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Effect of Chemical Additives on the Shelf Life of Tomato Juice

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ABSTRACT

Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular and demanding vegetables grown in Bangladesh. The aim of this study was to assess the effect of chemical additives on the shelf life of tomato juice. Tomato juice was prepared with three different chemical additives namely Potassium meta-bisulphate (KMS), Sodium benzoate and sorbic acid. The shelf life of these tomato juices was studied for 60 days storage period. Chemical analysis and sensory tests were carried out during the 60 days at an interval of 15 days to assess the effect of chemical additives on the shelf life of tomato juice. Negligible change in chemical constituents except vitamin C was observed in the prepared juices throughout the 60 days storage period. Color was gradually faded and off-flavor developed at the end of the storage time at room temperature. Additives and storage period has significant effect on percent acidity. Tomato juice prepared with potassium meta bisulphate was spoiled after 45 days whereas, tomato juice prepared with sorbic acid was spoiled after 30 days of storage at room temperature. Tomato juice prepared with sodium benzoate was more stable than others and spoiled at the end of the 60 days storage period at room temperature. Total number of viable bacteria was highest in tomato juice with potassium meta bisulphate and tomato juice with sodium benzoate contained least viable bacteria. There were no significant difference among the juices with three different chemical additives in respect to color and acceptability. Considering all the parameters, sodium benzoate tends to be better additive than potassium meta bisulphate and sorbic acid for preservation of tomato juice.

Key words: Tomato juice, sodium benzoate, shelf life, preservative, total viable count

INTRODUCTION

People consume Beverages for their nutritional value, thirst-quenching properties, stimulating effect and/or their medicinal values (Adegunloye *et al*., 1996; Elmahmood and Doughari, 2007). Tomato (*Lycopericon esculentum* Mill.) is one of the most popular and demanding vegetables grown in Bangladesh. Tomato is popular because of its vitamin C and valuable nutrients content. Recent statistics showed that tomato was grown in 44275 acres of land with the production of approximately 190213 metric ton in 2009-2010 (BBS, 2010). Tomato is highly water containing perishable vegetables (Mahmud *et al*., 2009). So, Tomatoes are processed in the form of various products such as Tomato juice, puree, cocktail, paste, ketchup, sauce, jelly, soups, powder and tomato chutneys etc.

Tomato juice is a ready to drink tomato product. Tomato juice or pulp is very much susceptible to microbial spoilage (Mahmud *et al.*, 2009). Different types of chemical additives or preservatives can be used for preservation of such food products. In juice preservation, chemical additives or preservatives which are commercially used are Potassium Meta Bisulphate (KMS) in the form of SO_2, Sodium-benzoate and Sorbic acid (Tasnim *et al.*, 2010; Jatto and Adegoke, 2010).

As huge amount of tomato is produced during peak harvest season, large quantities of this valuable vegetable is wasted due to limited storage life and improper preservation (Ahmed and Ismail, 1995). It is important to prepare products like juice which can be preserved for longer time. Keeping in view this fact, this study was undertaken to know the effect of different chemical preservatives namely Potassium meta-bisulphate, Na-Benzoate and sorbic acid on the microbial and sensory quality of tomato juice stored at room temperature.

MATERIALS AND METHODS

The study was conducted in the laboratory of the Department of Food Technology and Rural Industries under the faculty of Agricultural Engineering and technology, Bangladesh Agricultural University, Mymensingh. The duration of this experiment was 1 year from July (2006) to June (2007).

Formulation of tomato juice: Tomato juice was prepared with the following formula.

- Pulp 10%
- TSS 14%
- Acidity 0.35%
- Sugar 13.5%
- Preservative 350 ppm

Dose distribution of preservatives

Samples	Chemical additives	Dose (ppm)
S_1	KMS	350
S_2	Na-benzoate	350
S_3	Sorbic acid	350

Preparation of tomato juice: Tomato juices were prepared according to the method described by Mahmud *et al.* (2009).

Organoleptic observation: Organoleptic observations were done at every fifteen days interval. Off flavor, discoloration, sedimentation was recorded for each treatment.

Analytical methods: Tomato juices were analyzed at every fifteen days interval for their moisture, vitamin C, total soluble solids, ash, reducing sugar and non-reducing sugar. All the determinations were done in triplicate and the results were expressed as average value. Moisture was determined adopting AOAC (1984) method. TSS was measured directly by hand refractometer. Total acidity was measured by titration with standard NaOH using phenolphthalein indicator

(Srivastava and Sanjeev, 2003). Vitamin C content was determined by the method described by Ranganna (1979). Ash was determined by AOAC method. Total sugar was determined by Lane and Eynon (1923).

Microbiological test

Determination of total viable count: For total viable count of bacteria present in the tomato juice, colony count method was used according to "Laboratory Methods in Food Microbiology" (Harrigan, 1998). The total number of viable bacteria per mL. of tomato juice was obtained by multiplying the number of colony forming units (cfu) on the plate with respective dilution factor and then was converted into logarithmic form.

Counting of yeast and mould: Yeast and mould count of tomato juices were also determined according to the "Recommended method for the Microbiological Examination of Food", published by American Public health Association (APHA, 1967).

Subjective (sensory) evaluation of tomatoes: For statistical analysis of sensory data, three different types of tomato juices were evaluated for color, flavor, texture and overall acceptability by a panel of 10 testers (Hashimi *et al*., 2007). All the testers were the students, teachers and laboratory assistants of the Department of Food Technology and Rural Industries. Three types of juices were presented to 10 panelists and randomly coded samples. The test panelists were asked to rate the different juices presented to them on a 9 point hedonic scale with the ratings of: 9 = like extremely; 8 = like very much; 7 = Like moderately; 6 = Like slightly; 5 = Neither like nor dislike; 4 = Dislike slightly; 3 = Dislike moderately; 2 = Dislike very much and 1 = Dislike extremely. The results were evaluated by Analysis of Variance (ANOVA) and Duncan's Multiple Range Test (DMRT) procedures of the Statistical Analysis System (SAS) software (SAS, 1985).

RESULTS

The tomato juice is a ready to drink juice prepared from tomato pulp, sugar, chemical additive and water. The effect of different chemical additives on acceptability and shelf life of tomato juice at room temperature was studied. The acceptability and shelf life were evaluated through organoleptic taste testing procedure along with chemical and microbiological analysis.

Nutritional aspects: Tomato pulp was used to formulate tomato juice. The proximate composition of fresh pulp and processed juice was determined. From the table it was observed that, moisture and pH declines slightly after processing. Total soluble solid and total sugar level increased drastically after processing. Vitamin C (L-ascorbic acid) content of processed tomato juice was also gradually decreased from the fresh tomato juice. Ash content was unchanged after processing. Nutritional composition of fresh pulp and processed tomato juice is listed in Table 1. The content was more or less similar to that obtained by Bose (1985).

Effect of chemical additives on shelf life of tomato juice: Chemical compositions of tomato juices were determined during the storage period at every 15 days interval. The results are discussed below.

Effect of different chemical additives on moisture content: Moisture content reduced slightly in juices prepared with Na-benzoate and Potassium meta-bisulphate (KMS). But in case of juice prepared with sorbic acid, moisture content reduced significantly during storage. Juice prepared

Table 1: Approximate composition of tomato juice (per 100 g)

	Amounts	
Components	Fresh pulp	Processed juice
Moisture	93.50	76.20
Ash	0.28	0.28
Acidity	0.424	0.35
pH	3.85	3.60
Ascorbic acid (mg)	16.70	3.05
Total soluble solid	2.00	13.00
Total sugar	3.65	11.00

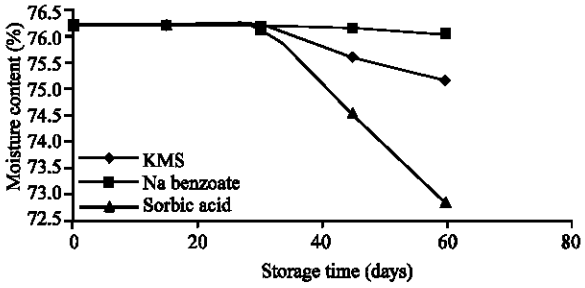

Fig. 1: Effect of different chemical additives on moisture content

with KMS contained 76.2% moisture content on the day of preparation and 75.15% moisture content after 60 days storage period. Juice prepared with Na-benzoate contained 76.2% moisture content on the day of preparation and 76.05% moisture content after 60 days storage period. On the other hand, Juice prepared with sorbic acid contained 76.2% moisture content on the day of preparation and 72.85% moisture content after 60 days storage period. The effect of chemical additives on moisture content of tomato juice has been shown in Fig. 1.

Effect of different chemical additives on acidity: According to results, Chemical additives have no significant effect on acidity though acidity of tomato juice with sorbic acid increased slightly during storage. Juice prepared with KMS contained 0.35% acidity on the day of preparation and 0.365% acidity after 60 days storage period. Juice prepared with Na-benzoate contained 0.358% acidity on the day of preparation and 0.361% moisture content after 60 days storage period. On the other hand, Juice prepared with sorbic acid contained 0.367% moisture content on the day of preparation and 0.44% moisture content after 60 days storage period. The effect of chemical additives on acidity of tomato juice has been shown in Fig. 2.

Effect of different chemical additives on total soluble solids (T.S.S.): According to results, Chemical additives affect TSS content of the tomato juices. Juice prepared with KMS contained 13% TSS on the day of preparation and 12.5% TSS after 60 days storage period. Juice prepared with Na-benzoate contained 13% TSS on the day of preparation and 12.8% TSS content after 60 days storage period. On the other hand, Juice prepared with sorbic acid contained 13% TSS content on the day of preparation and 12% TSS content after 60 days storage period. The effect of chemical additives on TSS content of tomato juice has been shown in Fig. 3.

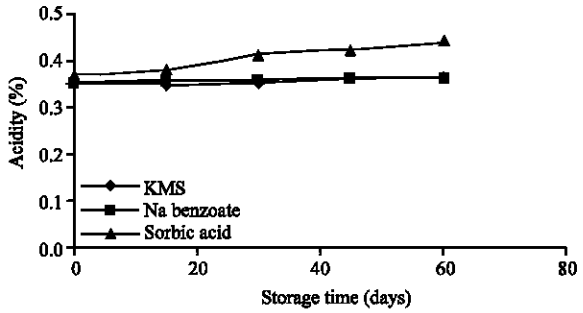

Fig. 2: Effect of different chemical additives on acidity

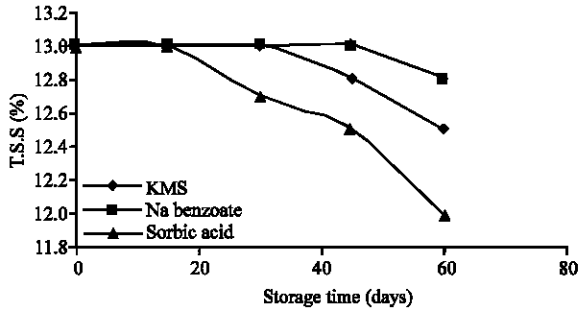

Fig. 3: Effect of different chemical additives on T.S.S

Effect of different chemical additives on pH: According to results, Chemical additives have differential effect on pH of the tomato juices. Juice prepared with KMS had pH value 3.60 on the day of preparation and 3.562 after 60 days storage period. Juice prepared with Na-benzoate had pH value 3.615 on the day of preparation and 3.610 after 60 days storage period. On the other hand, Juice prepared with sorbic acid had pH value 3.65 on the day of preparation and 3.58 after 60 days storage period. The effect of chemical additives on pH of tomato juice has been shown in Fig. 4.

Effect of different chemical additives on vitamin C: According to results, Chemical additives have significant effect on Vitamin C content of the tomato juices. Juice prepared with KMS contained 3.05 mg/100 gm vitamin C on the day of preparation and 2.98 mg/100 gm vitamin C after 60 days storage period. Juice prepared with Na-benzoate contained 3.05 mg/100 gm Vitamin C on the day of preparation and 3.01 mg/100 gm vitamin C after 60 days storage period. On the other hand, Juice prepared with sorbic acid contained 3.05 mg/100 gm Vitamin C on the day of preparation and 2.90 mg/100 gm Vitamin C after 60 days storage period. The effect of chemical additives on Vitamin C content of tomato juice has been shown in Fig. 5.

Vitamin C is light and heat sensitive, the concentration of Vitamin C follows first order kinetics and thus storage time affects vitamin Content (Heldman and Singh, 1981). However, Vitamin C is highly oxidized and may be oxidized with the increase of storage period.

Microbiological load calculation: Microbial activity, its multiplication and load were calculated during 60 days storage period for the juices with three different chemical additives.

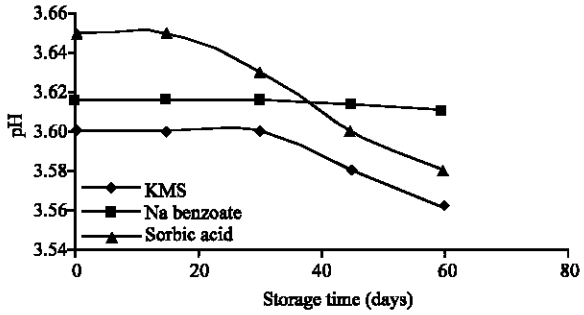

Fig. 4: Effect of different chemical additives on pH

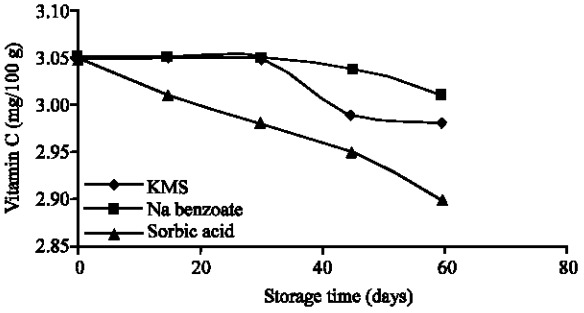

Fig. 5: Effect of different chemical additives on Vitamin C

Table 2: Growth of bacteria in tomato juices with three different additives at room temperature

Sample	Additive	Storage period	No. of total bacteria (cfu mL^{-1})	Total count (log cfu mL^{-1})
S_1	KMS	Initial	5.0×10^3	3.69
		15	7.0×10^3	3.84
		30	1.5×10^4	4.00
		45	5.6×10^4	4.74
		60	8.1×10^4	4.90
S_2	Na-benzoate	Initial	3.4×10^3	3.53
		15	5.2×10^3	3.71
		30	7.6×10^3	3.88
		45	9.0×10^3	3.95
		60	1.2×10^4	4.08
S_3	Sorbic acid	Initial	4.5×10^3	3.65
		15	6.0×10^3	3.77
		30	1.1×10^4	4.04
		45	3.2×10^4	4.51
		60	6.4×10^4	4.80

Bacterial growth: This study was performed by colony count method. After 48 h of incubation, colonies were counted. The total viable bacteria present in tomato juice were not uniform. Total viable bacterial count of the juice with KMS increased from 3.69 to 4.9 log cfu mL^{-1} after 60 days of storage at room temperature. Total viable bacterial count of the juice with sodium benzoate increased from 3.53 to 4.08 log cfu mL^{-1}. Total viable bacterial count of the juice with sorbic acid increased from 3.65 to 4.80 log cfu mL^{-1} after 60 days of storage at room temperature. The total numbers of viable bacterial count in juices with different additives have been shown in Table 2.

Table 3: Growth of Yeast and mold in tomato juices

			No. of total (cfu mL^{-1})		Total count (log cfu mL^{-1})	
Sample	Additive	Storage period (days)	Yeast	Mold	Yeast	Mold
S_1	KMS	60	4.5×10^2	Nil	2.65	Nil
S_2	Na-Benzoate	60	2.1×10^2	Nil	2.32	Nil
S_3	Sorbic acid	60	2.9×10^2	Nil	2.46	Nil

S_1: Tomato juice with KMS, S_2: Tomato juice with Na benzoate, S_3: Tomato juice with Sorbic Acid

Table 4: Mean score for color, flavor, texture and overall acceptability of processed tomato juice

	Sensory attributes			
Samples	Color	Flavor	Texture	Overall acceptability
S_1	7.2	6.70	6.30	7.0
S_2	7.4	7.70	7.60	7.2
S_3	6.7	7.00	6.40	6.4
LSD ($p<0.05$)	Not significant	0.81	0.75	Not significant

S_1: Tomato juice with KMS, S_2: Tomato juice with Na benzoate, S_3: Tomato juice with Sorbic Acid

The results showed that among the three juices stored at room temperature, juice with Na-benzoate contained least viable bacteria (log cfu mL^{-1}) and juice with KMS contained highest viable bacteria (log cfu mL^{-1}). From the above results, it is clear that the total viable bacterial count increased slightly with the increase of storage period. This may be due to the presence of preservatives in the juices.

Growth of yeast and mold: During the storage period there were no countable molds present in processed tomato juice. The juice was fermented due to the growth of yeast. The results have been shown in Table 3.

This result showed that, mold was not grown within 60 days but yeast count increased with time. This may occurred for either improper capping or improper pasteurization or faulty sterilization of the bottles or combination of these.

Sensory evaluation: The processed tomato juice was evaluated for its color, flavor, texture and overall acceptability through a taste testing panel. The panelists were asked to score the sample in ascending order of 1-9 points showing their degree of preference in respect of color, flavor, texture and overall acceptability of the juice sample. The responses were tabulated in Table 4.

A two way Analysis of Variance (ANOVA) was carried out for color preference and overall acceptability of processed tomato juices and the result showed that there were no significant differences among the three samples.

In case of flavor a two way Analysis of Variance (ANOVA) was carried out and the results showed that there were significant differences in flavor acceptance among the juices with different chemical additives as the calculated F value (5.3) was greater than the tabulated F value (3.6).

As shown in table, sample S_2 was the most acceptable in flavor preference among the samples securing the highest score (7.7) and ranked as "Like moderately". This was followed by sample S_1 and S_3 securing 6.7 and 7.0, respectively and was equally acceptable. However, sample S_1 and S_3

Table 5: Organoleptic observation of prepared tomato juice stored at room temperature (25-30°C)

		Storage duration (days)				
Tomato juice	Parameters	0	15	30	45	60
Sample S_1 (KMS)	Color	Natural	Natural	Natural	Natural	Turbid
	Flavor	Natural	Natural	Natural	Slightly pungent	Pungent
	Texture	Uniform	Uniform	Uniform	Slightly sedimented	Sedimented
Sample S_2 (Na-benzoate)	Color	Natural	Natural	Natural	Natural	Slightly turbid
	Flavor	Natural	Natural	Natural	Natural	Slightly pungent
	Texture	Uniform	Uniform	Uniform	Uniform	Slightly sedimented
Sample S_3 (Sorbic acid)	Color	Natural	Natural	Slightly turbid	Turbid	Turbid
	Flavor	Natural	Natural	Slightly pungent	Pungent	Pungent
	Texture	Uniform	Uniform	Uniform	Slightly sedimented	Sedimented

can be ranked as "Like Slightly". In case of texture of products there were significant differences among the samples at 5% level of significance as calculated F (4.9) value was higher than tabulated value of F (3.7).

As shown in the table there was no significant difference for texture preference between sample S_1 and S_3 securing 6.3 and 6.4, respectively. On the other hand sample S_2 secured the highest score (7.6) and was significantly different from other samples. Results showed that sample S_2 was the most acceptable in texture preference among the samples securing 7.6 out of 9 and ranked as "Like moderately".

Organoleptic observation: Organoleptic observation of tomato juices with three different preservatives during storage period at room temperature were judged on the basis of color, flavor and sedimentation. The observations have been shown in Table 5.

From the Table 5, it was found that there was a slight variation in color among the three different tomato juices during 60 days storage period. All the three juices become turbid at the end of the storage period. Color of the juices was found reddish/ deep reddish on the day of preparation. The color faded and flavor deteriorated gradually with the increase of storage period at room temperature. Tomato juice with Na benzoate seems to be more stable as after 60 days of storage, it develops slight turbidity, off-flavor and sedimentation. Whereas, tomato juice with sorbic acid deteriorated after 30 days of storage and tomato juice with KMS deteriorated after 45 days of storage.

DISCUSSION

The experiment was conducted to compare the effect of three different chemical additives on overall quality, acceptability and shelf life of tomato juice stored at room temperature. Negligible change in chemical constituents except Vitamin C was observed in the prepared juice throughout the 60 days storage period. Similar results were found in the study of Mehmood *et al.* (2008) where Vitamin C content decreases with the storage time in apple juice preserved with potassium sorbate and sodium benzoate. Hashimi *et al.* (2007) and Gupta *et al.* (2007) observed that mango pulp preserved with potassium metabisulphate either individually or in combination with other preservatives retains maximum overall acceptability, maintains maximum nutrients stability and negligible microbes. There was variation in color and flavor in prepared juice with three different chemical additives. Temperature has an effect on storage quality of food products.

Safdar *et al.* (2010) showed that tomato paste with sodium benzoate as additive remains acceptable for longer period when stored at lower temperature. On the shelf life study, after about 40 days fermentation and sedimentation problem occurs in the samples. This may be due to improper capping, coarse homogenization etc. Sensory evaluation showed that there was no significant difference among the juices with three different chemical additives considering color and overall acceptability. In general, synergistics effect of physical conditioning in combination with additives based minimal processing can give longer shelf life of tomato juice (Chauhan *et al.*, 2006). Chemical preservatives can be replaced with natural preservatives such as Baicalin (Bruzewicz *et al.*, 2006), plant essential oils (Fazlara *et al.*, 2008), Azelaic acid (Moniharapon *et al.*, 2005), extracts of different plants such as *Zingiber officinale* (Sunilson *et al.*, 2009) etc. to obtain longer shelf life with acceptable quality.

CONCLUSION

In this study, it is evident that Na-benzoate is better preservative than Potassium Meta bi-sulphate (KMS) and Sorbic acid for tomato juice. The quality of juice may be improved by fine homogenization, proper capping, proper pasteurization and using sterilized bottles. More detailed study is required for further improvement of quality characteristics of tomato juice.

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