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Quality assessment of apricot (*Prunus armeniaca* L.) juice treated with different chemical preservatives

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Abstract
The present investigation was conducted to evaluate the quality of Apricot juice treated with sodium benzoate and potassium sorbate. The samples were packed in 500ml PET bottles and stored at ambient temperature for 3 months. The ascorbic acid content was declined during storage from 8.66 to 5.10 mg/100g. Minimum reduction recorded in AJ_3 (7.81)27.68% while maximum in AJ_0 (6.17)54.02%. The pH content of sweet cherry juice reduced from 4.38 to 3.32 while maximum reduction happened in AJ_0 (3.46)29.09% and minimum in AJ_3 (3.66)20.85%. Total soluble solids content was increased from 14.73 to 15.17°brix maximum increment was note in AJ_0 (15.37)7.21% while minimum in AJ_3 (14.83)1.80%. An increased in titratable acidity was found range from 0.85 to 1.15% maximum was recorded in AJ_0 (0.95)27.27 at the same time lowest in AJ_3 (0.04)25.21%. The sugar acid ratio was declined during storage period from 17.42 to 13.37 peck was note in AJ_0 (16.35)24.57% and minimum in AJ_3 (14.41)21.62%. Reducing sugar content of cherry juice was increased from 10.38 to 11.25% highest in AJ_0 (10.62)12.78% and lowest in AJ_3 (10.77)3.18% and reduction in non-reducing sugar was observed, the value ranged from 1.52 to 1.29% greatest in AJ_0 (1.29)40.90% and AJ_3 (1.88)8.33%.

Keywords: apricot juice, chemical preservatives, cultivars, gilgit baltistan

1. Introduction
Apricot (*Prunus armeniaca* L.) is a member of the rosacea family, along with peaches, plum, cherries and almonds is one of the most famous fleshy, stone, pulpy, velvety with a very short hairs and temperate fruit. Apricot fruit can be eaten as fresh, dried and processed into in jam, marmalades, and juices or canned product. Its color from yellow to orange like peach and its taste ranges from sweet to tart. The Apricot fruits grown in more than 40 countries throughout the world commonly in those areas which having latitudes between 358N and 558S of temperate climates (Chadha, 2003). Swat, Chitral, Quetta and Gilgit Baltistan are the leading apricot producing areas of Pakistan. According to statistical data the production and area under cultivation of apricot fruits was estimated at 1,065 thousand hectares and 1,981 thousand tons respectively (Fruit. Veg. Condiments Stat. Pak. 2012-13) [9]. In Gilgit Baltistan area under cultivation and production of apricot fruits were estimated at 1302 hectares and 2,384 tons respectively (Agri. Stat. Dptt. Gilgit Baltistan. 2011-2012) [1].
The values of pH, titratable acidity and total soluble solids in Apricot are ranged from 3.30 to 4.80, 1.5 to 2.55 and 15.51 to 24.56 respectively (Diaz-Mula *et al.,* 2009) [7]. Sugar and organic acid ranged between 129-278 and 4.54 to 9.88 g/kg of fresh weight (Usenik *et al.,* 2008) [22]. In the balance diet of human nutrition fruit juices play a key role because these are rich source of nutrients and instant source of energy and provide necessary nutrients such as fructose, glucose, ascorbic acids, folic acid, other vitamins, minerals, antioxidant, polyphenol and organic acids. (Kranz *et al.,* 2006) [14]. Sodium benzoate and sorbats are widely used preservatives in soft drink industries.
At lower pH the effectiveness of sorbic acid reached its peck against yeasts and moulds growth but some time it also works at pH of 6.6 (Varnam & Sutherland., 1999) [22]. Sorbates are efficient, flexible, tasteless, odorless, and non-toxic chemical additives, due to it is widely range of foods such as juices, jams, breads, cheese, yogurt and other types of fruit (Sofo & Naidu, 2000). The aim of present investigation is minimize the post-harvest loses of Apricot fruits grown in Gilgit Baltistan, as Apricot is one of the main cash crop of Gilgit Baltistan.

2. Materials and Methods
The Apricot fruit were brought from the local orchard to PCSIR (Pakistan Council of Scientific and Industrial Research), Skardu Gilgit Baltistan.

2.1 Samples Preparation
The Apricot fruits were washed, graded and sorted after that juice were extracted by using fruit pulper. Sodium benzoate and Potassium sorbate were used as preservatives to the Apricot juice and each sample were packed in PET (polyethylene terephthalate) bottles of the volume 500 ml.

Treatments
Following are the treatments
AJ_0 = Apricot juice without preservatives
AJ_1 = Apricot juice + 0.05% sodium benzoate + 0.1% citric acid
AJ_2 = Apricot juice + 0.05% potassium sorbate + 0.1% citric acid
AJ_3 = Apricot juice + 0.1% sodium benzoate + 0.1% citric acid
AJ_4 = Apricot juice + 0.1% potassium sorbate + 0.1% citric acid

Storage
The samples were store at room temperature for the period of

90 days and physicochemical, microbial and sensory analysis was conducted at 30 days interval during storage.

Physico-chemical Analysis

All the phsysico chemical analysis such as 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 (2012) [2].

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 & Torrie, 1980) [21].

3. Results and Discussions

The Apricot juice samples were analyzed for ascorbic acid content at the first stage the ascorbic acid content of Apricot juice samples (CJ_0 to CJ_4) 8.69, 8.45, 8.55, 8.75 and 8.80 mg/100g then gradually decreased to 4.00, 5.65, 4.38, 6.40 and 4.10 mg/100g during the storage period. The result revealed that mean value of ascorbic acid content of Apricot juice was reduced significantly ($p < 0.05$) from 8.66 to 5.10 mg/100 g during storage period. The treatment AJ_3 (7.81) contained large mean value as followed by AJ_1 (6.97) mg/100g as well as the treatment AJ_0 (6.17) was contained minimum mean followed by AJ_4 (6.20). For the period of the three months storage, maximum percentage reduction in ascorbic acid was examined in AJ_0 (54.02%) go after treatment AJ_4 (53.40%) and minimum decrease was recorded in treatment AJ_3 (27.68%) when contrasted to AJ_1 (33.52%) (Table-1). Ascorbic acid content of sweet cherry juice was significantly affected by the treatment applied and the storage time. Ayub *et al*. (2010) [3, 8, 10] checked the effect of potassium sorbate and sodium benzoate on ascorbic acid content they concluded that reduction of ascorbic acid from 49.9mg to 32.8mg recorded. 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*. (1986) they inspected that the ascorbic acid decreased (18.96mg to 12.93mg) in citrus through the passage of time. Durrani *et al*. (2010) also stated the humiliation of the ascorbic acid content (25.98 to 21.45 mg/100g) during the preservation of apricot pulp. Sabina *et al*. (2011) work is also evidenced in reduction of ascorbic acid (48.1 to 35.9).

The pH of Apricot juice was analyzed at every 30 days interval during three month of storage result indicated that pH was declined. At the first time pH of treatments (AJ_0 to AJ_4) were 4.33, 4.15, 4.82, 4.22 and 4.50, that has been decreased up to 3.07, 3.25, 3.65, 3.34 and 3.30. Reduction in mean value of pH occurred significantly ($p < 0.005$) from 4.38 to 3.32. Highest fall off was noted in treatment AJ_2 (3.99) followed by AJ_3 (3.66).On other hand lowest fall off was recorded in AJ_0 (3.46) contrast to AJ_1 (3.62). Reduction in term of percentage, the highest was found in AJ_0 (29.09%) followed by AJ_4 (26.66) while at the same time minimum was note in AJ_3 (20.85 %) go after AJ_1 (21.68) (Table-2).The tenure of storage and applied treatments had significant ($p < 0.05$) effect on the pH of Apricot juice. The cause of reduction of pH was pectin conversion in pectic acid which was explored by Imran *et al*. (2000) [11]. Ali (1965) [4] research work was also evidence that the acidity in juice raised when the pH declined during storage. Hussain *et al*. (2011) also concluded that as acidity was enhanced after that pH (4.30 to 2.90) were decreased. During apricot pulp preservation Durrani *et al*. (2010) also confirmed that pH was declined from (3.71 to 3.65).

During three month of storage the Apricot juice was examined at every 30 days interval for total soluble solids content. The result showed that TSS was increased. At the early TSS of treatments (AJ_0 to AJ_4) were 14.80, 14.75, 14.70, 14.73 and 14.77°Brix that enhanced to 15.95, 15.05, 15.00, 15.00 and 15.65° Brix. The mean value increased significantly ($p < 0.05$) from 14.73 to 15.17. The highest mean value was reported in AJ_0 (15.37° Brix) followed by AJ_4 (15.05° Brix) at the same time lowest value was obtained in AJ_2 (14.82° Brix) nearby AJ_3 (14.83° Brix).In term of percentage increment highest was noted in AJ_0 (7.21%) go after AJ_4 (5.62%) although the smallest increment was noted in sample AJ_3 (1.80%) next with AJ_1 (1.90%) (Table-3).The percentage increase in total soluble solids of Apricot juice may be that the sucrose content is upturned in fructose and glucose because of temperature. The conclusion of Ayub *et al*. (2010) [3, 8, 10] is a harmony with our outcome that they found increment in TSS (16.5 to 17.4^o). Rab *et al*. (2011) [18] preserved orange with heat treatments concluded that enrichment in TSS. Durrani *et al*. (2010) during apricot pulp preservation also reported that increment in TSS (9.71 to 11.36^0). Muhammad *et al*. (2011) *et al*. reported that an increment was occurred in TSS (9.75 to 11.39$^{0)}$ in apricot pulp during the period of storage.

The Apricot juice samples were analyzed at every 30 days of interval, results indicated that the titratable acidity was increased significantly ($p < 0.05$) during 3 month of storage statistically the data was shown in appendix-IV. At the beginning in treatment (AJ_0 to AJ_4) it was 0.80, 0.87, 0.85, 0.89 and 0.83, after 3 month storage increased up to 1.10, 1.17, 1.15, 1.19 and 1.13. Mean value increased from 0.80 to 1.15. Treatment AJ_3 (1.04) contained highest % acidity nearby AJ_1 (1.02), on the other hand AJ_0 (0.95) indicated minimum mean value nearby AJ_4 (0.98). The peak enhance was verified in treatment AJ_0 (27.27%) next with AJ_4 (26.54%) as well lowest increment was found in AJ_3 (25.21%) go after AJ_1 (25.64%) (Table_4).Titratable acidity of Apricot juice was affected significantly ($p<0.05$) by storage time and treatment applied. Nunes *et al*. (2011) [16] worked on strawberry is witness of our study they investigated that % acidity increased significantly due to treatments applied and storage time. Main reason of increment in acidity may be due by the effect of sugar content and temperature. The work of Clyesdale *et al*. (1972) [5] is a proof that they concluded that the breakdown of pectin in to pectic acid increased the acidity. This research was also accordance with Iqbal *et al*. (2001) [12].During the period of preservation of strawberry juice Sabina *et al*. (2011) [20] also found upgrading in % acidity (1.31 to 2.09).

When the Apricot juice samples were analyzed at every 30 days of interval during storage, reduction in sugar acid ratio was found, at initial stage in treatments (AJ_0 to AJ_4) it was 18.50, 16.95, 17.29, 16.55 and 17.79, then declined up to 14.50, 12.86, 13.04, 12.60 and 13.84 throughout storage

tenure. The table-5 contained significantly ($p<0.05$) degraded mean value from 17.42 to 13.37. Greatest mean value of sugar acid ratio hold by treatment AJ_0 (16.35) followed by AJ_4 (15.53) at the same time treatment AJ_3 (14.41) enclosed minimum value next with AJ_1 (14.73). Reduction in term of percentage, highest was observed in AJ_0 (24.57%) go after AJ_4 (24.12%) at the same time as treatment AJ_3 (21.62%) and AJ_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 (14.31to 13.81) also experienced in apricot pulp preservation using various chemical preservatives by Durrani *et al*. (2010) [7]. Muhammad *et al.* (2011) [15] described that drop off in sugar acid ratio (29.14 to 28.13) during preservation of mashaday variety of apricot.

In all he products which based on fruits, the sugars are a crucial constituent because it worked as flavor contributor and natural preservatives. Reducing sugar increment in treatments (AJ_0 to AJ_4) was occurred from 10.03, 10.75, 10.10, 10.65 and 10.35 to 11.50, 11.45, 11.05, 11.00 and 11.40. The mean values were enhanced significantly ($p<0.05$) from 10.37 to 11.25. Maximum mean value was found in treatment AJ_1 (11.00) go after AJ_3 (10.77) at same time the lowest mean value was found AJ_2 (10.40) nearby AJ_0 (10.62). Increment in term of percentage, highest was found in treatment AJ_0 (12.78%) compared to AJ_4 (9.21%) while AJ_3 (3.18%) showed minimum increment followed to AJ_1 (6.11%) (Table-6) The treatment applied and duration of storage had significant ($p<0.05$) impact no reducing sugar content of Apricot juice. Kink *et al.* (2001) 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 temperature increase during storage had studied by Patil *et al.* (2013) [17]. Ruiz-Nieto *et al.* (1997) [19] research worked is good resemblance of our outcome. Increment in reducing sugar from 16.3 to 18.1 was also observed by Ayub *et al.* (2010) [3, 8, 10]

When the Apricot juice was analyzed at every 30 days of interval during three month of storage the mean value of non-reducing sugar was decrease significantly ($p<0.05$). Initially in treatments (AJ_0 to AJ_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 and1.20. Reduction happened in mean values significantly from 1.52 to 1.29.Among treatments the highest men value was found in AJ_3 (1.88) go after AJ_2 (1.34) at the same time minimum was observed in AJ_1 (1.07) as compared to AJ_4 (1.28). Reduction in term of percentage, maximum was shown by treatment AJ_0 (40.90%) followed by AJ_4 (16.66%) while lowest reduction noted in AJ_3 (8.33%) nearby AJ_1 (15.00%) (Table_7). Result illustrated that the storage duration and applied treatment had significant impact on Apricot juice. During canning of citrus fruit Karim (1966)[13] reported that increment in reducing sugar and reduction in non-reducing sugar occurred at ambient temperature is good accordance of our results. Ali (1965) 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.* (2010) [11] concluded in their research work that degradation in non-reducing sugar from (8.82 to 7.3) and Akesowan, (2010) [6] also found same result.

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

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
AJ_0	8.74	6.39	5.61	4.01	54.01	6.12c
AJ_1	8.47	7.47	6.22	5.62	33.55	6.91b
AJ_2	8.59	6.86	5.32	4.35	49.03	6.32bc
AJ_3	8.82	8.51	7.41	6.41	27.62	7.84a
AJ_4	8.79	6.40	5.51	4.11	53.41	6.25c
Means	8.63a	7.31b	6.13c	5.09d		

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 Apricot juice

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
AJ_0	4.33	3.28	3.18	3.07	29.09	3.46c
AJ_1	4.15	3.63	3.45	3.25	21.68	3.62bc
AJ_2	4.82	3.81	3.70	3.65	24.27	3.99a
AJ_3	4.22	3.65	3.39	3.34	20.85	3.66b
AJ_4	4.50	3.45	3.35	3.30	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 3: Effect of chemical preservatives and storage period on TSS of Apricot juice

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
AJ_0	14.80	14.85	15.90	15.95	7.21	15.37a
AJ_1	14.75	14.80	14.85	15.05	1.99	14.86b
AJ_2	14.70	14.75	14.84	15.00	2.00	14.84b

AJ_3	14.73	14.77	14.82	15.00	1.80	14.83b
AJ_4	14.77	14.80	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 4: Effect of chemical preservatives and storage period on acidity of Apricot juice

Treatments	Storage Interval (30 days)				% Increase	Means
	Initial	30	60	90		
AJ_0	0.80	0.90	1.00	1.10	27.27	0.95bc
AJ_1	0.87	0.97	1.07	1.17	25.64	1.02a
AJ_2	0.85	0.95	1.05	1.15	26.08	1.00c
AJ_3	0.89	0.99	1.09	1.19	25.21	1.04c
AJ_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 5: Effect of chemical preservatives and storage period on sugar acid ratio of Apricot juice

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
AJ_0	18.50	16.50	15.90	14.50	24.57	16.35a
AJ_1	16.95	15.25	13.87	12.86	22.17	14.73c
AJ_2	17.29	15.52	14.13	13.04	23.83	14.99d
AJ_3	16.55	14.91	13.59	12.60	21.62	14.41e
AJ_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 6: Effect of chemical preservatives and storage period on reducing sugar of Apricot juice

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
AJ_0	10.03	10.05	10.90	11.50	12.78	10.62bc
AJ_1	10.75	10.85	10.95	11.45	6.11	11.00a
AJ_2	10.10	10.15	10.30	11.05	8.59	10.40c
AJ_3	10.65	10.70	10.75	11.00	3.18	10.77ab
AJ_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 7: Effect of chemical preservatives and storage period on non-reducing sugar of Apricot juice

Treatments	Storage Interval (30 days)				% Decrease	Means
	Initial	30	60	90		
AJ_0	1.55	1.30	1.18	1.10	40.90	1.29b
AJ_1	1.15	1.10	1.05	1.00	15.00	1.07c
AJ_2	1.45	1.35	1.30	1.25	16.00	1.34b
AJ_3	1.95	1.90	1.85	1.80	8.33	1.88a
AJ_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

Conclusion

The present investigation was carried out on the Apricot 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 Apricot juice physico chemically. The Apricot juice was packed in PET (polyethylene terephthalate) bottles at a volume of 1000 ml and stored at room temperature for 90 days. Treatment AJ_3 that contained 0.1% sodium benzoate + 0.1% citric acid had shown the best result maintaining maximum quality followed by AJ_1, AJ_2 and AJ_4 on the other hand, AJ_0 (control) Apricot 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 compare to potassium sorbate.

References

1. AOAC. Association of Official and Analytical Chemists. Official methods of analysis Washington, DC, 2012.
2. Agriculture, Stat. Departmet of Agriculture Gilgit Baltistan, 2011-2012.

3. Ayub M, Javed Ullah, Zeb A. Evaluation of strawberry juice preserved with chemical preservatives at refrigeration temperature. Int. J of Nutri. and Metabolism. 2010; 2(2)79-85.
4. Akesowan A. Storage stability of reduced-sugar preserved mangoes prepared with acesulfame-k and aspartame. J Agri. and Bio. Sci. 2010; 6(2):150-156.
5. Ali M. Canning of fruits and vegetables and their juices. Effect of canning quality of juices from different varieties of oranges. M.Sc. Agriculture. Thesis Agricultural University, Faisalabad, 1965.
6. Clydesdale FM, Lin YD, Franci FJ. Formation of 2-pyrrolidone-5-carboxylic acid from glutamine during processing and storage of spinach puree. J Food Sci. 1972, 37-45.
7. Diaz-Mula HM, Castillo S, Martínez-Romero D, Valero D, Zapata PJ. Sensory, nutritive and functional properties of sweet cherry as affected by cultivar and ripening stage. Food Sci. Tech. Int. 2009; 15:535-543.
8. Durrani Y, Ayub M, Muhammad A, Ali A. Physicochemical response of apricot pulp to chemical preservatives and antioxidant during storage. Int. J Food Safety. 2010; 12:20-28.
9. Fruits, Vege. Condiments Stat. Pak. Govt. of Pakistan Ministry of National Food Security and Research Islamabad, 2012-2013.
10. Hussain I, Zeb A, Ayub M. Quality Attributes of apricot and apricot blend juice preserved with potassium sorbate during storage at low temperature. Int. J Food Safety. 2010; 12:80-86.
11. Imran A, Rafiullah K, Ayub M. Effect of added sugar at various concentration on the storage stability of guava pulp. Sarhad. J Agri. 2000; 7(25):35-39.
12. Iqbal SA, Yasmin S, Wadud Shah WH. Production storage packing and quality evaluation of Gouva Nectoir Pak. J Food Sci. 2001; 11:33-36.
13. Karim. Effect of Chemical preservatives on Canning of Citrus fruit at ambient temperature. J Agri. Food. Chem. 1966; 3:165-180.
14. Kranz S, Hartman T, Siega-Riz AM, Herring AH. A diet quality index for American preschoolers based on current dietary intake recommendations and an indicator of energy balance. J. American Dietetic Asso. 2006; 106(10):1594-1604.
15. Muhammad A, Ayub M, Zeb A, Durrani Y, Javid Ullah, Afridi SR. Physicochemical analysis of apricot pulp from mashaday variety during storage. Agri. Bio. J Nutr. 2011; 2(2):192-196.
16. Nunes MCN, Morais MB, Brecht JK, Sargent SA. Quality of strawberries after storage in controlled atmospheres at above optimum storage temperatures. Proceedings of the Florida State Hort. Society. 2011; 108:273-278.
17. Patil MM, Kalse SB, Sawant AA. Preparation of guava jam blended with sapota. Int. J Agri. Eng. 2013; 15:1167.
18. Rab A, Muhammad S, Saeed, Najia. Effect of wet heat treatment duration on the quality of sweet orange stored at room temperature. Sarhad J Agri. 2011; 27(2):189.
19. Ruiz-Nieto A, Lopez AJM, Lopez MR, Lopez MJ. Analysis of sucrose's from strawberry cultivars of commercial interest-contents evolution. Proceedings of the third international strawberry symposium, Veldhoven, Netherlands. 1997; 29(2):663-667.
20. Sabina R, Miyan S, Hoque M. Studies on the effects of chemical preservatives on the quality of strawberry (Fragaria ananassa) juice in Bangladesh. Int. J Natural Sci. 2011; 1:4.
21. Steel RGD, Torrie JH. Principles and procedures of statistics. Mc. Graw Hill Pub.Co. Inc. New York, 1997.
22. Usenik V, Fabcic J, Stampar F. Sugars, organic acids, phenolic composition and antioxidant activity of sweet cherry *Prunus avium* L. Food Chem. 2008; 107:185-192.
23. Varnam AH, Sutherland JP. Food Products Series. Technology, Chemistry and Microbiology. Aspen Publication. 1999; 2:96-102.