink et al. [28] concluded that in the rise of temperature and action of acid present in juice convert the sucrose content in reducing sugar. Conversion of pectin into glucose and fructose due to a temperature increase during storage had studied by Patil et al. [29]. Ruiz-Nieto et al. [30] research worked is a good resemblance to our outcome. An increment in reducing sugar from 16.3 to 18.1 was also observed by Ayub et al. [16].

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
CJ_0	18.5	16.5	15.9	14.5	24.57	16.35a
CJ_1	16.95	15.25	13.87	12.86	22.17	14.73c
CJ_2	17.29	15.52	14.13	13.04	23.83	14.99d
CJ_3	16.55	14.91	13.59	12.6	21.62	14.41e
CJ_4	17.79	15.91	14.57	13.84	24.12	15.53b
Means	17.42a	15.62b	14.42c	13.37d		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 5: Effect of chemical preservatives and storage period on sugar acid ratio of sweet cherry juice.

Treatments	Storage Interval (30 days)				%Decrease	Means
	Initial	30	60	90		
CJ_0	10.03	10.05	10.90	11.50	12.78	10.62bc
CJ_1	10.75	10.85	10.95	11.45	6.11	11.00a
CJ_2	10.10	10.15	10.30	11.05	8.59	10.40c
CJ_3	10.65	10.70	10.75	11.00	3.18	10.77ab
CJ_4	10.35	10.40	10.45	11.40	9.21	10.65abc
Means	10.38b	10.43b	10.72b	11.25a		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 6: Effect of chemical preservatives and storage period on reducing sugar of sweet cherry juice.

Treatments	Storage Interval (30 days)				%Decrease	Means
	Initial	30	60	90		
CJ_0	1.55	1.30	1.18	1.10	40.90	1.29b
CJ_1	1.15	1.10	1.05	1.00	15.00	1.07c
CJ_2	1.45	1.35	1.30	1.25	16.00	1.34b
CJ_3	1.95	1.90	1.85	1.80	8.33	1.88a
CJ_4	1.40	1.30	1.24	1.20	16.66	1.28b
Means	1.52a	1.41b	1.34bc	1.29c		
Mean values followed by different small letters are significantly (P<0.05) different from each other						

Table 7: Effect of chemical preservatives and storage period on non-reducing sugar of sweet cherry juice.

When the sweet cherry juice was analyzed at every 30 days of the interval during three months of storage the mean value of nonreducing sugar was decreased significantly ($p<0.05$). Initially in treatments (CJ_0 to CJ_4) non reducing sugars were 1.55,1.15,1.45,1.95 and 1.40, that later on declined up to 1.10,1.00,1.25,1.80 and 1.20. Reduction happened in mean values significantly from 1.52 to 1.29. Among treatments, the highest mean value was found in CJ_3 (1.88) go after CJ_2 (1.34) at the same time minimum was observed in CJ_1 (1.07) as compared to CJ_4 (1.28). Reduction in term of percentage, maximum was shown by treatment CJ_0 (40.90%) followed by CJ_4 (16.66%) while lowest reduction noted in CJ_3 (8.33%) nearby CJ_1 (15.00%) (Table 7). Result illustrated that the storage duration and applied treatment had a significant impact on sweet cherry juice. During canning of citrus fruit, Karim [31] reported that increment in reducing sugar and reduction in non-reducing sugar occurred at ambient temperature is good accordance of our results. Ali [21] finds out the breakdown of sucrose into glucose and fructose results in enhancement of reducing sugar while reduction of non reducing sugar. Similarly, Hussain et al. [32] concluded in their research work that degradation in non reducing sugar from (8.82 to 7.3) and Akesowan [33] also found the same result.

Conclusion

The research work was carried out on the sweet cherry juice treated with two different chemical preservatives like potassium sorbate and sodium benzoate and it was revealed that the treatments and storage periods had significant ($p<0.05$) impact on cherry juice physicochemically. The sweet cherry juice was packed in PET (polyethylene terephthalate) bottles at a volume of 1000 ml and stored at room temperature for 90 days. Treatment CJ_3 that contained 0.1% sodium benzoate +0.1% citric acid had shown the best result maintaining maximum quality followed by CJ_1, CJ_2 and CJ_4 on the other hand, CJ_0 (control) sweet cherry juice without preservative had shown worse results under the sensory acceptability grade. The result showed that sodium benzoate had excellence effect on keeping maximum quality of sweet cherry juice as compared to potassium sorbate.

References

1. Chadha KL (2003) In cherry, Handbook of horticulture. Delhi, India: Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research (ICAR).

2. Looney NE, Webster AD, Kupperman EM (1996) Cherries: Crop physiology, production and uses. CAB International, Cambridge, UK.
3. FAO (2012) Cherry production. United Nations: Statistical Database-Agriculture.
4. Fruits, Vege. Condiments Stat. Pak. 2012-2013. Govt. of Pakistan Ministry of National Food Security and Research Islamabad.
5. Agriculture, Stat. 2011-2012. Department of Agriculture Gilgit Baltistan.
6. Diaz-Mula HM, Castillo S, Martinez-Romero D, Valero P, Zapata J (2009) Sensory, nutritive and functional properties of sweet cherry as affected by cultivar and ripening stage. Food Sci Tech Int 15: 535-543.
7. Girard B, Kopp TG (1998) Physicochemical characteristics of selected sweet cherry cultivars. J Agri Food Chem 46: 471-476.
8. Usenik V, Fabcic J, Stampar F (2008) Sugars, organic acids, phenolic composition and antioxidant activity of sweet cherry (*Prunus avium* L.). Food Chem 107: 185-192.
9. Storey ML, Forshee RA, Anderson PA (2006) Beverage consumption in the US population. J Am Dietetic Assoc 106: 1992-2000.
10. Kranz S, Hartman T, Siega-Riz AM, Herring AH (2006) A diet quality index for American preschoolers based on current dietary intake recommendations and an indicator of energy balance. J Am Dietetic Assoc 106: 1594-1604.
11. Stiles BA, Duffy S, Schaffner DW (2001) Modeling mold spoilage in cold-filled ready to drink beverages by *Aspergillus niger* and *Penicillium spinulosum*. Food Microbiol 18: 521-529.
12. Varnam AH, Sutherland JP (1999) Fruit juices: Beverages: Technology, Chemistry and Microbiology. Aspen Publication, New York, USA.
13. Sofos JN, Naidu AS (2000) Natural food antimicrobial systems. CRC Press.
14. AOAC (2012) Association of Official and Analytical Chemists. Official methods of analysis Washington, DC.
15. Steel RGD, Torrie JH (1997) Principles and procedures of statistics. Mc. Graw Hill Pub. Co. Inc. New York.
16. Ayub M, Ullah J, Zeb A (2010) Evaluation of strawberry juice preserved with chemical preservatives at refrigeration temperature. Int J Nutr Metabol 2: 79-85.
17. Muhammad R (1986) Effect of light and packaging material on ascorbic acid content and other physicochemical and organolyptic characteristics of citrus during storage. Sarhad J Agri 15: 23-25.
18. Durrani Y, Ayub M, Muhammad A, Ali A (2010) Physicochemical response of apple pulp to chemical preservatives and antioxidant during storage. Int J Food Safety 12: 20-28.
19. Sabina R, Miyan S, Hoque M (2011) Studies on the effects of chemical preservatives on the quality of strawberry (*Fragaria ananassa*) juice in Bangladesh. Int J Nat Sci 1: 4.
20. Imran A, Rafiullah K, Ayub A (2000) Effect of added sugar at various concentrations on the storage stability of guava pulp. Sarhad J Agri 7: 35-39.
21. Ali M (1965) Canning of fruits and vegetables and their juices. Effect of canning quality of juices from different varieties of oranges. Agricultural University, Faisalabad.
22. Hussain I, Zeb A, Ayub M (2011) Evaluation of apple and apricot blended juice preserved with sodium benzoate at refrigeration temperature. World J Agric Sci 7: 136-142.
23. Rab A, Muhammad S, Saeed N (2011) Effect of wet heat treatment duration on the quality of sweet orange stored at room temperature. Sarhad J Agric 27: 189.
24. Muhammad A, Ayub M, Zeb A, Durrani Y, Ullah J, et al. (2011) Physicochemical analysis of apple pulp from mashaday variety during storage. Agric Biol J North Am 2: 192-196.
25. Nunes MCN, Morais MB, Brecht JK, Sargent SA (2011) Quality of strawberries after storage in controlled atmospheres at above optimum storage temperatures. Proc Flo State Hort Soc 108: 273-278.
26. Clydesdale FM, Lin YD, Franci FJ (1972) Formation of 2-pyrrolidone-5-carboxylic acid from glutamine during processing and storage of spinach puree. J Food Sci 37: 45-47.
27. Iqbal S, Yamin A, Wadud S, Shah WH (2001) Production storage packing and quality evaluation of Gouva Nectar. Pak J Food Sci 11: 33-36.
28. Kinh AEH, Dunne CP, Hoover DG (2001) Preparation and preservation of apple pulp with chemical preservatives and mild heat. J Food Prot 28: 111-114.
29. Patil MM, Kalse SB, Sawant AA (2013) Preparation of guava jam blended with sapota. Int J Agric Eng 15: 1167.
30. Ruiz-Nieto A, Lopez AJM, Lopez MR, Lopez MJ (1997) Analysis of sucrose's from strawberry cultivars of commercial interest-contents evolution. Proceedings of the third international strawberry symposium, Veldhoven, Netherlands.
31. Karim (1966) Effect of chemical preservatives on canning of citrus fruit at ambient temperature. J Agric Food Chem 3: 165-180.
32. Hussain I, Zeb A, Ayub M (2010) Quality Attributes of apple and apricot blend juice preserved with potassium sorbate during storage at low temperature. Int J Food Safety 12: 80-86.
33. Akesowan A (2010) Storage stability of reduced-sugar preserved mangoes prepared with acesulfame-k and aspartame. J Agric Biol Sci 6: 150-156.