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Short Communication

Evaluation of Watermelon (*Citrullus lanatus*) Juice Preserved with Chemical Preservatives at Refrigeration Temperature

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Abstract

This study was done to analyze the effect of chemical preservatives on watermelon juice. Ten different samples of pasteurized watermelon juices with different chemical preservatives, termed as T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_9, T_{10}, were made which were stored at 4 - 15°C for three months. T_1 and T_2 were rejected soon due to spoilage. pH decreased from 5.094 to 4.017 and minimum pH content was reduced in T_{10} (7.87%), while maximum in T_1 (57.55%). The total soluble solids (TSS) increased from 17.460% to 18.980% with maximum in T_1 (51.67%) and minimum in T_7 (4.88%). Reducing sugar was increased from 15.650 to 17.500% with maximum in T_{10} (18.22%) and minimum in T_2 (5.90%). Minimum microbial load was observed in T_{10} (0.20cfu/ml) and maximum in T_1 (>24 cfu/ml) in case of coliforms; minimum in T_{10} (78×10^5 cfu/ml) and maximum in T_1 (258×10^5 cfu/ml) in case of total viable bacteria and same results (minimum in T_{10} and maximum in T_1) were shown in case of fungal count. *E.coli* was found in T_1, T_2, T_3 and T_4 and some bacteria was found in SS agar (especially Salmonella) in T_1, T_2, T_3 and T_5. Among all the treated juice samples T_{10} was most effective in maintaining the sensory and nutritional quality during storage.

Keywords: Watermelon juice; Pasteurization; Sugar; Sodium benzoate; Potassium sorbate.

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1. Introduction

Watermelon originated in Africa and has been in cultivation for more than 4, 000 years in the drier parts of the continent and throughout India and parts of Asia [1]. It is used as a

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dessert fruit and a thirst quencher and in the very dry parts of Africa, it is relished by both man and his animals as a source of water. Watermelon was widely distributed throughout the remainder of the world by African slaves and European colonists. It was carried to Brazil, the West Indies, Eastern North America, islands of the Pacific, New Zealand, and Australia. It has been cultivated in the Middle East for thousands of years. The plants have weak stems and climb by tendrils, which hang from tree as tall as 20 to 60 feet, the watermelon fruit ripens on the ground. There is no way of determining with certainty when watermelons are ripe, and harvesting is based on the experience of the growers. Some believe that when the fruit is thumbed and gives out a dull sound, it is mature. Other criteria are the colour of that part of the fruit that touches the ground, which takes a yellow tinge as maturity approaches. High quality watermelon should have a sugar content (measured as soluble solid) of 10% or more in the flesh near the center of the melon [2]. Seeded watermelons have dark brown or black oval seeds, whereas seedless varieties may contain no seeds at all or only very small and thin, jelly-like white seeds. The colour of the flesh varies from yellow, orange, pink, or red in most commercial varieties [3]. The fruits are very juicy, with a moisture content of over 90%. Moreover, watermelon's high water content hydrates your body as against the caffeinated energy drinks that tend to dehydrate your body. Watermelon is rich in vitamin C, vitamin A, vitamin B, amino acid and also carotenoid lycopene. The red flesh of watermelon contains some vitamin A [4]. Watermelon is rich in vitamin B that is primarily responsible for the production of energy in your body. Hence, consuming watermelon can boost your energy levels. Watermelon can be viewed as a more nutritious alternative to having energy drinks or supplements prior to exercise.

The sugar content of the watermelon varied greatly and was different in different parts of the fruit. The average sugar content of the center part was 8.86%, and had the highest sugar content compared to other parts of the fruit. The sugar content of the stem part, omphalic part, sunlight-side part and ground-side part were 7.48%, 7.44%, 7.20%, and 6.99%, respectively. The sugar content of the ground-side part was significantly lower than the sunlight-side part. The sugar content of the stem end part and groundside part was significantly higher than the sunlight side part and ground side part[5]. This fruit is also free from cholesterol that elevates heart related problems hence preventing heart attacks.

Watermelon juice, as a beverage, is found almost exclusively as an over-the-counter drink made by hand from the pink flesh of the watermelon fruit. While, in some cultures such as those of Mexico and India, such watermelon drinks are popular, in the United States and elsewhere, watermelon juice drinks are rare, with commercially available packaged watermelon juice drinks virtually unknown.

Watermelon juice is commonly consumed in Mexico and can be found in many American bars as a mixer for alcoholic beverages. Due to its low acidity and growing conditions, watermelon is regarded as a potentially hazardous food [6]. According to the CDC [7], watermelon caused a Salmonella outbreak in 2002 and 2006, a Norovirus outbreak in 2005 and 2006, and a Campylobacter outbreak in 2006. Because of these pathogens, watermelon juice must be pasteurized prior to consumption. In the fruit juice industry, juice is typically pasteurized by high temperature short time (HTST)

pasteurization. This process uses plate heat exchangers to heat the sample quickly at least 78°C. Generally there is less information of watermelon juice during storage time . So the study during storage is important for harvesting and post harvest technology to improve quality and processing characteristics. Hence the present study is selected to determine the chemical properties (p^H, TSS, reducing sugar) and to analyze the microbiological characteristics during storage time.

2. Materials and Methods

2.1. *Preparation and treatment of juice*

Fresh mature watermelon were purchased from local market in Sylhet with uniform in color and size and stored at 25^0 C. The fruits were thoroughly washed with distilled water to remove dirt, dust, pesticide residues and then rinds were washed with pure ethanol to remove micro flora on the surface of the fruit prior to juice extraction. All glassware and knives were autoclaved at 121°C for 45 min and all other equipment was sanitized with hypochlorite prior to usage. The watermelons were cut into quarters and the flesh was scooped out and cut into small cubes. The cubes were placed in a laboratory scale juice processor. The extracted juice was then centrifuged and filtered. The filtered juice was placed in autoclaved screw-top glass bottles. The filtered watermelon juice, in screw-top glass bottles, was pasteurized in a covered water bath with high temperature short time (72^oC for 15s) (Precision Water bath 180 Series, Chicago, IL). The treatments were made as pasteurized watermelon juice {Treatment one, T_1 (control)}, pasteurized watermelon juice +20% sucrose (T_2), pasteurized watermelon juice +0.1% sodium benzoate (C_6H_5COONa) (T_3), pasteurized watermelon juice +20% sucrose +0.1% sodium benzoate (C_6H_5COONa) (T_4), pasteurized watermelon juice +0.1% potassium sorbate (CH_3-CH=CH-CH=CH=COOK) (T_5), pasteurized watermelon juice +20% sucrose+0.1% potassium sorbate (CH_3-CH=CH-CH=CH=COOK) (T_6), pasteurized watermelon juice +0.05% sodium benzoate (C_6H_5COONa) +0.05% Potassium Sorbate (CH_3-CH=CH-CH=CH=COOK) (T_7), pasteurized watermelon juice +20% sucrose +0.05% sodium benzoate (C_6H_5COONa) +0.05% potassium sorbate (CH_3-CH=CH-CH=CH=COOK) (T_8), pasteurized watermelon juice +0.1% sodium benzoate (C_6H_5COONa) +0.1% potassium sorbate (CH_3-CH=CH-CH=CH=COOK) (T_9), pasteurized watermelon juice +20% sucrose +0.1% sodium benzoate (C_6H_5COONa) +0.1% potassium sorbate (CH_3-CH=CH-CH=CH=COOK) (T_{10}) and stored at refrigeration temperature (4-15°C) for a period of three months.

2.2. *Chemical analysis*

Inolab digital ph meter was used for pH determination. The Nelson-Somogyi method was used for the quantitative determination of reducing sugars. The reducing sugars when heated with alkaline copper tartrate reduce the copper from the cupric to cuprous state and thus cuprous oxide is formed. When cuprous oxide is treated with arsenomolybdic acid,

the reduction molybdic acid to molybdenum blue takes place. The blue color developed is compared with asset of standards in a colorimeter at 620nm. The total soluble solids (TSS) were determined by using oven drying method [8].

2.3. *Microbial analysis*

Total coliform count was performed by using most probable number technique (MPN). Total viable count by using nutrient agar media [9], total fungal count by using rose bengal agar [10], *E.coli* confirmation test by using eosin methylene blue agar, and *Salmonella* confirmation test by using SS agar were done after preparing and treating the juice.

2.4. *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 Significance Difference) test [11]. For all the analyses, the alpha error was set at 0.05%.

3. Results and Discussion

pH of samples (T_1 to T_{10}) ranged from 4.90 to 5.30, which gradually decreased to 3.761 to 4.866 during three months of storage. The mean values decreased from 5.094 to 4.017. Maximum mean values were recorded in sample T_{10} (4.866) followed by T_8 (4.837), while minimum mean values were observed in sample T_1 (3.761) followed by T_2 (4.214). During storage maximum decrease was observed in sample T_1 (57.55%) followed by T_2 (28.57%), while minimum decrease was observed in T_{10} (7.87%) followed by T_8 (9.84%) (Table 1). Similar results were recorded in ref. [12] who reported that acidity in fruit juices increases during processing and storage.

Table 1. Effect of treatments and storage on pH of watermelon juice.

Treatment	Intervals (days)							Mean	% of decrease
	1st	15th	30th	45th	60th	75th	90th		
T_1	5.30	4.75	4.28	3.75	3.25	2.75	2.25	3.761 ± 1.09^{a}	57.55
T_2	4.90	4.80	4.50	4.20	3.90	3.70	3.50	4.214 ± 0.54^{ab}	28.57
T_3	5.10	4.90	4.70	4.50	4.30	4.10	3.90	4.500 ± 0.43^{b}	23.52
T_4	5.09	4.89	4.79	4.59	4.39	4.19	4.09	4.576 ± 0.37^{ab}	19.65
T_5	5.10	4.90	4.70	4.70	4.50	4.30	4.20	4.629 ± 0.32^{b}	17.65
T_6	5.09	4.89	4.79	4.79	4.59	4.49	4.39	4.719 ± 0.24^{b}	13.75
T_7	5.10	4.90	4.80	4.80	4.60	4.40	4.08	4.669 ± 0.34^{b}	20.00
T_8	5.08	4.98	4.88	4.88	4.78	4.68	4.58	4.837 ± 0.17^{b}	9.84

Table 1 (*contd.*)

T_9	5.10	4.90	4.80	4.70	4.70	4.70	4.50	4.771±0.19^{b}	11.76
T_{10}	5.08	4.98	4.88	4.88	4.78	4.78	4.68	4.866±0.13^{b}	7.87
Mean	5.094 ±0.09^{d}	4.889 ±0.07^{cd}	4.712 ±0.19^{bcd}	4.579 ±0.36^{abcd}	4.379 ±0.48^{abc}	4.209 ±0.61^{ab}	4.017 ±0.71^{a}		

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

The analysis of my data showed that different treatments and storage intervals had a significant effect on TSS of watermelon juice. TSS of samples (T_1 to T_{10}) ranged from 6.00 to 28.80, which were gradually increased to 7.000 to 29.914 during three months of storage. The mean values increased from 17.460 to 18.980. Maximum mean values were recorded in sample T_6 (29.914) followed byT_4 (28.314), while minimum mean values were observed in sample T_1 (7.000) followed by T_3 (8.229). During storage maximum increase was observed in sample T_1 (51.67%) followed by T_2 (8.67%) , T_8 (8.15%), while minimum increase was observed in T_7 (4.88%) followed by T_9 (5.68%) (Table 2).

Table 2. Effect of treatments and storage on TSS (%) of watermelon juice.

Treatment	Intervals (days)							Means	% of increase
	1st	15th	30th	45th	60th	75th	90th		
T_1	6.00	6.10	6.20	6.40	7.20	8.00	9.10	7.000±1.17^{a}	51.67
T_2	25.40	25.80	25.80	26.20	26.60	27.00	27.60	26.257±0.63^{c}	8.67
T_3	8.00	8.10	8.10	8.20	8.30	8.40	8.50	8.229±0.18^{b}	6.25
T_4	27.20	27.60	28.00	28.40	28.60	29.00	29.40	28.314±0.77^{d}	8.09
T_5	8.00	8.10	8.20	8.30	8.40	8.50	8.50	8.286±0.19^{b}	6.25
T_6	28.80	29.20	29.60	29.80	30.20	30.80	31.00	29.914±0.81^{e}	7.64
T_7	8.20	8.20	8.30	8.20	8.40	8.50	8.60	8.343±0.16^{b}	4.88
T_8	27.00	27.20	27.80	28.00	28.40	28.80	29.20	28.057±0.80^{d}	8.15
T_9	8.80	8.90	9.10	9.10	9.20	9.30	9.30	9.100±0.19^{b}	5.68
T_{10}	27.20	27.60	28.00	28.20	28.40	28.80	29.20	28.200±0.68^{d}	7.35
Mean	17.460 ±10.24^{a}	17.68 ±10.38^{a}	17.91 ±10.53^{a}	18.080 ±10.64^{a}	18.370 ±10.66^{a}	18.710 ±10.76^{a}	18.980 ±10.77^{a}		

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

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. The treatments

and storage intervals had a significant effect on reducing sucrose of the juice. The mean values increased from 15.650 to 17.500. Maximum mean values were recorded in sample T_{10} (28.186) followed by T_6 (27.571), while minimum mean values were observed in sample T_1 (5.714) followed by T_3 (5.871). During storage maximum increase was observed in sample T_{10} (18.22%) followed by T_8 (14.12%), while minimum increase was observed in T_2 (5.90%) followed by T_5 (6.78%) (Table 3). These results are in agreement with [13] who showed an increase in glucose and fructose contents in strawberry fruits.

Table 3. Effect of treatments and storage on reducing sugar (%) of watermelon juice.

Treatment	Intervals (days)							Mean	% of increase
	1st	15th	30th	45th	60th	75th	90th		
T_1	5.60	5.70	5.80	5.90	6.00	6.00	6.00	5.714±0.35[a]	7.14
T_2	25.40	25.80	26.20	26.60	26.60	26.80	26.90	26.329±0.55[b]	5.90
T_3	5.60	5.70	5.80	5.90	6.00	6.00	6.10	5.871±0.18[a]	8.93
T_4	25.20	25.70	26.20	26.70	27.10	27.60	28.00	26.643±1.01[bc]	11.11
T_5	5.90	5.80	5.90	6.00	6.10	6.20	6.30	6.029±0.17[a]	6.78
T_6	25.70	26.30	26.90	27.50	28.70	28.70	29.20	27.571±1.34[bc]	13.62
T_7	5.90	6.00	6.10	6.10	6.20	6.30	6.40	6.143±0.17[a]	8.47
T_8	25.50	26.10	26.70	27.30	27.90	28.50	29.10	27.300±1.20[bc]	14.12
T_9	5.90	6.00	6.10	6.20	6.30	6.40	6.50	6.200±0.22[a]	10.17
T_{10}	25.80	26.60	27.40	28.20	29.00	29.80	30.50	28.186±1.70[c]	18.22
Mean	15.65 ±10.40[a]	15.97 ±10.68[a]	16.31 ±10.94[a]	16.64 ±11.20[a]	16.89 ±11.59[a]	17.23 ±11.67[a]	17.50 ±11.88[a]		

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

Lactose medium was used to count the total *coliform* and the maximum number was found in treatment T_1 and the minimum in treatment T_{10} (Table 4). Total viable bacteria was identified by using nutrient agar media and the maximum population was observed in treatment T_1 ($258*10^5$), then to T_2 ($220*10^5$) and the minimum in treatment T_{10}($78*10^5$) (Table 4). In a total fungal count, maximum number of colonies was recorded in T_1 and T_2, while minimum growth of microorganism was observed in T_{10} (Table 4). Eosin Methylene blue agar (EMB) was used to determine the presence of *E.coli* in each treatment of watermelon juice and the population was found in treatment T_1, T_2, T_3, and T_4 (Table 5). SS agar was used to observe the presence of *Salmonella* in each treatment of watermelon juice and these are only found in treatment T_1, T_2, T_3 and T_5 (Table 5).

Table 4. Total coliform count (MPN) and total viable count of watermelon juice sample.

Treatment or sample	Coliform cfu /ml*	Total viable bacteria cfu /ml	Fungus cfu/ml**
T_1	>24	258×10^5	12
T_2	11	220×10^5	10
T_3	4.60	206×10^5	6
T_4	1.50	190×10^5	5
T_5	2.40	210×10^5	4
T_6	1.50	192×10^5	4
T_7	2.10	140×10^5	5
T_8	0.35	120×10^5	4
T_9	0.28	90×10^5	5
T_{10}	0.20	78×10^5	Fungus cfu/ml

* Since calculated value (8.997) is greater than tabulated value (1.833) so, null hypothesis may be rejected and they are significant.
******Since calculated value (6.33) is greater than tabulated value (1.833) so, null hypothesis may be rejected and they are significant.

Table 5. Result of *E.coli* and *Salmonella* confirmation tests.

Treatment or sample	*E.coli*	*Salmonella*
T_1	Present	Present
T_2	Present	Present
T_3	Present	Present
T_4	Present	Absent
T_5	Absent	Present
T_6	Absent	Absent
T_7	Absent	Absent
T_8	Absent	Absent
T_9	Absent	Absent
T_{10}	Absent	Absent

4. Conclusion

Finally from the study it can be concluded that pasteurized juice with 20% sucrose, 0.05 or 0.1% sodium benzoate and 0.05 or 0.1% potassium sorbate were considered most acceptable by taking into account some chemical properties (pH, TSS, and reducing sugar

content) and by consideration of the microbial load on comparison with other samples with three months storage.

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