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QUALITY EVALUATION OF WHOLE MANDARIN (Citrus Reticulata) JUICE DURING STORAGE

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Abstract

The effect of different chemical preservatives was studied on the overall quality of whole mandarin juice stored at ambient temperature (20 to 25 0C) during 90 days of storage. The treatments were Mn0 (whole mandarin juice), Mn1 (whole mandarin juice + 1.25% guar gum + 0.1% potassium metabisulphite), Mn2 (whole mandarin juice + 1.25% guar gum + 0.1% sodium benzoate), Mn3 (whole mandarin juice + 1.25% guar gum + 0.1% potassium sorbate), Mn4 (whole mandarin juice + 1.25% guar gum + 0.05% potassium metabisulphite + 0.05% sodium benzoate), Mn5 (whole mandarin juice + 1.25% guar gum + 0.05% potassium metabisulphite + 0.05% potassium sorbate), Mn6 (whole mandarin juice + 1.25% guar gum + 0.05% sodium benzoate + 0.05% potassium sorbate). All the samples were analyzed physiochemically i.e. ascorbic acid, titratable acidity, pH, reducing sugar, non reducing sugar, total soluble solid, sugar acid ratio and sensory (color, flavor and overall acceptability) fortnightly during the whole period of storage. Results showed that ascorbic acid decreased (from 42.42 to 14.60 mg/100g), pH (from 3.68 to 3.37), sugar acid ratio (26.26 to 23.90) non reducing sugar (from 3.19 to 2.76). During sensory analysis the mean score of judges decreased, color (from 9.00 to 5.30), flavor (from 8.00 to 5.07) and overall acceptability (from 8.50 to 5.18), while total soluble solid, titratable acidity and reducing sugar increased from 17.00 to 18.18o Brix, 0.64 to 0.76 % and 4.83 to 5.26 respectively. The maximum mean value for ascorbic acid was observed in treatment Mn1 (30.16), titratable acidity Mn0 (0.73), pH Mn1 and Mn4 (3.56), TSS Mn0 (17.76), sugar acid ratio Mn1 (26.08), reducing sugar Mn0 (5.15), non reducing sugar Mn1 (3.03), color Mn1 (8.11), flavor Mn1 (7.10) and overall acceptability Mn1 (7.60). The statistical analysis showed that storage interval and treatments had a significant ($P<0.05$) effect on the physicochemical and sensory characteristics of whole mandarin juice during storage.

Keywords:

whole mandarin juice.
physiochemical attributes.

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1. Introduction

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Citrus fruits are among the most important horticulture product belongs to family Rutacease. The genus citrus are usually a mix of acidic and sweet fruits. Some important citrus species grown in Pakistan are grapefruit, mandarin, sweet orange, bitter orange, lime, lemon, rough lemon and kinnow. Citrus fruits have very attractive shapes, size, colors, fragrant and having appetizing characteristics. Citrus fruits are first-class source of vitamins and some minerals and having good dietetic value. Fruits belong to citrus family are the richest sources of vitamin C and minerals such as magnesium and calcium which are vital for suitable fitness and vigor (Shah, 2007). The production of citrus fruits is very high in Pakistan and stands sixth in the world. Citrus fruits encompass of about 40% of the whole fruits production Pakistan, where it is cultivated, over a vicinity of 199400 hectares having about 2.29 million tons production annually (Anonymous, 2008). More than 95% of citrus fruits are being produced in the province, Punjab and 2.2 % in Khyber Pakhunkhuwa and 70% of citrus fruits produced in Punjab is kinnow. In Pakistan growth of citrus fruits is generally for the fresh fruit market and is also process into ready to serve juices, squashes, pickles or cordials (Niaz et al., 2004).

Mandarin (Citrus reticulata) is one of the most vital citrus fruit produced in Pakistan, having very attractive bright color, appearance, sweet taste and flavor. Mandarin is mainly consumed as fresh fruits but due to its high nutritive value it is also processed and preserved in different form such as jam, jelly, marmalade, squash, as well as ready to serve juice (Hussain, 1997). There is a great potential to use this fruit in value added products such as diet drinks. These types of citrus drinks are probably the most recognized and globally acceptable fruit drinks (Nchez-moreno et al., 2003; Gorinstein et al., 2004). Mandarin is a rich source of vitamins and minerals, approximately having vitamin A (3%), vitamin C (13%), pectin, carotenes, citric acid, and minerals like calcium (4%), iron (4%) and phosphorus (3%). Vitamin C is one of very important nutrient that protect health in many ways. It absorbs iron from plant food which is very beneficent to health. It (ascorbic acid) is very necessary for the production and maintaining of collagen, a type of protein that holds the body together, supporting and repairing muscles, bones, teeth and smooth skin (Koop, 1989).The composition of citrus fruit juice is beneficial with respect to its mineral and ascorbic acid content. An average fruit (131g fruit) has approximately 60-70mg ascorbic acid, which is enough to supply daily body requirements. (Fladae et al., 2003).

Mandarin (citrus reticulata) is grown all over Pakistan exclusively in different districts of Punjab and Khyber Pakhtunkhuwa. In Punjab it is grown in districts of Gujranwala, Multan, Lahore, Jhang, Sahiwal, Sialkot, Minwali, Sargodha, and in Khyber Pakhunkhuwa it is grown in Mardan, Peshawar, Swat, Swabi, Noshera, and Hazara. Total area under citrus cultivation in Pakistan is 199.4 thousands ha and the total productions is 2294.3 thousand ton which comprise of 189.2 thousand hectares in Punjab, 4.4 thousand hectares in Khyber Pakhunkhuwa, 4.5 thousand hectares in Sindh and 1.3 thousands hectares in Balochistan and the total production was 2294.5 thousand tons which includes 2219.3 thousand tons in Punjab, 35.9 thousand tons in Khyber Pakhunkhuwa, 30.9 in Sindh and 8.4 in Balochistan during year 2009-2010 (Agri. Stat. Pak., 2010-2011).

Fruit juice is prepared from the ripe portion of sound, matures and fresh fruit by mechanical extraction and preserve, either by chemical and physical ways (Woodroof and Luh, 2000; FAO/WHO, 2005). Water is the main constituent of fruit juices; sucrose, fructose, glucose and sorbitol all are charbohydrates (Heldman and Lund, 1998). It also enclose a little amount of protein, having no fat, cholesterol and enclose no fiber (Parish, 1991; Pao et al., 2000). Fruits juice is wealthy in mineral and vitamins, manily vitamin A and vitamin C, and can be fortified with additional minerals and vitamins. The fruit juice also contains anti oxidant which have some health benefit, declining the danger of heart disease and cancer (Boyer and Liu, 2004). Vitamin C contents of fruit juices increases the absorption of iron from food which is necessary for children who eat food with small iron bioavailability (Salunkhe and Kadam, 1995; Heldman and Lund, 1998; Ray, 2001).

The main focus of the research was to prepare a shelf stable and consumer acceptable whole mandarin juice for all season of the year and to analyze the effects of chemical preservatives on the shelf life of fruits juice during storage. Due to this consumer will be able to enjoy more nutritious and energy rich drink throughout the year and the losses of mandarin fruit can be minimized, the farmer will get the maximum return even in the peak season of the fruit.

2. Research Method

Fully matured, sound and fresh mandarin fruit were procured from the local market of Peshawar. Mandarin juice was prepared and studied physiochemically (reducing sugar, total sugar, TSS, sugar acid ratio, ascorbic acid, acidity and pH) and sensory (overall acceptability, flavor and color) throughout the storage for three months at room temperature. The research work was done in the laboratory of Food Science and Technology, The University of Agriculture, Peshawar.

Preparation of juice

Fruits were rinsed with potable running water to eliminate impurities and to reduce the initial microbial load on the surface of the fruits. Mandarin fruits peeled and were divided into halves. Fruit juice was extracted with the help of rose head juice extractor. The extracted juice was then passed through muslin cloth to remove the undesirable suspended solid materials in order to get clear juice. The mandarin juice sacs were prepared and added to the clear mandarin juice. The mandarin whole juice was then preserved with different chemicals preservatives potassium metabisulphite, sodium benzoate and potassium sorbate. The juice were then poured into 250ml capacity of the apparent glass bottles and kept at room temperature for sensory and physicochemical assessment at period of fifteen days for the whole period of 3 months.

Propose scheme of study

Mn0 = control.
Mn1 = Whole mandarin juice + 1.25% guar gum + 0.1% potassium metabisulphite.
Mn2 = Whole mandarin juice + 1.25% guar gum + 0.1% sodium benzoate.
Mn3 = Whole mandarin juice + 1.25% guar gum + 0.1% potassium sorbate.
Mn4 = Whole mandarin juice + 1.25% guar gum + 0.05% sodium benzoate + 0.05% potassium metabisulphite.
Mn5 = Whole mandarin juice + 1.25% guar gum + 0.05% potassium metabisulphite + 0.05% potassium sorbate.
Mn6 = Whole mandarin juice + 1.25% guar gum + 0.05% potassium sorbate + 0.05% sodium benzoate.

Physicochemical analysis

Ascorbic acid

A standard method of AOAC (2000) was used to determine the ascorbic acid content (mg/100gm) of the whole mandarin juice.

Titratable acidity

A standard method of AOAC (2000) was used to measure the titratable acidity (%) of whole mandarin juice.

pH

For the determination of pH the standard method of AOAC (2000) was followed. The pH meter was used for the measurement of pH values of whole mandarin juice. The pH meter was first standardized with buffer solutions of known pH (9 and 4), then 10 ml of the whole mandarin juice was taken in a cleaned beaker, the electrode of the pH meter was then immersed in the juice sample to record the pH value of the juice.

Total soluble solids

Standard methods of AOAC (2000) were used for the determination of TSS of whole mandarin juice. The whole mandarin juice sample was placed on the dry prism of refractometer and readings were taken in oBrix, for removal of errors factors related to temperature was also added to obtain accurate readings of total soluble solids of the whole mandarin juice.

Sugar acid ratio

The following formula was used for the determination of sugar acid ratio:
Sugar /acid = total soluble solids (TSS) / titratble acidity (%)

Reducing sugar

Reducing sugars in whole mandarin juice was determined by standard method of Eynon and Lane as described in the AOAC (2000).

Non reducing sugars

Non reducing sugar in whole mandarin juice was measured by the standard method of Lane and Eynon as described in AOAC (2000).

Sensory evaluation

The whole mandarin juices were evaluated sensory for the color, overall acceptability and flavor by team of 10 judges. Larmond (1977) 9-points of hedonic scale were used for evaluation. The evaluation was performed at fifteen days intervals throughout the storage period of 3 months.

Statistical study

Statistically were analyzed all the data regarding treatments and storage intervals with complete randomized design (CRD) two factorial without interaction as recommended by Gomez and Gomez (1984), and mean

values were set apart by the application of (LSD) at 5% level of probability as explained by Steel and Torrie (1997).

3. Results and Analysis

Ascorbic Acid (mg/100g)

The data regarding the ascorbic acid content of the whole mandarin juice are given in table 1.The statistical analysis make clear a significant ($P < 0.05$) consequence as a result of the treatments effect and storage on the ascorbic acid content of whole mandarin juice for the whole period of storage. These outcomes are in conformity with finding of Sandhu and Singh (2001) who account vitamin C losses in the juices during storage. In other study Moshonas and Shaw (1989) also observed the losses of ascorbic acid and stated that the losses of ascorbic acid were attributed to the effect of processing, storage time and exposure to light.

Titratable Acidity (%)

The data regarding the titratable acidity (%) of the whole mandarin juice are given in table 2. The statistical analysis presents a significant ($P < 0.05$) outcome as a consequence of the effect of storage intervals and treatments on the percent acidity of the whole mandarin juice for the whole period of storage. These findings are in conformity with conclusion of Sandhu (2001) and Rodriqo (2003). Who reported a raise in the titratable acidity of the kinnow juice throughout storage. Oxidation or degradation of sugars present in the juice into carboxyl acids cause raise in acidity of the juice during storage.

pH

The data regarding the pH of the whole mandarin juice are given in table 3. The statistical analysis give you an idea that the storage intervals and treatments had a significant ($p<0.05$) effect on the pH of the whole mandarin juice for the whole period of storage (Appendix- III). These results are in formal contract with research consequences of Saini and Pal (1996), who noted a decline in pH of kinnow juice. This decline in pH was due to the acidic components formation.

Total soluble solids (TSS)

The data regarding the TSS of the whole mandarin juice are given in table 4. The statistical study portrayed a significant ($P < 0.05$) consequence as a result of the effect storage intervals and treatments on the total soluble solid results of whole mandarin juice right through storage. These findings are in formal contract with the verdict of Rodriqo (2003) who investigated that the TSS of mixed carrot and orange juice was inclined throughout storage and stated that the increased in the TSS of the juice during storage was due to the degradation of disaccharides into monosaccharide (degradation of sucrose into fructose and glucose).

Sugar acid ratio

The data regarding the Sugar acid ratio of the whole mandarin juice are given in table 5. The statistical study portrayed a significant ($P < 0.05$) consequence as a result of the effect of storage intervals and treatments on the sugar acid ratio of whole mandarin juice for the whole period of storage.The obtained consequences are in concurrence with results of Asad and Durrani (2009), who concluded decline (20.15 to 18.25) in sugar acid ratio during storage of apple pulp.

Reducing Sugar

The data regarding the reducing sugar content of the whole mandarin juice are given in table 6. The statistical study exhibited a significant ($P < 0.05$) consequence as a result of the effect of treatments and storage period on the reducing sugar of whole mandarin juice for the whole period of storage .The present results are full accordance with what was found by Saini and Pal (1996) who reported the quick raise in the reducing sugar of fruit juices during storage. The increases in reducing sugar of juice during storage might be due to the inversion process of sucrose into fructose and glucose by the action of acids in juice.

Non Reducing Sugar

The data regarding the non reducing sugar content of the whole mandarin juice are given in table 7. The statistical study portrayed a significant ($P < 0.05$) consequence as a result of the effect of storage intervals and treatments on the non-reducing sugar of whole mandarin juice for the whole period of storage. These results are in formal contract with the research consequences of Ghorai and Khurdiya (1998) who recorded a quick decline in non reducing sugar of the juice during storage. The declined in the non reducing sugar of the juice might be due to sucrose conversion to reducing sugar (glucose, fructose etc.) by the action of acids of the juice and temperature.

Overall Acceptability

The data regarding the overall acceptability of the whole mandarin juice are given in table 8. The statistical study portrayed significant ($P < 0.05$) consequences as a result of the effect of storage intervals and treatments on the average scores for overall acceptability of all of whole mandarin juice throughout the storage. The achieved results are in same streak with the findings of Martin (1993), who noted decline (8.00 to 6.00) in score of judges for of overall acceptability of pasteurized orange juice bottled in apparent glass bottles. Table 1-8

Table 1. Effect of treatments and storage period on Ascorbic Acid content (mg /100g) of whole mandarin juice.

Treatmens	**Storage interval (15 days)**								**Means**
	0	15	30	45	60	75	90	% Decree	
Mn0	43	33.29	25.15	23.11	15.17	11.33	9	79.069	22.86f
Mn1	43	39.17	33.13	31.42	23.29	21.93	19.19	55.372	30.16a
Mn2	41	37	29.67	27.35	20.91	19.19	15.49	62.219	27.23c
Mn3	43	35.97	27.33	25.19	15.65	15.21	13.11	69.511	25.06e
Mn4	43	37.11	31.53	29.13	21.18	19.55	17.21	59.976	28.38b
Mn5	41	36	29.49	27	17.29	17.31	15.13	63.097	26.17d
Mn6	43	35.21	27.13	25.1	15.15	13.15	13.1	69.534	24.54e
Means	42.4a	36.2b	29.0c	26.9d	18.3e	16.8e	14.6f		

Table 2.Effect of treatments and storage period on Titratable Acidity (%) of whole mandarin juice.

Treatments	**Storage interval (15 days)**								**Means**
	0	15	30	45	60	75	90	%Increase	
Mn0	0.65	0.67	0.7	0.73	0.75	0.79	0.85	30.769	0.73a
Mn1	0.65	0.65	0.66	0.67	0.68	0.69	0.69	6.153	0.67b
Mn2	0.64	0.65	0.66	0.69	0.7	0.73	0.74	15.625	0.68ab
Mn3	0.65	0.67	0.68	0.71	0.73	0.75	0.77	18.461	0.70ab
Mn4	0.65	0.66	0.67	0.68	0.7	0.71	0.73	12.307	0.72a
Mn5	0.64	0.65	0.67	0.7	0.71	0.72	0.77	20.312	0.69ab
Mn6	0.65	0.67	0.69	0.7	0.73	0.77	0.79	21.538	0.71ab
Means	0.64c	0.66c	0.67bc	0.697b	0.71ab	0.73a	0.76a		

Table 3. Effect of treatments and storage period on pH of whole mandarin juice.

Treatments	**Storage interval (15 days)**								**Means**
	0	15	30	45	60	75	90	%Decrease	
Mn0	3.69	3.65	3.58	3.51	3.4	3.33	3.23	12.466	3.48d
Mn1	3.68	3.66	3.61	3.57	3.51	3.47	3.43	6.793	3.56a
Mn2	3.68	3.65	3.62	3.55	3.48	3.45	3.41	7.336	3.55ab
Mn3	3.69	3.64	3.6	3.51	3.43	3.41	3.38	8.401	3.52bc
Mn4	3.69	3.66	3.63	3.56	3.49	3.46	3.41	7.588	3.56a
Mn5	3.68	3.65	3.6	3.57	3.47	3.45	3.39	7.880	3.54abc
Mn6	3.68	3.64	3.59	3.5	3.43	3.4	3.37	8.423	3.51c
Means	3.68a	3.65b	3.60c	3.53d	3.46e	3.42f	3.37g		

Table. 4. Effect of treatments and storage period on Total Soluble Solids (o Brix)of whole mandarin juice.

Treatments	Storage interval (15 days)								Means
	0	15	30	45	60	75	90	%Increase	
Mn0	17	17.31	17.45	17.85	18.1	18.27	18.39	8.176	17.76a
Mn1	17	17.22	17.31	17.49	17.61	17.77	17.91	5.352	17.47e
Mn2	17	17.27	17.41	17.62	17.79	17.97	18.15	6.764	17.57d
Mn3	17	17.31	17.43	17.69	17.91	18.13	18.23	7.235	17.67bc
Mn4	17	17.25	17.39	17.59	17.73	17.93	18.1	6.470	17.60cd
Mn5	17	17.27	17.43	17.65	17.87	18.1	18.19	7.000	17.64bcd
Mn6	17	17.31	17.45	17.73	17.93	18.15	18.29	7.588	17.69ab
Means	17.00g	17.28f	17.41e	17.66d	17.84c	18.04b	18.18a		

Table. 5. Effect of treatments and storage period on the Sugar acid ratio of whole mandarin juice.

Treatments	Storage interval (15 days)								Means
	0	15	30	45	60	75	90	%Decrease	
Mn0	26.15	25.84	24.3	24.45	24.13	23.13	21.64	17.246	24.32c
Mn1	26.15	26.49	26.23	26.1	25.89	25.75	25.95	0.764	26.08a
Mn2	26.56	26.57	26.38	25.54	25.41	24.62	24.53	7.643	25.66ab
Mn3	26.15	25.84	25.63	24.92	24.53	24.17	23.68	9.445	24.99abc
Mn4	26.15	26.14	25.96	17.95	25.33	25.25	24.79	5.200	24.51bc
Mn5	26.56	26.57	26.01	25.21	25.17	25.14	23.62	11.069	25.47abc
Mn6	26.15	25.84	25.29	25.33	24.56	23.57	23.15	11.472	24.84abc
Means	26.26a	26.184a	25.77ab	24.21c	25.00abc	24.52bc	23.90c		

Table. 6.Effect of treatments and storage period on Reducing Sugar of whole mandarin juice.

Treatments	Storage interval (15 days)								Means
	0	15	30	45	60	75	90	%Increase	
Mn0	4.83	4.9	4.99	5.23	5.27	5.37	5.47	13.250	5.15a
Mn1	4.82	4.83	4.87	4.91	4.95	5.02	5.11	6.016	4.93d
Mn2	4.83	4.84	4.93	4.95	4.99	5.14	5.23	8.281	4.99c
Mn3	4.83	4.86	4.94	5.00	5.06	5.18	5.28	9.316	5.02c
Mn4	4.83	4.84	4.91	4.99	5.00	5.14	5.19	7.453	4.98cd
Mn5	4.83	4.85	4.9	4.94	4.97	5.13	5.23	8.281	4.97cd
Mn6	4.83	4.88	4.96	5.11	5.16	5.28	5.33	10.351	5.08b
Means	4.83e	4.86e	4.93d	5.02c	5.06c	5.18b	5.26a		

Table 7. Effect of treatments and storage period on Non-Reducing Sugar of whole mandarin juice.

Treatments	Storage interval (15 days)								Means
	0	15	30	45	60	75	90	%Decrease.	
Mn0	3.19	3.1	2.97	2.89	2.8	2.73	2.65	16.927	2.90f
Mn1	3.21	3.17	3.11	3.03	2.95	2.89	2.85	11.214	3.03a
Mn2	3.19	3.15	3.07	2.97	2.91	2.85	2.79	12.539	2.99bc
Mn3	3.21	3.13	3.03	2.93	2.87	2.8	2.75	14.330	2.96d
Mn4	3.21	3.16	3.09	2.99	2.93	2.87	2.81	12.461	3.00ab
Mn5	3.19	3.13	3.05	2.97	2.9	2.81	2.77	13.166	2.97cd
Mn6	3.19	3.1	3	2.91	2.85	2.79	2.71	15.047	2.93e
Means	3.19a	3.13b	3.04c	2.95d	2.89e	2.82f	2.76g		

Table 8. Effect of treatments and storage intervals on Overall Acceptability of whole mandarin juice.

Treatments	Storage interval (15 days)								Means
	0	15	30	45	60	75	90	%Decrease.	
Mn0	9	6.5	5	3	2	1	1	88.888	4.53e
Mn1	9	8.3	8	7.9	7.85	7.8	7.5	16.666	7.60a
Mn2	9	7.8	7.5	7.3	7.21	7	6.9	23.333	7.29abc
Mn3	9	7.2	7	6.9	6.5	6.43	6	33.333	6.68cd
Mn4	9	7.3	7.21	7	6.54	6.3	6	33.33	7.44ab
Mn5	9	7.1	7	7	6.45	6.21	5.9	34.444	6.90bcd
Mn6	9	7	7	6.95	6.49	6.31	5.95	33.888	6.40d
Means	8.50a	7.68b	7.18bc	6.60cd	6.05de	5.67ef	5.18f		

4. Conclusion

In the present research work whole, mandarin juice were prepared and chemically preserved. Whole mandarin juice was packed in a glass bottle having 250ml capacity and stored at ambient temperature (20-25 0C) for storage duration of three months. The samples were analyzed at fifteen days intervals for sensory evaluation and physicochemical analysis. The results of this research work showed that the treatments Mn1 (Whole mandarin juice + 1.25% guar gum + 0.1% potassium metabisulphite) followed by Mn4 (Whole mandarin juice + 1.25% guar gum + 0.05% potassium metabisulphite + 0.05% sodium benzoate) were found most satisfactory during sensory evaluation and physicochemical analysis. During storage a decrease was observed in ascorbic acid, pH, non reducing sugar and sugar acid ratio of the whole mandarin juice, while increase was recorded in TSS, acidity and reducing sugar of whole mandarin juice.

Suggestion and recommendations for further research work are:

1.Further research should be done on the debittering of kinnow mandarin juice by bounding naringinase with hen egg white.

2.Same research work should be repeated using cans and aseptic packaging.

3.In this research work nutritive sweetener i.e. sucrose was used to prepare whole mandarin juice so that further research can also be done by using non nutritive sweeteners i.e. aspartame, cyclamate, saccharin and acesulfame K to prepared diet whole mandarin juice.

4.Research should be done to evaluate the microbial analysis of the juices during storage.

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