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Evaluation of strawberry juice preserved with chemical preservatives at refrigeration temperature

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This study was carried out to investigate the effect of chemical preservatives on strawberry juice. The samples were; pasteurized strawberry juice (T_0), pasteurized strawberry juice with 20% sucrose (T_1), pasteurized juice with 0.1% sodium benzoate (T_0), pasteurized juice with 20% sucrose and 0.1% sodium benzoate (T_3), pasteurized juice with 0.1% potassium sorbate (T_4) pasteurized juice with 2% sucrose and 0.1% potassium sorbate (T_5) pasteurized juice with 0.05% sodium benzoate and 0.05% potassium sorbate (T_6) pasteurized juice with 20% sucrose, 0.05% sodium benzoate and 0.05% potassium sorbate (T_7) pasteurized juice with 0.1% sodium benzoate and 0.1% potassium sorbate (T_8) and pasteurized juice with 20% sucrose, 0.1% potassium sorbate and 0.1% sodium benzoate (T_9). The samples were stored at 4 - 15°C for three months. T_0 and T_1 were rejected soon due to spoilage. Minimum ascorbic acid content was reduced in T_9 (9.8%), while maximum in T_2 (26%). Acidity increased from 1.39 to 2.38% with maximum in T_1 and T_9. pH decreased from 3.29 to 2.22. Reducing sucrose increased from 15.7 to 17.8 and non-reducing sucrose decreased from 11.6 to 8.3. The total soluble solids (TSS) increased from 16.5 to 17.4° brix with maximum in T_0 (60%) and minimum in T_6 (5.6). Treatments T_9, T_7 T_5 and T_3 were found most acceptable in maintaining the sensory characteristics compared to others during storage. Minimum microbial load were observed in T_9 and maximum in T_0 and T_1 (uncountable). Among all the treatments T_9 were most effective in maintaining the sensory and nutritional quality during storage.

Key words: Strawberry juice, pasteurization, benzoate, benzoate, citric acid, sucrose.

INTRODUCTION

Strawberry (*Fragaria* sp.*)* is a herbaceous perennial member of the family "Rosaceae", which is grown in many countries of the world, but it is cultivated extensively in USA, Japan, Mexico, Italy and Lebanon (Childer, 1983). It is more widely distributed than any other fruit including the grapes (Childer, 1980). In Pakistan its cultivation gradually increased due to its bright scope in future for the farmers as the fruit can return maximum economic benefit to the farmers.

Strawberry has low chilling requirements and the crops can successfully be grown in tropical and sub-tropical areas. The fruit matures in a short period of time that is, 30 - 40 days, is perishable and should be consumed early after picking. The fruit must be handled carefully, while transporting to the distant market as there are chances of deterioration of fruit during transportation (Amin, 1996). Strawberry is first fresh fruits in the market during spring. Because of its delicious flavor and attractive color and shape structure, the consumer demand for the fruit is increasing not only in Pakistan but also in other regions of the world. The fruit is mainly consumed as fresh, also used in processed form such as cooked and sweetened preserves that is, jams or jellies and frozen whole berries. The sweetened juice extracts or flavoring is used in making variety of other processed products (Galletta and Bringhoist, 1955). The fruit is firm, red fleshed and sweet. More than 50% of the sucrose in strawberries is glucose. The fruit contains mostly citric acid and some malic acid. The red colour of the fruit is due to an anthocyanin pigment. Many volatile esters responsible for the flavor of the fruit are present in it.

Nutritionally, strawberry contains low calorie carbohydrate and a potential source of vitamin C, fibers and provides more vitamin C than oranges. The main constituents of the fruit, Vitamin C in strawberry is (64.0 mg), water (91.75 g), protein (0.61 g), fat (0.37 g), carbohydrate (7.02 g), fibre (2.3 g), calcium (14.0 mg), potassium (166.0 mg/160 g) respectively, vitamin-A 27 IU, pH ranges from 3.27 –

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3.86, which helps in stabilizing color. Acidity ranges between 0.58 - 1.35%, citric and malic acids are primary organic acids contributing excellent flavour. Soluble solids are in the range of 8.0 - 11.5% and are ideal for juice concentrate needed in market. Soluble solids/acid ratio 8.52 - 13.79 is good balance of sweet-tart flavour.

In the last decade there has been considerable increased in demand for a strawberry juice because possess an excellent flavor with attractive colour. However, being a soft textured fruit a little fluctuation in a temperature results in spoilage and wastage of fruit. Due to lack of other preservation facilities to preserve the product in raw form, this study has been initiated to utilize the very perishable fruit in the form of juice and to study the affect of chemical preservatives on the preservation quality of strawberry juice, at refrigeration storage. It is hoped that the findings will help the beverage industries to utilize this fruit for juice preparation with increased shelf stability and consumer demand. This will offer high income return to growers and will improve the economy of Pakistan.

MATERIALS AND METHODS

Fresh mature and sound strawberries were purchased from the local fruit market of Peshawar and were brought to Food Processing and Analytical Laboratory of the Department of Food Science and Technology, North West Frontier Province Agricultural University Peshawar, Pakistan where research work was carried out. The berries were washed followed by sorting, the juice was extracted using juice extracting machine. Before filling in glass bottles the juice was pasteurized. The treatments were made as (T_0) pasteurized juice (control), (T_1) pasteurized juice with 20% sucrose, (T_2) pasteurized juice with 0.1% sodium benzoate, (T_3) pasteurized juice with 20% sucrose and 0.1% sodium benzoate, (T_4) pasteurized juice with 0.1% potassium sorbate, (T_5) pasteurized juice with 20% sucrose and 0.1% potassium sorbate , (T_6) pasteurized juice with 0.05% sodium benzoate and 0.5% potassium sorbate, (T_7) pasteurized juice with 20% sucrose, 0.05% sodium benzoate and 0.05% potassium sorbate, (T_8) pasteurized juice with 0.05% potassium sorbate and 0.05% sodium benzoate and (T_9) pasteurized juice with 20% sucrose, 0.0.5% potassium sorbate and 0.05% sodium benzoate. The juice was filled in glass bottle, sealed and stored at refrigeration temperature (4 - 15°C) for a period of three months.

Chemical analysis

Ascorbic acid was determined by the direct colorimetric method using 2, 6- dichlorophenol- indophenols as decolorizing agent by ascorbic acid in sample extract and in slandered ascorbic acid solution (AOAC, 1984). Acidity was determined by dissolving a known weight of sample in distilled water and titration against 0.01 N NaOH using phenolphthalein as indicator (Srivastava and Sanjeev, 2003). Inolab digital pH meter was used for pH determination. Reducing and non-reducing sucrose was determined by lane Eynon method (AOAC, 1984). The total soluble solids (TSS) were determined by using Abbe refractometer at room (AOAC, 1984).

Sensory evaluation

A panel of ten judges selected from staff and students of food science department evaluated the product fortnightly for color, flavor and overall acceptability by the method of Larmond (1977) using a scale from 1 to 9, where 1 represented extremely disliked and 9 represent extremely liked.

Microbial evaluation (Total fungal count)

Total Fungal Counts (TFC) was determined by slandered dilution plate method using nutrient agar medium (AOAC, 1984).

Statistical analysis

The data obtained was subjected to statistical analysis using RCBD (Randomized Complete Block Design) and the means were compared by using LSD (Least Significant Difference) test (Steel and Torrie, 1980). For all the analyses, the alpha error was set at 0.05%.

RESULTS AND DISCUSSION

Chemical analysis

Our results indicated that storage period and temperature had significant effect on ascorbic acid content of different samples. There was a gradual decrease in ascorbic acid of strawberry juice from 50 mg initially to 32.8 mg. Results show that minimum percent decrease in ascorbic acid content was recorded in sample T_9 (9.8%) and maximum T_2 (26%) (Table 1). Ascorbic acid is the most difficult vitamin to be preserved during pasteurization. As it is the least stable vitamin, it decreases in the product during storage. In a similar study Viberg et al. (1999) reported a decrease in ascorbic acid during they recorded that ascorbic acid in strawberry pulp were affected after treatment involving freezing, heating and accelerated storage. These results are in agreement with the findings of Nunes et al. (1995), who recorded a change in Chandler variety of strawberries stored at 4°C.

Acidity of samples (T_0 to T_9) ranged from 1.44 to 1.33, which were gradually increased to 2.14 to 1.59% during 3 months of storage. The mean values increased from 1.39 to 2.38. Maximum mean values were recorded in sample T_0 (2.14) followed by T_1 (2.13), while minimum mean values were observed in sample T_5 (1.59). During storage maximum increase was observed in sample T_1 (102.8%), while minimum increase was observed in T_9 (50.7%) (Table 2). The findings of this study suggest that storage intervals and treatments had a significant effect on acid content of juice during storage. These results are in agreement with the findings of Nunes et al. (1995), who reported an increase in acidity of strawberry during storage. This increase might be due to the break down of pectin in to pectenic acid. The results are confirmed by the findings of Riaz et al. (1988).

The data showed that different treatment and storage intervals had a significant effect on pH of all samples. The mean pH values of all samples decreased from 3.29 to 2.22 during storage. Maximum decrease was recorded in T_2 (36.4%), while minimum in T_9 (12.2%) (Table 3). Similar

Table 1. Effect of treatments and storage on ascorbic acid (mg /100g) of strawberry juice.

Treatments	Intervals (Days)							Means	% decrease
	1st	15th	30th	45th	60th	75th	90th		
T_0	50.1	47.9	42.4	36.7	30.9	25.0	19.4	36.5^{c}	63.7
T_1	49.1	46.0	40.4	35.7	30.6	25.5	20.4	35.6^{c}	59.3
T_2	49.7	47.6	45.5	43.4	41.2	39.0	36.8	43.31^{b}	26.0
T_3	50.1	48.2	46.3	44.4	42.6	40.8	40.0	44.63^{b}	20.0
T_4	49.8	47.7	46.5	43.3	41.2	39.1	37.6	43.46^{b}	24.5
T_5	50.2	48.5	47.2	46.0	44.8	43.6	42.4	46.10^{b}	15.5
T_6	49.7	47.5	46.5	45.3	44.0	43.2	41.0	46.31^{ab}	17.5
T_7	50.1	48.5	47.3	46.1	44.6	44.6	44.5	46.53^{ab}	11.2
T_8	49.6	48.5	45.5	41.3	41.2	41.1	41.0	44.17^{b}	17.3
T_9	50.0	48.5	46.9	46.9	45.6	45.6	45.1	46.97^{a}	9.8
Means	49.9^{a}	47.8^{ab}	45.4^{bc}	35.9^{cd}	34.5^{de}	33.7^{e}	32.8^{e}		

Values followed by different letters are significantly ($p < 0.05$) different from each other.

Table 2. Effect of treatments and storage on acidity (%) of strawberry juice.

Treatments	Intervals (Days)							Means	% Increase
	1st	15th	30th	45th	60th	75th	90th		
T_0	1.44	1.66	1.88	2.11	2.36	2.62	2.93	2.14^{a}	103.5
T_1	1.43	1.63	1.83	2.13	2.33	2.63	2.90	2.13^{a}	102.8
T_2	1.33	1.35	1.55	1.77	2.07	2.27	2.37	1.82^{b}	78.2
T_3	1.42	1.44	1.48	1.51	1.71	2.01	2.31	1.64^{cde}	62.7
T_4	1.34	1.30	1.50	1.70	2.00	2.20	2.30	1.76^{bcde}	71.6
T_5	1.40	1.21	1.31	1.51	1.71	1.90	2.13	1.59^{e}	51.1
T_6	1.35	1.34	1.54	1.74	1.94	2.24	2.34	1.78^{bc}	73.3
T_7	1.41	1.24	1.34	1.54	1.74	2.04	2.14	1.64^{cde}	51.0
T_8	1.33	1.31	1.51	1.71	2.01	2.21	2.31	1.77^{bcd}	73.3
T_9	1.40	1.21	1.31	1.51	1.71	2.01	2.11	1.61^{de}	50.7
Means	1.39^{ef}	1.35^{f}	1.51^{e}	1.72^{d}	1.96^{c}	2.21^{b}	2.38^{a}		

Values followed by different letters are significantly ($p < 0.05$) different from each other.

results were recorded by Ali (1965) who reported that acidity in fruit juices increases and pH decreased during processing and storage.

The analysis of our data showed that different treatments and storage intervals had a significant effect on TSS of strawberry juice. Maximum mean values were recorded in T_5 (28.9) followed by T_7 (27.1) and T_9 (27.2), while minimum mean values were recorded T_4 and T_6 (7.3). Our results indicated a gradual increase in TSS of all samples. Maximum increase was observed in T_0 (60%) and minimum in T_2 (7.1%) (Table 4).

Sugars are the most important constituent of fruit product and are essential factor for the flavor of the food product and also act as a natural food preservative. Results showed that reducing sucrose increased in all samples from 15.7 to 17.8% during three months of storage. The treatments and storage intervals had a significant effect on reducing sucrose of the juice. Mean scores for different treatments were T_0 (5.8), T_1 (26.3), T_2 (5.8), T_3 (26.6), T_4 (6.0), T_5 (27.6), T_6 (6.1), T_7 (27.3), T_8 (6.2) and T_9 (28.2), (Table 5). These results are in agreement with Ruiz-Nieto et al. (1997) who showed an increase in glucose and fructose contents in strawberry fruits.

The non reducing sucrose decreased in all samples from 11.6 to 8.3%. Mean values for different treatments were recorded as T_0 (0.8), T_1 (14.9), T_2 (1.5), T_3 (19.0), T_4 (1.5), T_5 (19.4), T_6 (3.0), T_7 (19.1), T_8 (1.6) and T_9 (18.9) percent (Table 6). The storage and treatments had significant effect on the non reducing sucrose of the juice stored at refrigeration temperature. These results are confirmed by Ruiz-Nieto et al. (1997) who suggested that

Table 3. Effect of treatments and storage on pH of strawberry juice.

Treatments	Intervals (Days)							Means	% decrease
	1st	15th	30th	45th	60th	75th	90th		
T_0	3.50	2.95	2.48	1.95	1.45	0.95	0.45	1.96^{c}	87.1
T_1	3.09	2.99	2.69	2.39	2.09	1.89	1.69	2.40b^{c}	45.3
T_2	3.30	3.10	2.90	2.70	2.50	2.30	2.10	2.70^{ab}	36.4
T_3	3.29	3.09	2.99	2.79	2.59	2.39	2.29	2.78^{ab}	30.4
T_4	3.30	3.10	2.90	2.90	2.70	2.50	2.40	2.83^{ab}	27.3
T_5	3.29	3.09	2.99	2.99	2.79	2.69	2.59	2.92^{a}	21.3
T_6	3.30	3.10	3.00	3.00	2.80	2.60	2.28	2.87^{ab}	30.9
T_7	3.28	3.18	3.08	3.08	2.98	2.88	2.78	3.04^{a}	15.2
T_8	3.30	3.10	3.00	2.90	2.90	2.90	2.70	2.97^{a}	18.2
T_9	3.28	3.18	3.08	3.08	2.98	2.98	2.88	2.64^{ab}	12.2
Means	3.29^{a}	3.09^{ab}	2.61^{cd}	2.78^{bc}	2.58^{cd}	2.41^{cd}	2.22^{d}		

Values followed by different letters are significantly ($p < 0.05$) different from each other.

Table 4. Effect of treatments and storage on TSS of strawberry juice.

Treatments	Intervals (Days)							Means	% Increase
	1st	15th	30th	45th	60th	75th	90th		
T_0	5.0	5.1	5.2	2.4	2.2	2.0	2.0	2.6^{f}	60.0
T_1	24.4	24.8	24.8	25.2	25.6	26.0	26.6	25.3^{c}	9.0
T_2	7.0	7.1	7.1	7.2	7.3	7.4	7.5	7.2^{e}	7.1
T_3	26.2	26.6	27.0	27.4	27.6	28.0	28.4	27.3^{b}	8.4
T_4	7.0	7.1	7.2	7.3	7.4	7.5	7.5	7.3^{e}	7.1
T_5	27.8	28.2	28.6	28.8	29.2	29.8	30.0	28.9^{a}	7.9
T_6	7.2	7.2	7.3	7.2	7.4	7.5	7.6	7.3^{e}	5.6
T_7	26.0	26.2	26.8	27.0	27.4	27.8	28.2	27.1^{b}	8.5
T_8	7.8	7.9	8.1	8.1	8.2	8.3	8.3	8.1^{d}	6.4
T_9	26.2	26.6	27.0	27.2	27.4	27.8	28.2	27.2^{b}	7.6
Means	16.5^{d}	16.4^{d}	16.6^{cd}	16.8^{bcd}	17.0^{abc}	17.2^{ab}	17.4^{a}		

Values followed by different letters are significantly ($p < 0.05$) different from each other.

Table 5. Effect of treatments and storage on reducing sugar (%) of strawberry juice.

Treatments	Intervals (Days)							Means	% Increase
	1st	15th	30th	45th	60th	75th	90th		
T_0	5.6	5.7	5.8	5.9	6.0	6.0	6.0	5.8^{d}	5.9
T_1	25.4	25.8	26.2	26.6	26.6	26.8	26.9	26.3^{c}	8.3
T_2	5.6	5.7	5.8	5.9	6.0	6.0	6.1	6.0^{c}	6.3
T_3	25.2	25.7	26.2	26.7	27.1	27.6	28.0	26.6^{a}	11.1
T_4	5.9	5.8	5.9	6.0	6.1	6.2	6.3	6.0^{c}	6.8
T_5	25.7	26.3	26.9	27.5	28.7	28.7	29.2	27.6^{a}	13.6
T_6	5.9	6.0	6.1	6.1	6.2	6.3	6.4	6.1^{c}	8.5
T_7	25.5	26.1	26.7	27.3	27.9	28.5	29.1	27.3^{a}	14.1
T_8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.2^{c}	10.2
T_9	25.8	26.6	27.4	28.2	29.0	29.8	30.5	28.2^{a}	18.2
Means	15.7^{a}	16.0^{a}	16.3^{a}	16.6^{a}	17.0^{a}	17.3^{a}	17.8^{a}		

Values followed by different letters are significantly ($p < 0.05$) different from each other.

Table 6. Effect of treatments and storage on non-reducing sugar (%) of strawberry juice.

Treatments	Intervals (Days)							Means	%Increase
	1st	15th	30th	45th	60th	75th	90th		
T_0	1.4	1.2	0.9	0.6	0.5	0.5	0.5	0.8^{d}	7.2
T_1	21.6	19.0	17.0	15.0	15.0	14.5	14.3	14.9^{b}	9.1
T_2	1.6	1.6	1.5	1.5	1.5	1.4	1.4	1.5^{cd}	12.5
T_3	21.2	20.4	19.6	18.8	18.8	17.2	16.8	19.0^{a}	20.8
T_4	1.7	1.6	1.6	1.5	1.5	1.4	1.4	1.5^{cd}	17.6
T_5	21.6	20.9	20.0	19.5	18.8	18.1	17.0	19.4^{a}	21.3
T_6	1.7	1.6	1.6	1.5	1.5	11.5	1.4	3.0^{c}	17.6
T_7	21.7	20.3	19.9	19.1	18.2	17.3	16.9	19.1^{a}	22.1
T_8	1.7	1.6	1.6	1.6	1.5	1.5	1.4	1.6^{cd}	17.6
T_9	21.5	20.6	19.7	18.9	18.0	17.1	16.6	18.9^{a}	22.8
Means	11.6^{a}	10.9^{ab}	10.3^{ab}	9.8^{bc}	9.1^{bc}	9.6^{bc}	8.3^{c}		

Values followed by different letters are significantly ($p < 0.05$) different from each other.

Table 7. Effect of treatments and storage on overall acceptability of strawberry juice.

Treatments	Intervals (Days)							Means	% Decrease
	1st	15th	30th	45th	60th	75th	90th		
T_0	6.78	5.00	5.00	4.00	3.67	1.44	1.00	3.84^{e}	85.3
T_1	7.44	6.22	5.22	4.11	3.00	2.44	1.00	4.20^{de}	86.6
T_2	6.67	5.30	5.12	5.00	4.50	2.67	2.02	4.49^{d}	67.0
T_3	7.11	6.44	6.00	5.67	5.00	3.33	2.12	5.10^{be}	70.2
T_4	6.78	5.44	5.22	5.00	3.89	2.56	2.64	4.50^{d}	61.1
T_5	6.89	5.89	5.56	5.67	5.00	3.44	3.67	5.16^{b}	46.7
T_6	6.67	5.44	4.89	5.44	5.00	2.56	2.56	4.65^{ed}	61.6
T_7	7.11	6.00	5.78	6.00	5.44	3.89	4.00	5.56^{ab}	43.7
T_8	6.56	5.44	4.89	4.89	4.44	2.89	2.67	4.54^{d}	59.3
T_9	7.44	6.33	6.11	6.33	5.67	4.33	3.89	5.73^{a}	47.7
Means	6.95^{a}	5.75^{b}	5.38^{bc}	5.21^{c}	4.56^{d}	2.96^{e}	2.58^{e}		

Values followed by different letters are significantly ($p < 0.05$) different from each other.

sucrose content of the fruit convert to glucose and fructose during the storage, results in the change in sucrose contents of juices.

Sensory analysis

The analysis of our data showed that storage period and treatments had a significant on overall acceptability (obtained from color, flavor and odor) of the strawberry juice. The mean score of judges decrease from 6.95 to 2.58. Maximum mean score of judges was recorded in T_9 (5.73) followed by T_5 (5.16), while minimum mean score of judges was recorded in T_0 (3.84) followed by T_1 (4.2). Maximum decrease was observed in sample T_1 (86.6%) followed by T_0 (85.3%), while minimum increase was observed in T_7 (43.7%) followed by T_5 (46.7%), (Table 7). The findings of this study showed that the product preserved with chemical preservatives retain maximum overall acceptability during storage. These results are confirmed by Kinh et al. (2001).

Microbial evaluation

Maximum number of colonies recorded in T_0 and T_1 (uncountable during 30 days), while minimum growth of microorganism was observed in T_9 ($3.5X\ 10^3$) T_7 ($6.1\ X\ 10^3$) cfu ml^{-1}(Table 8).

Conclusion

From the study it can be concluded pasteurized juice with 20% sucrose, 0.05 or 0.1% sodium benzoate and 0.05 or 0.1% potassium sorbate were found most acceptable sensory evaluation and microbial safety and retention of

Table 8. Effect of treatments and storage on Total Fungal Count of strawberry juice.

Treatments	Intervals (Days)							% Increase
	1st	15th	30th	45th	60th	75th	90th	
T_0	1.2×10^1	1.8×10^1	8.7×10^1	9.0×10^1	--	--	--	--
T_1	1.0×10^1	1.6×10^1	7.5×10^1	9.2×10^1	--	--	--	--
T_2	6.0×10^1	1.2×10^1	7.5×10^1	1.10×10^2	2.00×10^2	2.90×10^2	3.40×10^2	2033.3
T_3	5×10^0	1.1×10^1	6.7×10^1	1.00×10^2	1.80×10^2	2.80×10^2	3.20×10^2	2100
T_4	4×10^0	8×10^0	6.0×10^1	1.02×10^2	2.00×10^2	2.85×10^2	3.30×10^2	1900
T_5	4×10^0	8×10^0	4.3×10^1	9.5×10^1	1.50×10^2	2.25×10^2	2.93×10^2	1900
T_6	5×10^0	9×10^0	4.0×10^1	1.00×10^2	1.80×10^2	2.40×10^2	2.72×10^2	1333
T_7	4×10^0	7×10^0	3.5×10^1	8.3×10^1	1.50×10^2	2.10×10^2	2.50×10^2	1360
T_8	5×10^0	8×10^0	4.5×10^1	9.5×10^1	1.70×10^2	2.00×10^2	2.60×10^2	1753
T_9	4×10^0	6×10^0	3.0×10^1	6.7×10^1	1.10×10^2	1.80×10^2	2.40×10^2	

most of the nutrients during 3 months storage.

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