EFFECT OF SODIUM BENZOATE AND REFRIGERATION STORAGE ON THE OVERALL QUALITY OF PASTEURIZED TOMATO AND WATERMELON BLENDS

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ABSTRACT

Tomato and watermelon both fruits are of highly commercial importance but perishable in nature. Aim of study was to develop preserved blends with different ratios from these fruit juices. Blends prepared from tomato and watermelon fruit juices were examined physicochemical (pH, titratable acidity, TSS, vitamin c, reducing sugar and non-reducing sugar) and sensory attributes (color, flavor, taste and overall acceptability) during 3 months refrigerator storage at an interval of 15 days. In-terms of physicochemical study a decrease was observed in pH (5.17 - 4.35), non- reducing sugar (1.57 - 1.30%) & vitamin C (14.3 - 9.96mg/100g) while, an increase in numbers of TSS (5.87 - 6.74^{o}brix), reducing sugar (3.25 - 3.68%) and titratable acidity (0.27 - 0.35%) were observed. The addition of watermelon juice decreased the intensity of acidity and increased the sensory attributes of developed samples, as during sensory as of samples it was noticed that TW_5 (tomato 50% juice and watermelon 50% juice) was highly acceptability and selected as the best sample by the team of judges. All the quality parameters were significantly affected by the application of selected treatments storage time. Thus it is concluded from this study that watermelon juice might be given to tomato juice to develop a healthy juice blend.

Key words: Tomato and watermelon juice, sodium benzoate, refrigeration storage.

INTRODUCTION

Tomato (Lycopersicon esculentum Mill) is widely produced and consumed vegetable. It ranks second in all vegetables worldwide in terms of importance and good nutritional

importance (Bamidele *et al*., 2017) [1]. The vegetable is consumed in fresh form and also as processed form like tomato ketchup, tomato sauce, tomato juice, stews and soup and canned tomatoes. (Lenucci *et al*., 2006) [2]. It is a worthy cause of bioactive compounds such as carotenoids, flavonoids, and phenolic acids, becomes a good antioxidant source (Adebooye *et al*., 2008) [3]. Lycopene is found in abundant quantity and is responsible for the red color of tomato. It contain high quantity of bioactive compounds (e.g. beta carotene, lycopene, vitamin A, E and C and folic acid etc), tocopherol compounds and phenolic compounds which include flavonoids and hydroxylcinnamic acid derivatives. Their regular consumption is related to improved health as well as decline in the risks of cardiovascular diseases, including different types of cancer (Khachick *et al*., 2002) [4]. These compounds may inhibit oxygen species which are the reason for certain main diseases through free-radical scavenging. Juice and leaves of tomatoes are also reported to be valuable in treating diabetes (Heinrich *et al*., 2005) [5] and liver diseases (Islam *et al*., 2006) [6]. In Pakistan tomatoes are grown on an area of 40,238 hectares with the average production of 5, 66043 tones. While in Khyber Pakhtunkhwa they are grownup on an area of 1, 3252 hectares with the production of 1, 27552 tones (MNFSR, 2014-15) [7].

Tomatoes are highly perishable so are easily vulnerable to microbial attack and can get contaminated by microbial pathogens such as Shigella, Salmonella, Escherichia Coli O157:H7 and Listeria monocytogenes. Therefore for preservation of tomatoes or their products (such as tomato blends) pasteurization and refrigeration is the most useful, popular and widely used method. Today consumers are demanding minimally processed and safer foods, with retained nutritional and organoleptic attributes. Of late, safe processing techniques like pasteurization, preservative addition and refrigeration is completely being accepted by the consumers and food industry. Therefore, these techniques are reported to make less quality changes in a product and is proficient of reducing microbial load (Bhat 2016) [8]. Based on this background, the main aim of undertaking this study relies on the fact that exposure of tomato and watermelon juice blends to mention treatments can either enhance/retain the nutritional and overall sensory qualities, thus benefiting the consumers.

Watermelon belongs to family *Cucurbitaceae* and species *Citrulluslanatus* is a major fruit widely distributed in tropics and subtropics (Yamaguchi, 2006) [9]. According to (Chahal *et al*., 1999) [10] the third most popular fruit among consumers are watermelon containing good quantity of nutrients. It contain certain varieties of round, oval or oblong shapes. Watermelon has smooth dark greenish had rind with some varieties gives yellowish color on

ripening and is a magnificent source of vitamins and rich source of phyto- chemicals (Perkins and Colins 2004) [11]. Watermelon is a popular thirst quencher during hot summer weather and can be used as appetizer. Growth of melon in Pakistan is on an area of 4, 6518 hectares with average produce of 544966 tons. Area for melon growth in Khyber Pakhtunkhwa is 4,240 hectares and production are 5,502 tons (MNFSR, 2014-15)[7]. Juice of watermelon is becoming progressively popular due to its refreshing taste, attractive color and potential health benefits (Edwards *et al*., 2003) [12]. Studies have reported that typical watermelon juice flavor is due to the result of complex mixture of about 75 compounds such as aldehydes, alcohol, ketones, furans and the important cause responsible for its unique flavor is geranylacetone (Beaulieu and Lea 2006) [13]. It contains 90% water, B vitamins, minerals (phosphorus, magnesium, potassium, iron and calcium) and amino acids (citrulline and arginine) bioactive and phenolic compounds such as lycopene and citrulline which have a beneficial effects on human health in the shape of controlling different cardiovascular diseases and certain types of cancer, reduce the blood pressure and inflammation processes, increase of antioxidant value and decreasing the oxidative stress (Martins *et al*., 2018) [14].

According to the mentioned information tomato is abundantly grown in Pakistan and majority of it spoiled due to the unavailability of preservation facilities. While watermelon is only consumed in raw form and its products are not available in Pakistan. For this purpose an effort has been made to develop tomato and watermelon blend and its shelf life was studied under the effect of sodium benzoate and refrigeration condition. To accomplish this task the following objectives were proposed.

MATERIALS AND METHODS

The research was done to analyze the refrigerator storage impact on the developed blends from tomato and watermelon juice. This study was carried out in three replications for 90 days. The study was finished out at the Food Science and Technology branch of the University of Agriculture Peshawar. Mentioned below quality traits were examined throughout the entire period. The examination point was to get high favored blend proportion sample both physico-chemically and organoleptically.

Juice Extraction

Fresh and fully ripped tomatoes and watermelons were procured from the local fruit market of Peshawar city. Both fruits were after that washed with distilled water, sorted and separately cut with the knife. Then the peels were removed from both fruits, as well as seeds

of watermelon were separated manually. Peacock juice extractor machine (Model no, KQ 107) were used for pulp extraction. Muslin cloth was used to sieve the extracted pulp for juice. (Bamidele and Fasogbon, 2017).

Heat treatment and Blending of juice

The extracted juices was then transferred in a separate containers and was pasteurized at 90°C, for sixty seconds. The juices was permitted to cool at adequate temperature and about 0.1% (1000ppm) preservative (sodium benzoate) was added in each sample. The developed juice blends were distributed into sterile bottles previously washed and dried in the oven at 45°C for 30 minutes. The tomato and watermelon juice was mixed in nine different proportions shown below, after that the models were evaluated for both physico-chemical and sensory attributes and kept at refrigeration temperature 4±2°C.

Plan of study

Blend	Tomato (%)	Watermelon (%)	Preservatives
T0	100%		Without Preservative
W0		100%	Without Preservative
T1	100%		0.1% Sodium Benzoate
W1		100%	0.1% Sodium Benzoate
TW1	90%	10%	0.1% Sodium Benzoate
TW2	80%	20%	0.1% Sodium Benzoate
TW3	70%	30%	0.1% Sodium Benzoate
TW4	60%	40%	0.1% Sodium Benzoate
TW5	50%	50%	0.1% Sodium Benzoate

Physiochemical analysis:

The Physicochemical analysis studied by the standard method as described by AOAC (2012) [16].

Reducing sugar:

The method suggested of AOAC (2012) [16] stated by Lane and Eynon was applied during the determination of reducing sugar content for all treatments.

Non reducing sugar:

The method suggested of AOAC (2012) [16] stated by Lane and Eynon was applied during the determination of glucose - fructose content for all treatments.

Organoleptic Examination:

Organoleptic properties of created product were done for color, taste, flavor and overall acceptability. Made blends were umpired by the board of judges through 9 point hedonic scale by Larmond (1977) [17].

Statistical analysis:

Data examination were dissected by 2 factorial (Two way investigation) CRD. Means were isolated by utilizing LSD at 0.05% level of significance as indicated by Steel and Torrie (1997) [18].

RESULTS AND DISCUSSION

pH

Storage and treatments effect on pH of pasteurized tomato and watermelon juice blend is mentioned in Table-1. Both storage and treatments significantly affected the pH level of tomato and watermelon blends. The overall means within storage breaks for pH were significantly declined from (5.17 to 4.35%) during 3 months of storage time. Our outcome showed high decrease in pH of watermelon sample W0 than fresh tomato juice T0 in comparison with samples having preservative, and when we associate it with the blends, sample TW5 comparatively showed more decrease in pH percentage among blends may be due to high content of watermelon juice. However treatments and storage effect was statistically dissimilar from one another.

Fruits acidity is expressed as pH, which shows strength of hydrogen ions in samples while pH has a substantial character in the taste of the juice product also act as a factor of preservation. Generally tomato and watermelon are acidic in nature. Blending of tomato juice in watermelon juice has a minute effect on pH despite the differences in blending ratios.

However the incorporation of watermelon juice in the blend decreased the pH of juice in comparison with 100% tomato juice which had a good effect on neglecting microbial growth. Preservative had also significantly retained the pH of blended juice samples during storage. Sodium benzoate is highly persuasive in acidic foods, it penetrates into the individual cells in the food and balancing its pH level, increasing the overall acidity of the food. While certain decrease in pH of tomato and watermelon blends is may be due to the presence of carbohydrates and sugars so it is vulnerable to microbial attack including lactic acid bacteria which may produce acetic acid, lactic acid which causes decrease in pH. Francis et al., (2017) [19] expressed a declined in pH of watermelon and soursop fruit blend from (4.02 - 3.90%) throughout 10 days of storing. pH decline in watermelon and orange juices blend from (4.8 - 4.6%) was also observed by (Ayodele (2015) [20]. Similarly our consequences is in accordance along results of Yousaf et al., (2016) [21] who expressed a lessening of pH in watermelon pulpy juice from (4.77 to 4.32%) throughout storing of 3 months.

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

Treat	Days (Interval)							%Dec	Mean
	First	15	30	45	60	75	90		
T0	4.55	4.45	4.35	4.2	4.05	3.8	3.55	21.98	4.14h
W0	5.9	5.75	5.55	5.3	5.05	4.66	4.33	26.61	5.22b
T1	4.3	4.25	4.19	4.15	4.1	4.02	3.88	9.77	4.13h
W1	5.75	5.64	5.52	5.4	5.27	5.12	5.02	12.70	5.39a
TW1	4.8	4.75	4.69	4.6	4.51	4.42	4.3	10.42	4.58g
TW2	5.00	4.94	4.86	4.76	4.67	4.57	4.4	12.00	4.63f
TW3	5.2	5.12	5.03	4.91	4.75	4.62	4.46	14.23	4.87e
TW4	5.4	5.3	5.2	5.08	4.95	4.76	4.55	15.74	5.03d
TW5	5.6	5.5	5.4	5.25	5.08	4.9	4.62	17.50	5.19c
Mean	5.17a	5.08b	4.98c	4.77d	4.71e	4.54f	4.35g		

Small letters in columns and rows are dissimilar [P<0.05]

Titratable Acidity

Storage and treatments effect on acidity of pasteurized tomato and watermelon juice blend is mentioned in Table-2. Both storage and treatments significantly affected the acidity level of tomato and watermelon blends. The overall means values within storage intervals for

acidity were significantly increased from (0.27 - 0.35%) during 3 months of storage time. Our results presented high increase in acidity of watermelon sample W0 than fresh tomato juice T0 in comparison with samples having preservative, and when we associate it with the blends, sample TW5 comparatively showed more increase in acidity percentage among blends may be due to high quantity of watermelon juice. However treatments and storage effect was statistically dissimilar from one another.

The ionic power of a solution expressed its acidity, this determines the rate of chemical reaction and one of the physicochemical properties, which effects both organoleptic and keeping qualities of a product. The acidity values of all the samples ranged between 0.07 and 0.38 with control watermelon juice (W0) having the least (0.07) and tomato (T1) juice having the highest (0.38) value among all samples might be due to the effect of preservative. The increment of watermelon juice in the blends had no significant impact on the acidity, nevertheless, inclusion of watermelon juice in the blends decreased acidity level of the juice compared to 100% tomato juice (T1). This decrease might be due to high content of sugar in the watermelon juice which enhanced the sweetness perception of the juice and increased the acceptance of the blends. Preservative had also significantly affected the level of acidity in blended juice samples during storage. Increase in acidity of watermelon and orange juices blend from (0.18–0.22%) was also expressed by (Ayodele (2015) [20]. Francis et al., (2017) [19] described an increasing trend in acidity of watermelon and soursop fruit blend from (0.08 to 0.10%) during storage. Mishra et al., (2012) [22] proclaimed acidity increased from (0.4 to 0.49%) in amla-grape blend juice throughout study period. Our outcomes are also in concurrence with Kilima et al., (2014) [23] who announced increment from (0.8 - 1.61%) in the acidity level of roselle-mango juice blends during research period.

Table 2: Effect of treatments and storing on titratable acidity of tomato and watermelon juice blends.

Treat	Days (Interval)							%Inc	Mean
	First	15	30	45	60	75	90		

T0	0.33	0.34	0.35	0.38	0.41	0.44	0.49	32.65	0.39b
W0	0.07	0.07	0.08	0.09	0.1	0.11	0.13	46.15	0.09i
T1	0.38	0.38	0.38	0.39	0.41	0.43	0.45	15.56	0.40a
W1	0.18	0.18	0.19	0.2	0.21	0.22	0.24	25.00	0.20h
TW1	0.35	0.35	0.36	0.37	0.38	0.4	0.42	16.67	0.38c
TW2	0.32	0.32	0.33	0.34	0.35	0.37	0.39	17.95	0.35d
TW3	0.29	0.29	0.3	0.31	0.32	0.34	0.36	19.44	0.31e
TW4	0.27	0.28	0.29	0.3	0.31	0.32	0.34	20.59	0.30f
TW5	0.25	0.26	0.27	0.28	0.3	0.32	0.33	24.24	0.29g
Average	0.27g	0.27f	0.28e	0.30d	0.31c	0.33b	0.35 a		

Small letters in columns and rows with mean values are significantly dissimilar [P<0.05]

TSS

Storage and treatments effect on TSS of pasteurized tomato and watermelon juice blend is mentioned in Table-3. Both storage and treatments significantly affected the TSS level of tomato and watermelon blends. The overall means values within storage intervals for TSS were significantly increased from (0.27 - 0.35%) during 3 months of storage time. The research showed high increase in TSS of watermelon sample W0 than fresh tomato juice T0 in comparison with samples having preservative, and when we associate it with the blends, sample TW5 comparatively showed more increase in TSS percentage among blends might be due to high ratio of watermelon juice. However treatments and storage effect was statistically dissimilar from one another.

TSS are predominantly expressed as sugars, which in turn are important contributors to flavor. TSS of the juice blends was between 5.2% for tomato juice and 9.1% for watermelon juice during storage time. The High amount of sugars present in watermelon juice may be responsible for the high value of TSS in blended juice (Bamidele and Fasogbon 2017) [24]. This may be attributed to the reduction in TSS of tomato juice which the TSS of watermelon juice was complementing. The increase in TSS might be due to hydrolysis of polysaccharides into mono-saccharides and oligosaccharides. During this study it was noticed that TSS of tomato-watermelon juice blends during refrigerator storage were retained may be due to the addition of preservatives. Similarly the addition of watermelon juice with tomato juice helped in improving the organoleptic properties including the sweet taste of juice blends. Similar results were discussed for tomato - watermelon - pineapple blends by Oludemi et al., (2013)

[15]. Ejiofor et al (2016) [25] reported increment in TSS of spiced watermelon juice ranged from (5.60 to 9.90%) during storage, while Yousaf et al., (2016) [21] also revealed an increasing trend of TSS in watermelon pulpy juice from (14.00 to 15.61%) during storage of 90 days.

Table 3; Effect of treatments and storage on TSS of tomato and watermelon juice blends.

Treat	Days (Interval)							%Inc	Mean
	First	15	30	45	60	75	90		
T0	4.5	4.6	4.7	4.8	4.9	5.1	5.2	13.46	4.83i
W0	7.5	7.7	7.9	8.1	8.4	8.7	9.1	17.58	8.20b
T1	5.00	5.1	5.2	5.3	5.4	5.5	5.6	10.71	5.30h
W1	8.00	8.1	8.2	8.4	8.6	8.7	9.00	11.11	8.43a
TW1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	10.34	5.50g
TW2	5.4	5.5	5.6	5.7	5.8	5.9	6.1	11.48	5.71f
TW3	5.5	5.6	5.7	5.8	5.9	6.1	6.3	12.70	5.84e
TW4	5.7	5.8	5.9	6.1	6.3	6.4	6.6	13.64	6.11d
TW5	6.00	6.2	6.4	6.5	6.7	6.8	7	14.29	6.51c
Mean	5.87g	5.99f	6.11e	6.24d	6.40c	6.54b	6.74a		

Small letters in columns and rows are dissimilar [P<0.05]

Ascorbic acid (mg/100 ml)

Storage and treatments effect of pasteurized tomato and watermelon juice blend on ascorbic acid is mentioned in Table - 4. Both storage and treatments significantly affected the ascorbic acid level of tomato and watermelon blends. The overall means values within storage intervals for ascorbic acid were significantly declined from (14.33 to 9.96 mg/100 ml). The ascorbic acid content of watermelon juice sample W0 decreased more than fresh tomato juice T0 in comparison with samples having preservative, and when we associate it with the blends, sample TW5 comparatively showed high loss of percentage among blends of ascorbic acid might be due to high content of watermelon juice. However treatments and storage effect was statistically dissimilar from one another.

Ascorbic acid is an important attribute that contain antioxidant ability and provides defense against free radicals Storage temperature, type of processing and quality of packaging

greatly affect the rate of its degradation through an aerobic pathway. It is a heat-sensitive bioactive compound and highly unstable in the presence of oxygen and an indicator of the nutritional quality of juices (Esteve et al., 2005) [26]. The ascorbic acid content ranged between 6.5 and 21.8 mg/100 ml for all the samples with tomato juice had the highest 21.8mg/100 ml while watermelon juice W1 had the least 6.5mg/ ml content. The ascorbic acid in the juice blends decreased with the increase in the proportion of watermelon juice. The influence of different watermelon juice ratio was reflected in the entire chemical characteristics tested for in the juice blends. However, the addition of watermelon juice in the blend decreased the ascorbic acid content but it helped in improving the taste of the juice blend. The rise in acidity of the tomato juice were noticeable where the proportion of tomato juice was higher than that of watermelon juice and vice versa. This revealed how important tomato juice is in increasing the ascorbic acid content of the juice blends and that of watermelon juice in increasing the soluble solid and flavor of the developed juice blends. Atmospheric oxygen is responsible for most deprivation during long-term storage. Ascorbic acid usually degraded by oxidative process which are stimulated in the presence of oxygen, heat, heat peroxides and enzymes (especially ascorbate oxidase and peroxidase). Francis et al., (2017) [19] reported a decreasing trend in ascorbic acid content of watermelon and soursop fruit blend from (77.57 to 59.40mg /100g) during study period. Mishra et al., (2012) [22] reported a reduction in ascorbic acid level from (134 to 62.6mg/100g) in amla-grape blend juice throughput storing. Yousaf et al., (2016) [21] expressed a loss in watermelon pulpy juice ascorbic acid from (37.03 to 20.61mg/100g) during storage of 90 days.

Table 4; Effect of treatments and storage on ascorbic acid of tomato and watermelon juice blends.

Treat	Days (Interval)							%Dec	Mean
	First	15	30	45	60	75	90		

T0	21.8	20.5	18.8	17.5	16.3	15.2	13.9	36.24	17.71a
W0	7.2	6.8	6.2	5.4	4.6	4.00	3.2	55.56	5.34h
T1	18.2	17.8	17.5	16.9	16.6	16.1	15.8	13.19	16.99b
W1	6.5	6.1	5.7	5.3	4.8	4.3	3.8	41.54	5.21i
TW1	16.4	15.7	14.8	13.9	13.2	12.3	11.6	29.27	13.99c
TW2	16.2	15.4	14.6	13.8	13.1	12.2	11.3	30.25	13.80d
TW3	15.5	15.1	14.5	13.5	12.9	11.9	11.2	27.74	13.51e
TW4	14.9	14.4	13.7	12.8	12.2	11.4	10.6	28.86	12.86f
TW5	12.3	11.5	10.8	10.2	9.4	8.9	8.2	33.33	10.19g
Mean	14.33a	13.7b	12.96c	12.14d	11.46e	10.70f	9.96g		

Small letters in columns and rows are dissimilar $P<0.05$

Reducing Sugar

Storage and treatments effect on pasteurized tomato and watermelon juice blend on reducing sugar is mentioned in Table-5. Both storage and treatments significantly affected the reducing sugar level of tomato and watermelon blends. The overall means values within storage intervals for reducing sugar were significantly increased from (3.25 - 3.68) through 90 days of time period. This findings showed high increment in reducing sugar of watermelon sample W0 than fresh tomato juice T0 in comparison with samples having preservative, and when we associate it with the blends, sample TW5 comparatively showed more rise percentage among blends might because of high proportion of watermelon juice. However treatments and storage effect was statistically dissimilar from one another.

Sugars are most important component of the fruit product and are essential cause for the flavor of the food product and also act as a natural food preservative. It is also considered an important trait for tomato quality assessment. Tomato contains more glucose and fructose than sucrose as in watermelon (Bamidele et al., 2016) [24]. In tomatoes about 95% of total soluble sugars are reducing sugars, with fructose levels higher than glucose. Preservative had significantly affected the level of reducing sugar in tomato-watermelon juice blends. The reducing sugar of the juice blends was between 2.2% for tomato juice and 5.55% for watermelon juice during storage time. The reducing sugar of all the juice blends increased with the substitution of watermelon juice. This may be attributed to the reduction in reducing sugar

in tomato juice with the reducing sugar in watermelon juice was complementing. Addition of watermelon juice is associated with high reducing sugar and this was reflected in the blends as the samples with a high ratio of watermelon juice had high ratio of reducing sugar. The increase in the reducing sugar might be due to breakdown of polysaccharides into water soluble sugar during glycolysis process. Our observations are in contract with Nagamani et al., (2014) [27] who expressed content in tomato ranged from (1.87 to 2.13%) for reducing sugar. Similarly rise in glucose and fructose of watermelon juice also described by Yousaf et al., (2016) [21] ranged from (5.11 to 6.05%) in watermelon pulp throughout their study. Our results obtained are in promise with Ayub et al., (2010) [28] announced inflation from (6.5 - 6.9) of apricot and apple blend. Similarly a gradual increase from (2.39 to 5.29) in reducing sugar of RTS beverage also noted by Tiwari and Deen (2015) [29].

Table: 5 Impact of treatments and storage on reducing sugar of tomato and watermelon juice blends.

Treat	Days (Interval)							%Inc	Mean
	First	15	30	45	60	75	90		
T0	2.2	2.22	2.24	2.26	2.28	2.3	2.32	5.17	2.26h
W0	5.55	5.64	5.75	5.88	6.02	6.14	6.28	11.62	5.89a
T1	2.1	2.12	2.14	2.15	2.21	2.27	2.33	9.87	2.19i
W1	5.4	5.48	5.57	5.72	5.83	5.98	6.15	12.20	5.73b
TW1	2.4	2.42	2.45	2.48	2.55	2.62	2.68	10.45	2.51g
TW2	2.6	2.62	2.65	2.69	2.76	2.85	2.96	12.16	2.73f
TW3	2.8	2.82	2.85	2.95	3.03	3.12	3.2	12.50	2.97e
TW4	3.00	3.04	3.08	3.16	3.24	3.35	3.48	13.79	3.19d
TW5	3.2	3.25	3.3	3.38	3.48	3.58	3.75	14.67	3.42c
Mean	3.25g	3.29f	3.34e	3.41d	3.49c	3.58b	3.68a		

Small letters in columns and rows are dissimilar [P<0.05]

Non Reducing Sugar

Storage and treatments effect on non - reducing sugar of pasteurized tomato and watermelon juice blend is mentioned in Table-6. Both storage and treatments significantly

affected the non-reducing sugar level of tomato and watermelon blends. The overall means values within storage intervals were significantly decreased from (1.57 to 1.30%) throughout the whole study period. The results are reporting high decrease in non-reducing sugar of watermelon sample W0 than fresh tomato juice T0 in comparison with samples having preservative, and when we associate it with the blends, sample TW5 comparatively showed more reduction in percentage among blends might because of high ratio of watermelon juice. However factors and storing effect was statistically dissimilar from one another.

Sucrose is commonly referred as non-reducing sugar. Cultivated tomato contains trace amount of sucrose, while wild tomato species, for instance Lycopersicon chmielewskii, may contain sucrose as a main sugar. The tomato and watermelon both accumulate low content of sucrose than of fructose and glucose. Sucrose is one of the disaccharide that is very beneficial to the body in the provision of energy. The level of non - reducing sugar were significantly affected by preservative. The non-reducing sugar content for tomato juice was between 1.12% and 2.4% for watermelon juice throughout the suggested period. The non-reducing sugar of all the juice blends increased with the substitution of watermelon juice. This may be due to the reduction in non-reducing sugar in tomato juice which watermelon juice was complementing. The loss in the attribute might because of hydrolysis of complex carbohydrates. The announcements for non-reducing sugar are similar with findings of Alam et al., (2006) [30] reported a reduction of sucrose in tomato ranged (1.08 - 2.88%). Similarly the findings are also in contract with Yousaf et al., (2016) [21] who stated a reduction in revealed attribute from (2.22 to 1.78%) in watermelon juice throughout the storing time, and revealed reason behind the decline might because of change of non – reducing sugar into reducing sugars. Selvi et al. (2013) [31] also noted a gradual decline throughout his study from (12.24 to 10.95) in guava-lime-ginger RTS beverage. The outcomes are too in accordance with Ayub et al., (2010) [28] they also depicted a decreasing trend from (1.5 - 0.5) in sucrose of strawberry juice.

Table 6: Effect of treatments and storage on non-reducing sugar of tomato and watermelon juice blends.

Treat	Days (Interval)	%Dec	Mean

	First	15	30	45	60	75	90		
T0	1.12	1.09	1.06	1.03	0.99	0.94	0.88	21.43	1.02h
W0	2.4	2.32	2.24	2.15	2.06	1.94	1.84	23.33	2.14a
T1	1.04	1.02	1.00	0.98	0.96	0.94	0.92	11.54	0.98i
W1	2.15	2.12	2.08	2.04	1.98	1.92	1.86	13.49	2.02b
TW1	1.2	1.18	1.16	1.14	1.12	1.08	1.04	13.33	1.13g
TW2	1.32	1.29	1.26	1.22	1.18	1.14	1.11	15.91	1.22f
TW3	1.45	1.42	1.39	1.36	1.32	1.27	1.21	16.55	1.35e
TW4	1.62	1.59	1.56	1.52	1.47	1.41	1.34	17.28	1.50d
TW5	1.8	1.77	1.74	1.68	1.62	1.54	1.46	18.89	1.66c
Mean	1.57a	1.53b	1.50c	1.46d	1.41e	1.35f	1.30g		

Small letters in columns and rows with mean values are dissimilar [P<0.05]

Organoleptic evaluation

Color

Storage and treatments effect on color of pasteurized tomato and watermelon juice blend is mentioned in Table-7. Both storage and treatments significantly affected the color level of tomato and watermelon blends. The overall means values within storage intervals for color were significantly decline from (8.21 to 6.68) throughout the entire period of 90 days. High loss of color was noted in watermelon W0 than fresh tomato juice T0, and when we associate it with the blends, sample TW5 comparatively showed more decrease in color percentage among blends may be due to high quantity of watermelon juice. However treatments and storage effect was statistically dissimilar from one another.

In juices the most important and attractive sensory attribute for the consumers are color. Red color of both fruits is due to the presence of lycopene. Preservative had significantly affected the level of color in tomato-watermelon juice blends. The juice blends were scored higher than the 100% fruit juices, with sample TW5 (50% tomato juice and 50% watermelon juice) rated the highest 8.5 among the blends which may be as a result of watermelon juice which diluted the red color of the tomato juice. Among 100% juices tomato juice samples had the same and highest value of 8.2, while the least was 8.0 in watermelon juices samples. The color decrease might because degradation of ascorbic acid and lycopene content which is highly sensitive to heat also mentioned by Siddiqui et al., (2015) [32]. Decrease in color was

also observed by Yousaf et al., (2016) [21] in watermelon pulpy juice from (8.5 to 5.5) and discussed the reasons that decrease might be due to Millard reaction or browning reaction. Decrease in color of watermelon-pineapple juice blends was also noticed by Akande and Ojekem (2013) [33] from (6.78 to 4.45) throughout the storing time. Gupta et al., (2015) [34] also noticed a reduction in orange based blended beverage color from (8.32 to 6.94).

Table 7; Effect of treatments and storage on color of tomato and watermelon juice blends.

Treat	Days (Interval)							% Dec	Mean
	First	15	30	45	60	75	90		
T0	8.2	8	7.8	7.4	7.2	6.8	6.5	20.73	7.41e
W0	8	7.8	7.6	7.4	7.2	6.8	6	25.00	7.26h
T1	8.2	8	7.8	7.6	7.4	7.2	7	14.63	7.60d
W1	8	7.8	7.6	7.4	7.2	6.8	6.2	22.50	7.29g
TW1	8.1	7.9	7.7	7.5	7.2	6.9	6.5	19.75	7.40f
TW2	8.2	8	7.8	7.6	7.3	6.8	6.6	19.51	7.47e
TW3	8.3	8.1	7.9	7.7	7.5	7.3	6.9	16.87	7.67c
TW4	8.4	8.2	8	7.8	7.6	7.4	7.1	15.48	7.79b
TW5	8.5	8.3	8.1	7.9	7.7	7.5	7.3	14.12	7.90a
Mean	8.21a	8.01b	7.81c	7.59d	7.37e	7.06f	6.68g		

Small letters in columns and rows are dissimilar [P<0.05]

Taste

Storage and treatments effect on taste of pasteurized tomato and watermelon juice blend is mentioned in Table-8. Both storage and treatments significantly affected the taste level of tomato and watermelon blends. The overall means values within storage intervals for taste were significantly lessened from (7.72 to 6.35) throughout the entire period of 90 days. High loss of taste was observed in tomato sample T0 than fresh watermelon juice W0 in comparison with samples having preservative, and when we associate it with the blends, sample TW5 comparatively showed more decrease in taste percentage among blends may be due to high quantity of watermelon juice. However treatments and storage effect was statistically dissimilar from one another.

Taste is the second important attribute for the consumer desirability. Preservative had significantly affected the level of taste in tomato-watermelon juice blends. Among blends

sample TW5 (50% tomato juice and 50% watermelon juice) was rated the highest 8.5, which may be due to watermelon juice which is highly sweet in taste. Among 100% juices watermelon juice samples had the same and highest value of 8.2, while the least was 7.0 in 100% tomato juice samples. The decrease in taste of tomato and watermelon juices blends may be due to the inflation in acidity and reduction in pH with the time. Loss in taste of watermelon-pineapple juice blends was also noticed by Akande and Ojekemi (2013) [33] from (6.67 to 3.14) throughout the whole storage time. Similarly Alam et al., (2018) [35] announced decrease level in tomato puree from (8.9 to 3.5) and stated the reason that decrease might be due to the conversion of Cis-3-hexena to trans-2-hexenol. Gupta et al., (2015) [34] expressed a reduction in taste in orange based blended RTS beverage from (6.83 to 5.2) throughout 90 days of storing time, while Selvi et al., (2013) [31] also revealed a lessened from (8.7 to 8.4) in taste score value of guava-lime-ginger RTS beverage.

Table 8: Effect of treatments and storage on taste of tomato and watermelon juice blends.

Treat	Days (Interval)							% Dec	Mean
	First	15	30	45	60	75	90		
T0	7	6.9	6.8	6.7	6.5	6.1	5.6	20.00	6.51g
W0	8.2	8	7.8	7.6	7.2	6.8	6.5	20.73	7.44c
T1	7	6.9	6.8	6.6	6.4	6.2	5.9	15.71	6.54g
W1	8.2	8.1	7.9	7.7	7.5	7.3	6.8	17.07	7.64b
TW1	7.2	7.1	6.9	6.7	6.5	6.3	5.9	18.06	6.66f
TW2	7.5	7.3	7.1	6.9	6.7	6.5	6.1	18.67	6.87e
TW3	7.8	7.6	7.4	7.2	7	6.8	6.4	17.95	7.17d
TW4	8.1	7.9	7.7	7.5	7.3	7.1	6.8	16.05	7.49c
TW5	8.5	8.3	8.1	7.9	7.7	7.5	7.2	15.29	7.89a
Mean	7.72a	7.53b	7.31c	7.21d	6.94e	6.76f	6.35g		

Small letters in columns and rows with mean values are dissimilar [P<0.05]

Flavor

Storage and treatments effect on flavor of pasteurized tomato and watermelon juice blend is mentioned in Table-9. Both storage and treatments significantly affected the flavor level of tomato and watermelon blends. The overall means values within storage intervals for

flavor were significantly lessened from (7.76 to 6.28) throughout the entire storing period of 90 days. High loss of flavor noticed in watermelon juice W0 than fresh tomato juice T0 in comparison with samples having preservative, and when we associate it with the blends, sample TW5 comparatively showed more decrease in flavor percentage among blends may be due to high quantity of watermelon juice. However treatments and storage effect was statistically dissimilar from one another.

The flavor of tomatoes and watermelon is influenced by sugar and acid content of the varieties. Preservative significantly affected the level of flavor in our product. Among blends sample TW5 (50% tomato juice and 50% watermelon juice) was rated the highest 8.5, which may be as a result of watermelon juice which possesses highly sweet flavor. High value of flavor in 100% juices was noted in watermelon juice W0 as 8.2, while the least was 7.1 for 100% tomato juice sample T1. The decline in flavor might because the loss of some volatile compounds. Decrease in flavor of watermelon-pineapple juice blends was also noticed by Akande and Ojekemi (2013) [33] from (6.56 to 4.56) throughout study period. Tiwari and Deen (2015) [29] expressed a reduction in the flavor of blended RTS beverage which might be due to biochemical changes taken place due to the temperature variation. Decrease in color observed by Yousaf et al., (2016) [21] in watermelon pulpy juice was (8.6 to 4.5) and discussed that decrease might because the degradation of ascorbic acid and furfural production. Gupta et al., (2015) [34] revealed a decline in flavor of orange based blended RTS beverage from (6.83 - 5.2) throughout the whole storing time of 90 days. Selvi et al., (2013) [31] also reported a decreasing trend from (9.0 to 8.6) in flavor score value of guava-lime-ginger RTS beverage throughout storing.

Table 9; Effect of treatments and storage on flavor of tomato and watermelon juice blends.

Treat	Days (Interval)							% Dec	Mean
	First	15	30	45	60	75	90		
T0	7.2	7.1	6.8	6.5	6.2	5.9	5.5	23.61	6.46i

W0	8.2	8	7.7	7.4	7	6.5	6	26.83	7.26d
T1	7.1	7	6.9	6.7	6.5	6.2	5.8	18.31	6.60h
W1	8.1	8	7.8	7.5	7.2	6.9	6.5	19.75	7.43c
TW1	7.3	7.1	6.9	6.7	6.5	6.3	6	17.81	6.69g
TW2	7.5	7.1	6.9	6.7	6.5	6.3	6.2	17.33	6.74f
TW3	7.8	7.6	7.5	7.2	7	6.7	6.5	16.67	7.19e
TW4	8.1	7.9	7.7	7.5	7.3	7.1	6.8	16.05	7.49b
TW5	8.5	8.2	8	7.8	7.6	7.4	7.2	15.29	7.81a
Mean	7.76a	7.56b	7.36c	7.11d	6.87e	6.59f	6.28g		

Small letters in columns and rows with mean values are dissimilar [P<0.05]

Overall acceptability

Storage and treatments effect on overall acceptability of pasteurized tomato and watermelon juice blend is mentioned in Table-10. Both storage and treatments significantly affected the overall acceptability level of tomato and watermelon blends. The overall means values within storage intervals for overall acceptability were significantly decreased from (7.87 to 6.41) throughout 90 days of storing time. High decline of overall acceptability was noticed in watermelon sample W0 than fresh watermelon juice T0 in comparison with samples having preservative, and when we associate it with the blends, sample TW5 comparatively showed more decrease in overall acceptability percentage among blends may be due to high quantity of watermelon juice. However treatments and storage effect was statistically dissimilar from one another.

All the various attributes of the juice blends influenced their overall acceptability by sensory panelists. The 100% tomato juice had the lowest value for color, taste, flavor, and overall acceptability; this may be due to the sourness and astringency of the juice which contributed immensely to sensory panelist's behavior. However, addition of watermelon juice to the tomato juice reduced the pulpiness, sourness of the juice blends and gave a better acceptability. The decrease in overall acceptability is due to the decrease in all other sensory attributes. Among blends sample TW5 (50% tomato juice and 50% watermelon juice) was rated the highest 8.5, which may be as a result of watermelon juice which is fresh, sweet and becoming popular among consumers. Rosario (1996) [36] described in his study that time and temperature are the reasons in loss of superiority which effects in overall acceptability. The overall acceptability of tomato-watermelon juices blend decreased significantly with the time.

However, their overall rating remained above the acceptable level even after 90 days. Decline in overall acceptability of watermelon-pineapple juice blends was noticed by Akande and Ojekemi (2013) [33] from (6.78 to 4.11) throughout the whole storing time. Gupta, (2015) [34] also noticed a loss in overall acceptability in orange based blended RTS beverage from (6.83 - 5.2) during storage. Decrease in attribute was also observed by Yousaf et al., (2016) [21] in watermelon pulpy juice from (8.48 to 4.03) and stated that decrease may be as a result of vitamin C decline and furfurals which results in the loss of flavor, odor and taste.

Table 10; Effect of treatments and storage on overall acceptability of tomato and watermelon juice blends.

Treat	Days (Interval)							% Dec	Mean
	First	15	30	45	60	75	90		
T0	7.4	7.3	7.1	6.8	6.6	6.2	5.8	21.62	6.74g
W0	8.1	7.9	7.7	7.4	7.1	6.7	6.1	24.69	7.29d
T1	7.4	7.3	7.1	6.9	6.7	6.5	6.2	16.22	6.87f
W1	8.1	7.9	7.7	7.5	7.3	7	6.5	19.75	7.43c
TW1	7.5	7.3	7.1	6.9	6.7	6.5	6.1	18.67	6.87f
TW2	7.7	7.4	7.2	7	6.8	6.5	6.3	18.18	6.99e
TW3	7.9	7.7	7.6	7.3	7.1	6.9	6.6	16.46	7.30d
TW4	8.2	8	7.8	7.6	7.4	7.2	6.9	15.85	7.59b
TW5	8.5	8.2	8	7.8	7.6	7.4	7.2	15.29	7.81a
Mean	7.87a	7.67b	7.48c	7.24d	7.03e	6.77f	6.41g		

Small letters in columns and rows with mean values are significantly dissimilar [P<0.05]

CONCLUSION

It was finished up from this study that sodium benzoate is an effective preservative in red colored products due to its better solubility and capability of color maintenance. It increases the shelf life of the product when added according to recommended level of food safety. Refrigeration storage also showed good impact on the stability of tomato and watermelon juices

blend. Current study showed that addition of watermelon juice to tomato juice contributes to acceptable juice blends in terms of taste, color and flavor by the sensory panelists. Sensory scores showed that although the taste of some of the fruit blends was not favorable but in terms of overall acceptability the TW5 (tomato50% juice and watermelon50% juice) blend was mostly preferred and the sample was ranked highest overall.

Data availability

The data that support the findings of this study are listed in the article and are available from the corresponding authors upon reasonable request.

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Declaration of Interest

We declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere. The authors certified that there is no conflicts of interest associated with this publication, and there has been no significant financial support for publishing this work that could have influenced its outcome. As corresponding Author, I conform that the manuscript has been read and approved for submission by all the named authors. Thank you for receiving our manuscript and considering it for review.

REFERENCES

Bamidele, O. P., & Fasogbon, M. B. (2017). Chemical and antioxidant properties of snake tomato (Trichosanthes cucumerina) juice and Pineapple (Ananas comosus) juice blends and their changes during storage. Food chemistry, 220, 184-189.

Lenucci, M. S., D. Candinu, M. Taurino, G. Piro and G. Dalessandro. 2006. Antioxidant composition in cherry and high pigment tomato cultivars. J. Agric. Food chem. 54: 2606-2613.

Adeeboye, O. C. (2008). Phyto-constituents and antioxidant activity of the pulp of snake tomato. Africa. Jour of Medic, 5(2): 173-179.

Khachik, F., L. Carvalho. P. S. Muir. Katz. N. B. (2002). Chemistry distribution and metabolism of tomato carotenoids and their impact on human health. Exp. bio & medic (227): 845-851.

Heinrich, M. A. Cetto. 2005. Mexican plants with hypoglyceamic effect used in the treatments of diabetes. Jour of Eth. (99): 325-348.

Islam, A. K. M. Rahman. A. H. M. Annisuzzaman. 2006. Taxonomic studies of the cucurbits grown in parts of Bangladesh. Res. Jour. Agri. & Bio Sci 2: 299-302.

MNFSR. 2014-15. Ministry of national food security and research, economic wing Islamabad. 1-8.

Bhat, R. 2016. Impact of ultraviolet radiation treatments on the quality of freshly prepared tomato juice. F. chemist, 213(1): 635-640.

Yamaguchi, M. 2006. World vegetables: principles production and nutritive values. AVI publishing Co., Westport, USA.

Chahal, G. S., & Saini, S. P. (1999). Storability of juice from New Hybrid watermelon variety. Indi. F. Pack, 53(6): 12-50.

Perkins-veanzie, P. J., K. Collins. 2004. Flesh quality and lycopene stability of fresh cut watermelon. Post. Ha. Bio & tech, 31: 159-166.

Edwards A. J., Bryan T. V., Eugene R. W., Ellen D. B., Julie K. C., Penelope P., Robert A. B., Beverly A. C., 2003. Consumption of watermelon juice increases plasma concentrations of lycopene and β-Carotene in humans. The J. of Nutr. 133(4):1043-1050.

Beaulieu, J. C., J. M. Lea 2006. Characterization and semiquantitative analysis of volatiles in seedless watermelon varieties using solid-phase microextraction, J. of Agric. and Food Chem. 54 (20): 7789-7793.

Martins, C. P.C., M. V. S. Ferreira, E. A. Esmerino, J. Moraes, T. C. Pimentel, R. S. Rocha, M. Q. Freitas, J. S. Santos, C. S. Ranadheera, L. S. Rosa, A. J. Teodoro, S. P. Mathias, M. C. Silva, R. S. L. Raices, S. R. M. Couto, D. Granato and A. G. Cruz. 2018. Chemical, sensory, and functional properties of whey-based popsicles manufactured with watermelon juice concentrated at different temperatures. J. of Food Chem. 255(1): 58-66.

Oludemi, F.O. and C.T. Akanbi. 2013. Chemical, antioxidant and sensory properties of tomato-watermelon-pineapple blends, and changes in their total antioxidant capacity during storage. Int. J. Food Sci. Technol. 48(1):1416-1425.

AOAC. 2012. "Official methods of analysis Association of Official and Analytical Chemists 17th Edi, Washington, D.C.

Larmond, E. 1977. Laboratory methods of survey evaluation of food publication in canada. Deptt. Agric. Ottawa. 30:78-88

Steel, R. G. D. and J. H. Torrie. 1997. Principals and procedures of statistics with special reference to the biological sciences. J. Bio. 4: 207-208.

Francis,G. A., N. C. Igwemmar., I. E. Omoniyi, A. Olalekan and A. Babatunde. 2017. Effects of preservatives on physiochemical properies of watermelon and soursop fruit blend. Direct Res. J. Agric. Food Sci. 5(10):333-337.

Ayodele, A. A. 2015. Effect of storage on physicochemical properties of orange-watermelon juice. Annals. Food Sci and Tech.16(20:326-332.

Yousaf, S. Zeb. Arsalan, Muhammad, Khurshid 2016. Effect of different antimicrobial agents on Watermelon juice. American. J. Agr. Env. Sci. 16 (3): 617-624.

Mishra,V. Puranik, S., G. K Rai 2012. Development of vitamin C rich value added beverage. J. Food tech 7 (4): 222-229.

Kilima, B. M., Remberg, S. F., Chove, B. E., and Wicklund, T. 2014. Influence of storage temperature and time on the physicochemical and bioactive properties of roselle-fruit juice blends in plastic bottles. Food Sci. and Nutr. 2(1):181-191.

Bamidele, O. P., & Fasogbon, M. B., 2017. Chemical and antioxidant properties of snake tomato (*Trichosanthes cucumerina*) juice and Pineapple (*Ananas comosus*) juice blends and their changes during storage. J. Food Chem. 220(1):184-189.

Ejiofor, J., E. B. Banigo. E. Victor-Uku, 2016. Product Development, sensory and Chemical composition of spiced watermelon juice. Inter. J. of Biotech. and Food Sci. 4(2):15-21..

Esteve, M. J. A. Frígola, C. Rodrigo, and D. Rodrigo. 2005. Effect of storage period under variable conditions on the chemical and physical composition and color of Spanish refrigerated orange juices. J. Food and Chem. Toxicology. 43(9):1413-1422.

Nagamani, G. 2014. Processing technology for tomato powder. J. Scientific Res., 3(2): 210-213.

Ayub, I., Zeb, A., & Hussain, M. (2010). Quality attributes of apple and apricot blend juice preserved with potassium sorbate during storage at low temperature. Inter Jour of Food Safety, 12, 80-86.

Tiwari, D. K, Deen B, 2015. Preparation and storage of blended Ready to serve beverage from Bael and Aloe vera. The bioscan.in. 10 (1), 113-116, 2015.

Alam, M. J. , M. H. Rahman , M. A. Mamun , I. Ahmad and K. Islam. 2006. Enzyme activities in relation to sugar accumulation in tomato. Proc. Pak. Acad. Sci. 43(4):241-248.

Selvi J, P. Banumathi, Kanchana, M. llamaran 2013. Formulation of therapeutic drink to boon human health guava-lime-ginger RTS beverage. F. Sci. Res. 4 (2):141-146.

Siddiqui M.W., J.P. Singh 2015. Compositional Alterations in Tomato products during storage. Research. J. Chem. & Envir. 19 (2):82-87.

Akande. E. A. and O. R. Ojekemi. 2013. Biochemical changes in watermelon and pineapple juice blend during storage. Sky J. Food Sci. 2(7): 54-55.

Gupta, R., M. Malav, N. K. Kushwaha, and A. Pandey, 2015. Studies on organoleptic qualities of orange based blended ready to serve (RTS) beverages. *The Bioscan.* 10(3): 1041-1043.

Alam, N., S. Wahab, Y. Durrani and A. Khan (2018) Effect of chemical preservatives on quality and storage condition of tomato puree. Pure Appl. Biol., 7(2): 579-589.

Rosario, M.J.G. 1996. Formulation of ready to drink blends from fruits and vegetables juices. J. of Phillippines. 9(1):201-209.