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Effect of Pasteurization and Chemical Preservatives on the Quality and Shelf Stability of Apple Juice

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Abstract: Effect of pasteurization and chemical preservatives on preservation of apple juice at ambient temperature for 3 months was investigated. The treatments studied were control (T_0), pasteurization alone (T_1), Un-pasteurized + 0.1% potassium sorbate (T_2), pasteurized + 0.1% potassium sorbate (T_3), un-pasteurized + 0.1% sodium benzoate (T_4), pasteurized + 0.1% sodium benzoate (T_5), un-pasteurized + 0.05% potassium sorbate 0.05% sodium benzoate(T_6), pasteurized + 0.05% potassium sorbate 0.05% sodium benzoate(T_7), un-pasteurized + 0.1% potassium sorbate 0.1% sodium benzoate (T_8), pasteurized + 0.1% potassium sorbate 0.1% sodium benzoate (T_9). Ascorbic acid decreased significantly in T_0, T_1, T_3 and T_5 while in the effect of rest of the treatment it was non-significant. With storage the ascorbic acid content decreased from 3.31 to 1.00 mg 100 g^{-1}. Treatments and storage period have a significant effect on percent acidity. Lowest value for acidity was observed in T_8 and T_9 (0.41%) and highest in control (0.52%). It increased from 0.34 to 0.52% with 0 to 90 days storage, respectively. Maximum values for pH were noted in T_9 (3.64) and minimum in T_0 (3.07). However, with storage time, pH values decreased consistently with the advancement of storage time. Reducing sugars increased from 7.12 to 7.65% with the passage of storage time while the reverse was true for the non-reducing sugars. T_0 and T_1 have maximum non reducing and minimum reducing sugars. Effect of treatments on non-reducing was more profound as compared to reducing sugars. As might be expected, sensory quality (color and flavor), decreased with increase in storage time, however, the remained within the acceptable. Treatments T_6, T_7, T_8 and T_9 were more effective in maintaining the sensory quality compared to other one. Minimum microbial load was observed in T_9 and maximum in T_0 and T_1 (uncountable). Among all the treatments T_9 was most effective in retaining nutritional, hygienic and sensory quality of apple juice.

Key words: Apple Juice, sorbate, benzoate, pasteurization, sensory quality, nutritional quality

INTRODUCTION

Apples (*Malus sylvestris*) are more widely grown than any other fruit; apple trees of one kind or another are grown all around the world. (Somogyi *et al*., 1996) and are the most beneficial/ important fruits that belongs to family Rosaceae. In Pakistan it is grown in the Northern hilly areas of Punjab, NWFP and Balochistan. Common varieties are Kashmiri, Kandhari, Amri, Qalat Special, Golden Delicious, Red Delicious and Kulu (Chaudhary, 1994).

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The nutritional benefits of apple juice are often underestimated. It contains 83.1% moisture, 9.2% sugar, 1.87% protein, 2.0 mg sodium, 8.7 mg potassium, 2.7 mg calcium, 0.22 mg iron, 0.11 mg copper, 5.1 mg phosphorous and 4.5 mg vitamin C per 100 g of whole fruit (Anonymous, 2006). When closely evaluating the nutritional composition of apple juice and other apple products, it becomes apparent that the lack of fat, cholesterol and sodium are just a few of the many reasons these products are an important part of a healthful dietary routine.

Research studies around the world are now uncovering the wide array of phytonutrients that are contained in fruits and vegetables that make them an important part of a nutritious diet. These nutrients offer many benefits, like the antioxidants (e.g., quercetin, numerous other flavonoids). In fact, recent research suggests that it is the antioxidants that are plentiful in apple juice which are responsible for improving cognitive function. According to Anonymous (2006), apples are rich source of antioxidants; and researchers reported that one apple packs more cancer-fighting antioxidant capability than a 1,500 mg dose of vitamin C.

Fruit sugars such as those found in apple products serve as an immediate source of energy and because apple products taste so good, they are readily consumed by infants and children. Apple juice also serves as an excellent means of providing essential fluids to the body and is unlikely to cause allergic reactions. Moreover, apple products have a nutrient/calorie ratio superior to many of the alternative snacks being consumed by children and the US Department of Agriculture's (USDA, 2000) new food pyramid My Pyramid states that 100% juice can be substituted for other fruits. A recent national survey of pediatric health professionals has confirmed that apple juice is most often recommended as the first juice for infants. It is easily accepted and pleasing to infants. Also, since babies love the sweet taste of apple juice, it may help motivate them to use a cup and accept new tastes and foods.

There have been numerous incidences of food poisoning associated with the use of drops for fresh, unpasteurized apple juice. Even with improved sanitation and a microbial kill step between processor and consumer, drops will invariably contain many damaged or partially rotten fruit, impossible to grade out. In addition, it doesn't take many mouldy juice apples to exceed the 50 parts per billion limit in juice of the fungal metabolite, patulin, a human carcinogen (Ashurst, 1995). There are various chemical preservatives, which can be used to preserve fruit juices and prevent both chemical and biological deterioration of foods such as potassium sorbate, sodium benzoate (http://www.solarnavigator.net).

In Pakistan apple is used in fresh form, but at the peak harvesting time the production of apple is very high and become abundant in market. Lack of storage facility and perishable nature can result in severe post harvest losses of this nutritious fruit. In keeping with recent health professionals' recommendations to increase servings of fruits and vegetables and reduce the amount of fat in the diet as well as minimize post harvest losses by product development, the present study was undertaken. This can make an important contribution to a well-balanced diet in one way and increase the earning of the farmers on the other way.

MATERIALS AND METHODS

Fresh matured and healthy apples were purchased from the Peshawar Fruit Market and were brought in wooden crates to the Food Processing and Analytical Laboratory of the Department of Food Science and Technology, NWFP Agricultural University Peshawar, Pakistan where research work was carried out.

Apples were washed, followed by sorting trimming and peeling. Juice was extracted, filtered with muslin cloth and divided in to nine lots. First one was kept as control (T_0), pasteurization at 150°F for 20 min (Awan, 1995). (T_1), Un-pasteurized + 0.1% potassium sorbate (T_2), pasteurized + 0.1%

potassium sorbate (T_3), un-pasteurized + 0.1% sodium benzoate (T_4), pasteurized + 0.1% sodium benzoate (T_5), un-pasteurized + 0.05% potassium sorbate 0.05% sodium benzoate(T_6), pasteurized + 0.05% potassium sorbate 0.05% sodium benzoate(T_7), un-pasteurized + 0.1% potassium sorbate 0.1% sodium benzoate (T_8), pasteurized + 0.1% potassium sorbate 0.1% sodium benzoate (T_9). Apple juice was filled into clear glass bottles and sealed with cork-wax. The product was studied for chemical, microbiological and sensory evaluation at two week interval for 3 months.

Chemical Analysis

The direct colorimetric method was used for the measurement of vitamin C which is based on the measurement of the extent to which a 2, 6-dichlorophenol-indophenol solution is decolorized by ascorbic acid in sample extracts and in standard ascorbic acid solutions (AOAC, 1984). Acidity was determined by dissolving a known volume or weight of sample in a known volume of distilled water and titrating an aliquot with 0.1 N NaOH using phenolphthalein as indicator (Srivastava and Sanjeev, 2003). Hanna pH meter (HI 8417) was used for pH determination while reducing and non-reducing sugars were determined by lane Eynon method (AOAC, 1984).

Sensory Evaluation

A panel of trained 10 judges evaluated the samples weekly for appearance and taste using a 10 score scale where 0 indicates dislike extremely and 10 like extremely (Larmond, 1977).

Microbial Evaluation (Total Bacterial Counts TBC mL^{-1})

Total bacterial counts were determined by standard dilution plate method using nutrient agar medium (Khan *et al*., 2005).

Statistical Analysis

The data thus obtained was subjected to statistical analysis by RCBD and means were separated by applying LSD test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Chemical Analysis

Ascorbic acid content decreased with the storage time. Mean ascorbic acid content ranged from 3.31 to 1.00 mg 100 g^{-1} (Table 1). Minimum percent decrease in ascorbic acid of apple juice was found in T_6 (60.34%). Maximum percent decrease in ascorbic acid content was observed in T_1 (100%) and T_0 (100%). Finding suggested the results were statistically significant for both storage time and different treatments. The results are in agreement with those of Khan (1987) who also reported loss of vitamin C during storage in orange juice preservation. Kalra *et al*. (1987) observed gradual decrease of ascorbic acid in guava beverage during storage. Iqbal *et al*. (2001) reported gradual decrease of ascorbic acid in guava nectar during storage. Safdar *et al*. (1999) also observed the gradual loss of ascorbic acid in tomato concentrate during storage at 3 different temperatures.

Mean values for Titratable acidity of apple juice increased from 0.34 to 0.53% during storage (Table 2). Lowest percent increase was observed in T_9 (28.57%) while highest percent increase in the acidity of apple juice was recorded in T_1 (93.93%). Results showed that both storage time and treatments were statistically significant during storage. Similar results are also reported by Khan (1987) in orange juice preservation. Safdar *et al*. (1999) observed gradual increase in acidity during storage of tomato concentrate at 3 different temperatures. This increase in acidity may be due to the formation of acid by sugars or by breakdown of polysaccharide and oxidation of reducing sugars or by breakdown of pectic substances. Similar views were expressed by Ahmed (1997) and Iqbal *et al*. (2001) who

Table 1: Effect of different treatments on ascorbic acid content (mg 100 g^{-1}) of apple juice during storage

	Storage period (Days)								
Treatments	0	15	30	45	60	75	90	Means	Decrease (%)
T_0	3.52	3.01	2.22	0.55	0.00	0.00	0.00	1.33-C	100.00
T_1	3.12	2.81	2.00	0.55	0.00	0.00	0.00	1.21-C	100.00
T_2	3.48	3.20	3.00	2.50	2.13	1.58	1.33	2.46-AB	61.78
T_3	3.10	2.85	2.63	2.09	1.84	1.40	1.11	2.15-B	64.19
T_4	3.50	3.22	3.10	2.60	2.15	1.55	1.34	2.49-AB	61.71
T_5	3.09	2.84	2.65	2.14	1.80	1.43	1.09	2.15-B	64.72
T_6	3.48	3.23	3.05	2.53	2.18	1.60	1.38	2.49-AB	60.34
T_7	3.13	2.86	2.68	2.15	1.86	1.50	1.15	2.19-AB	63.25
T_8	3.52	3.20	3.08	2.65	2.22	1.71	1.39	2.54-A	60.51
T_9	3.13	2.90	2.69	2.20	1.89	1.54	1.22	2.22-AB	61.02
Means	3.31A	3.01AB	2.71B	1.97C	1.61D	1.23E	1.00E		

Mean values sharing the same letter(s) are not significantly different ($p<0.05$)

Table 2: Effect of different treatments on acidity (%) of apple juice during storage

	Storage period (Days)								
Teatments	0	15	30	45	60	75	90	Means	Increase (%)
T_0	0.35	0.38	0.46	0.55	0.59	0.64	0.66	0.52-A	88.57
T_1	0.33	0.37	0.44	0.53	0.58	0.63	0.64	0.50-A	93.93
T_2	0.34	0.39	0.43	0.44	0.46	0.49	0.52	0.44-BCD	52.34
T_3	0.34	0.38	0.41	0.45	0.46	0.49	0.49	0.43-BCD	44.11
T_4	0.35	0.39	0.42	0.46	0.49	0.50	0.54	0.45-BCD	54.28
T_5	0.35	0.37	0.41	0.45	0.47	0.49	0.51	0.44-BCD	45.71
T_6	0.33	0.40	0.42	0.46	0.49	0.50	0.52	0.45-BCD	57.57
T_7	0.35	0.38	0.42	0.44	0.47	0.49	0.50	0.45-BCD	42.85
T_8	0.34	0.37	0.39	0.43	0.44	0.46	0.47	0.41-D	38.23
T_9	0.35	0.37	0.39	0.42	0.43	0.43	0.45	0.41-D	28.57
Means	0.34F	0.38E	0.42D	0.46C	0.49BC	0.51AB	0.53A		

Mean values sharing the same letter(s) are not significantly different ($p<0.05$)

Table 3: Effect of different treatments on pH of apple juice during storage

	Storage period (Days)								
Teatments	0	15	30	45	60	75	90	Means	Decrease (%)
T_0	4.0	3.8	3.3	2.9	2.7	2.5	2.3	3.07E	42.50
T_1	3.9	3.7	3.4	3.0	2.8	2.6	2.5	3.13-DE	35.89
T_2	3.9	3.6	3.4	3.4	3.3	3.1	2.9	3.37-C	25.64
T_3	3.8	3.7	3.5	3.3	3.3	3.1	3.1	3.40-BC	18.42
T_4	3.9	3.7	3.5	3.2	3.1	3.0	2.8	3.31-C	28.20
T_5	4.0	3.8	3.5	3.4	3.2	3.1	3.0	3.43-BC	25.00
T_6	3.8	3.6	3.4	3.3	3.0	2.9	2.9	3.27-CD	23.64
T_7	3.9	3.7	3.5	3.4	3.2	3.1	3.0	3.40-BC	23.07
T_8	3.8	3.7	3.7	3.6	3.5	3.3	3.2	3.54-AB	15.78
T_9	3.9	3.8	3.7	3.7	3.5	3.4	3.5	3.64-A	10.25
Means	3.89A	3.71B	3.49C	3.32D	3.16E	3.01F	2.92F		

Mean values sharing the same letter(s) are not significantly different ($p<0.05$)

reported that gradual increase in acidity may be due to degradation of pectic substances and formation of uronic acid in tomato concentrates.

Table 3 shows that pH decreased during storage and the mean values ranged between 3.89 and 2.92. Minimum percent decrease in the pH of apple juice was observed in T_9 (10.25%) during storage and maximum in T_0 (42.5%). Results suggested that both storage time and treatments have statistically significant effect on this parameter. Results are in agreement with those of Khan (1987), Safdar *et al*. (1999) and Bajwa *et al*. (2003), who also reported decrease in pH value with increase in acidity during storage of grape fruit apple marmalade.

Table 4: Effect of different treatments on reducing sugars (%) of apple juice during storage.

	Storage period (Days)								
Teatments	0	15	30	45	60	75	90	Means	Increase (%)
T_0	7.14	7.25	7.33	7.41	7.49	7.54	7.59	7.39-B	6.03
T_1	7.12	7.21	7.29	7.38	7.47	7.56	7.61	7.38-B	6.59
T_2	7.13	7.27	7.36	7.45	7.52	7.59	7.64	7.42-A	7.15
T_3	7.15	7.28	7.37	7.45	7.53	7.60	7.66	7.43-A	7.13
T_4	7.14	7.26	7.35	7.45	7.52	7.58	7.63	7.42-A	6.86
T_5	7.12	7.27	7.38	7.46	7.54	7.60	7.67	7.43-A	7.72
T_6	7.13	7.25	7.34	7.44	7.52	7.59	7.65	7.42-A	7.29
T_7	7.10	7.23	7.35	7.45	7.53	7.59	7.66	7.42-A	7.88
T_8	7.11	7.24	7.39	7.46	7.54	7.60	7.68	7.43-A	8.01
T_9	7.10	7.25	7.38	7.47	7.56	7.61	7.69	7.44-A	8.30
Means	7.12G	7.25F	7.35E	7.44D	7.52C	7.59B	7.65A		

Mean values sharing the same letter(s) are not significantly different ($p<0.05$)

Table 5: Effect of different treatments on non-reducing sugars (%) of apple juice during storage

	Storage period (Days)								
Teatments	0	15	30	45	60	75	90	Means	Decrease (%)
T_0	2.01	1.97	1.92	1.86	1.81	1.77	1.71	1.86-A	14.92
T_1	1.99	1.96	1.91	1.85	1.81	1.76	1.70	1.85-AB	14.57
T_2	2.00	1.95	1.88	1.83	1.78	1.73	1.67	1.83-CDE	16.50
T_3	2.01	1.95	1.87	1.82	1.77	1.74	1.68	1.83-CDE	16.41
T_4	2.00	1.94	1.88	1.84	1.78	1.73	1.67	1.83-CDE	16.50
T_5	2.02	1.96	1.89	1.83	1.77	1.72	1.66	1.83-CD	17.82
T_6	1.99	1.95	1.89	1.82	1.76	1.72	1.66	1.83-DE	16.58
T_7	2.02	1.96	1.90	1.84	1.77	1.73	1.68	1.84-BC	16.83
T_8	2.01	1.94	1.88	1.81	1.75	1.70	1.65	1.82-EF	17.91
T_9	2.00	1.93	1.87	1.81	1.73	1.69	1.64	1.81-F	18.00
Means	2.01A	1.95B	1.29C	1.83D	1.77E	1.73F	1.67G		

Mean values sharing the same letter(s) are not significantly different ($p<0.05$)

Table 6: Effect of different treatments on sensory characteristics (color) of apple juice during storage

	Storage period (Days)								
Teatments	0	15	30	45	60	75	90	Means	Decrease (%)
T_0	7.5	5.3	4.7	4.3	4.0	3.8	3.5	4.73-D	53.33
T_1	7.2	5.0	4.6	4.2	4.0	3.8	3.6	4.63-D	50.00
T_2	7.4	7.0	6.8	6.1	5.8	5.5	5.3	6.27-C	28.37
T_3	7.0	6.9	6.7	6.2	5.7	5.5	5.3	6.19-C	24.28
T_4	7.6	7.2	6.9	6.5	6.2	5.9	5.9	6.6-ABC	22.36
T_5	7.0	6.7	6.6	6.3	6.1	5.8	5.7	6.31-C	18.57
T_6	7.5	7.3	6.8	6.5	6.2	5.7	5.7	6.53-ABC	24.00
T_7	7.3	6.9	6.7	6.4	6.1	5.7	5.6	6.39-BC	23.28
T_8	7.5	7.2	7.0	6.8	6.6	6.7	6.5	6.90-A	13.33
T_9	7.0	7.0	6.8	6.8	6.7	6.6	6.6	6.79-AB	5.71
Means	7.30A	6.65B	6.36BC	6.01CD	5.74DE	5.50EF	5.37F		

Mean values sharing the same letter(s) are not significantly different ($p<0.05$)

Reducing sugars (mean values 7.12-7.65%) in apple juice also increased with storage period (Table 4 and 5). Lowest percent increase was observed in T_0 (6.03%) while highest in T_9(8.30%). Non-reducing sugars in apple juice decreased during storage. Mean value ranged from 2.01 to 1.67%. Minimum percent decrease was recorded in T_1 (14.57%) and maximum in T_9 (18%). Storage time and treatments were found to have statistically significant effect on both reducing and non-reducing sugars. Increase in reducing sugars might be due to the conversion of non-reducing sugars to reducing sugars. These results are in agreement with findings of Bajwa *et al*. (2003) and Rhiz-Nielo *et al*. (1997), who reported increase in glucose and fructose contents in strawberry fruits.

Table 7: Effect of different treatments on sensory characteristics (flavor) of apple juice during storage

	Storage period (Days)								
Teatments	0	15	30	45	60	75	90	Means	Decrease (%)
T_0	7.7	5.2	4.5	3.9	3.4	3.3	3.2	4.46-F	58.44
T_1	7.6	5.3	4.7	3.6	3.5	3.5	3.4	4.51-F	55.26
T_2	7.7	6.6	6.3	5.4	5.2	5.2	5.3	5.96-E	31.16
T_3	7.7	6.8	6.4	5.5	5.4	5.2	5.5	6.07-DE	28.57
T_4	7.6	7.0	6.9	6.0	5.5	5.3	5.3	6.23-CDE	30.26
T_5	7.5	7.1	6.8	6.2	5.9	5.6	5.4	6.36-CDE	28.00
T_6	7.6	7.2	6.9	6.5	6.2	5.9	5.6	6.56-BCD	21.31
T_7	7.6	7.3	6.7	6.5	6.3	6.0	5.8	6.60-ABC	23.68
T_8	7.7	7.2	7.0	6.9	6.8	6.8	6.6	7.00-AB	14.28
T_9	7.6	7.4	7.1	7.0	7.0	6.8	6.7	7.09-A	11.84
Means	7.63A	6.71B	6.33B	5.75C	5.52CD	5.36CD	5.28D		

Mean values sharing the same letter(s) are not significantly different ($p<0.05$)

Table 8: Effect of different treatments on Total Bacterial Count of apple juice during storage

	Storage time (Days)						
Treatments	0	15	30	45	60	75	90
T_0	7.2×10^1	1.2×10^2	2.4×10^4	---	---	---	---
T_1	5.2×10^1	1.1×10^2	2.2×10^4	---	---	---	---
T_2	7.3×10^1	7.0×10^2	9.8×10^2	2.4×10^3	7.2×10^3	5.2×10^4	9.5×10^4
T_3	5.3×10^1	5.2×10^2	7.8×10^2	1.6×10^3	5.6×10^3	9.0×10^3	3.0×10^4
T_4	7.2×10^1	7.1×10^2	8.9×10^2	1.8×10^3	6.1×10^3	1.1×10^4	5.3×10^4
T_5	5.3×10^1	5.1×10^2	6.9×10^2	9.8×10^2	4.0×10^3	7.0×10^3	4.2×10^4
T_6	7.0×10^1	7.0×10^2	7.3×10^2	9.9×10^2	4.5×10^3	8.0×10^3	3.9×10^4
T_7	5.3×10^1	5.1×10^2	6.7×10^2	9.0×10^2	3.2×10^3	6.0×10^3	1.0×10^4
T_8	7.3×10^1	4.01×10^2	6.5×10^2	7.0×10^2	9.5×10^2	2.0×10^3	6.5×10^3
T_9	5.2×10^1	3.7×10^2	4.5×10^2	6.5×10^2	8.0×10^2	9.6×10^2	3.9×10^3

Mean values sharing the same letter(s) are not significantly different ($p<0.05$)

Sensory Evaluation

Table 6 and 7 showed that increased storage period reduced the mean acceptability scores for color in apple juice. Minimum scores were obtained by T_1 (4.63) and T_0 (4.73) while maximum by T_8 (6.90) and T_9 (6.79). Score of flavor decreased during storage of apple juice. Minimum decrease was observed in T_9 (7.09) and T_8 (7.00). Maximum decrease in flavor score was recorded in T_0 (4.46) and T_1 (4.51). Minimum score was recorded in T_0 (4.30) and T_1 (4.37). Results are in agreement with those of Khan (1987).

Microbiological Analysis

Maximum numbers of colonies were present in T_0 and T_1 (uncountable after 30 days) while minimum growth of microorganism was observed in T_9 (3.9×10^3 TBC mL^{-1}) followed by T_8 (6.5×10^3 cfu mL^{-1}). However, the overall increase in microbial population except in T_0 and T_1 after 30 days, still remained with in the acceptable range (Table 8).

CONCLUSIONS

It can be concluded that like other fruit juices, best quality nutritious apple juice prepared by pasteurization followed by 0.1% potassium sorbate plus 0.1% sodium benzoate (T_9) treatment was found most beneficial by securing highest score during sensory evaluation, microbial safety and retention of most of the nutrients during 3 months ambient storage.

REFERENCES

Ahmed, 1997. Chemical preservation of tomato concentrate preserved with cold break method. M.Sc. (Hons.) Thesis, Univ. Agric., Faisalabad.

Anonymous, 2006. Nutritional benefits of apple products. Apple Products Research and Education Council (Formerly The Processed Apples Institute) http://www.appleproducts.org/nutritn.html.

AOAC., 1984. Official Methods of Analysis. 13th Edn., Association of Official Analytical Chemists. Washington DC.

Ashurst, P.R., 1995. Production and Packaging of Non-Carbonated Fruit Juices and Fruit Beverages. Blackie Academic and Professional.

Awan, J.A., 1995. Elements of Food Science and Technology. 1st Edn., Agric. Univ., Faisalabad, pp: 124.

Bajwa, E., E.Z. Naeem, J. Anjum and Nazir, 2003. Development standardization and storage studies on grape fruit apple marmalade. Pak. J. Food Sci., 13: 11-15.

Chaudhary, M.I., 1994. Fruit Crops. In: Horticulture. Malik, M.N. (Ed.), 1st Edn., National Book Foundation, Islamabad, pp: 468.

Iqbal, S., A. Yasmin, S. Wadud and W.H. Shah, 2001. Production, storage, packing and quality evaluation of guava nectar. Pak. J. Food Sci., pp: 33-36.

Kalra, S.K., D.K. Tandon and H.C. Lodham, 1987. Preservation of discoloration in guava beverage during storage. Indian Food Parker, 47: 21-24.

Khan, M., N. Bibi, B.K. Amal and M.A. Chaudry, 2005. Effect of irradiation on microbial safety and nutritional quality of minimally processed Bitter gourd (*Momordica charantia*). J. Food Sci., 70: 255-259.

Khan, N.R., 1987. Photochemical changes in packed orange juice during storage. M.Sc. Thesis, NWFP Agric. Univ., Peshawar.

Larmond, 1977. Laboratory method of sensory evaluation of food. Publication 1977, Canada, Dep. Agric. Ottawa.

Rhiz-Nielo, A., A.J. Lopez, M.R. Lopez, M.J. Lopez and D.J. Dijkstra, 1997. Analysis of sugar from strawberry cultivar of commercial interest-contents evaluation. Proceeding of the Third International Strawberry Symposium, Veldhonen, Netherland. 29 Vol. 2, Acta-Hortic., 439: 663-664.

Safdar, N.M., M. Asrar, N. Abdullah, Zia-ur-Rahman and W.H. Shah, 1999. Studies on the effect of storage condition on ascorbic acid, acidity and pH of tomato concentrate. Pak. J. Food Sci., pp: 15-17.

Somogyi, L.P., D.M. Barrett and Y.H. Hui, 1996. Processing Fruits: Science and Technology. Vol. 2, Major Processed Products. Technomics Publ. Co. Inc.

Srivastava, R.P. and K. Sanjeev, 2003. Fruit and Vegetable Preservation Principles and Practices: Important Methods for Analysis of Fruits/Vegetables and Their Products. Third Revised and Enlarge Edition. International Book Distributing Co., Lucknow, Indiao, pp: 363.

Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics. Mc. GrawHill Publ. Co. Inc., New York.

USDAARS (US Department of Agriculture Agricultural Research Service), 2000. USDA Nutrient Database for Standard Reference. Release 13. Nutrient Data Laboratory Home Page, http://www.nal.usda.gov/fnic/foodcomp

USDA (US Department of Agriculture's). New Food Pyramid: My pyramid. Pyramid/Fruits/Tips to help you eat fruitshttp://www.mypyramid.gov/pyramid/fruits_tips.html.