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Study of physico-chemical composition of fresh tomato and standardization of recipe for tomato juice

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Abstract: *The present investigation was conducted at the Fruit and Vegetable Processing Laboratory, Department of Horticulture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) during the year 2008-09 and 2009-10. Fully- ripened fruits of tomato obtained from the local market were used for processing under the experiments. The aim of investigation was to study the physico-chemical composition of fresh tomatoes, to standardize the recipe for tomato juice. During recipe standardization of tomato juice, the combination of sugar and salt with each four and three levels were used with two factor factorial experiment under Completely Randomized Design with three replications. In recipe standardization, tomato juice with 10.0 g sugar and 7.0 g salt was the best treatment scoring highest acceptable score of 7.20 among different combinations. Organoleptic evaluation of standardized tomato juice and changes in chemical composition were tested periodically and it was found that tomato juice was acceptable upto 90 days of storage under ambient storage condition. Total soluble solids, TSS/acid ratio showed a decreasing trend with increasing period of storage (0-90 days), while acidity, ascorbic acid, total sugar, reducing sugar, non-reducing sugar and lycopene content of the tomato juice showed an increasing trend.*

Key words: *Recipe standardization, Tomato, Juice.*

INTRODUCTION

Tomato, *Lycopersicon esculentum* Mill. (2n=24) is one of the most popular and principal vegetable crops grown in India and other parts of the world for its edible fruits. It has wider coverage in comparison to other vegetable crops. The genus *Lycopersicon* (Greek,"wolf peach") is a member of the Solanaceae, the nightshade family originated along the coastal highlands of western South America.

Tomato fruit is universally treated as protective food and is valuable source of minerals, organic acids including â-carotene, vitamins and lycopene, a potent antioxidant that gives the fruit its characteristic red colour (Daniells, 2006). The characteristic taste and flavour of tomato is due to a combination of fructose, citric acid and fructose: citric ratio (Petro-Turza, 1986).

Tomato juice is nutritious and appealing in taste. It is often canned and sold as a beverage. India produces surplus amount of tomato but about 20-50 per cent of the produce are spoiled every year due to its perishable nature and glut during harvesting time, which reduces the market value of this vegetable. Research has shown that this waste is because of lack of preservation mechanism. Hence, production of value-added products may overcome this problem. These processed products do not spoil for a fairly long time during storage and reduce the post-harvest losses of tomato. However, tomato ranks first among the processed vegetables (Sethi and Anand, 1986).

The shelf life or storage of fresh tomato fruits for longer time is not quite feasible; therefore, storage of processed products is practicable. The value-added products like tomato juice are utilized as raw material for the preparation of ketchup and sauces etc. But, little attempts have been made to

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study the shelf life of tomato products. Hence, with this background the present investigation entitled "Study of physico-chemical composition of fresh tomato and standardization of recipe for tomato juice " was undertaken with following objectives:

1. To study the physico-chemical composition of tomato fruits.
2. To standardize the recipes for Tomato Juice.

MATERIALS AND METHODS

The present investigation entitled "Study of physico-chemical composition of fresh tomato and standardization of recipe for tomato juice " was carriedout at Fruit and Vegetable Processing Laboratory, Department of Horticulture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) during the year 2008-09 to 2009-10. Fully- ripened fruits of tomato obtained from the local market were used for processing under the experiment in a two factor factorial experiment under Completely Randomized Design with three replications.

Standardization of recipe for tomato juice

Number of treatments : (S) Sugar- 4 levels - factor 1
(T) Salt - 3 levels - factor 2

Treatment Details

Treatments	*Sugar (g)*	*Salt (g)*
S_1T_1	7.5	3.0
S_1T_2	7.5	5.0
S_1T_3	7.5	7.0
S_2T_1	10.0	3.0
S_2T_2	10.0	5.0
S_2T_3	10.0	7.0
S_3T_1	12.5	3.0
S_3T_2	12.5	5.0
S_3T_3	12.5	7.0
S_4T_1	15.0	3.0
S_4T_2	15.0	5.0
S_4T_3	15.0	7.0

Different recipes were prepared for tomato juice with different levels of sugar and salt. The prepared juice was organoleptically tested by a panel of five judges to find out the acceptable recipe. After standardization of recipe, the acceptable juice was kept for further storage study. Sodium benzoate was added to enhance the shelf life of acceptable juice.

Preparation of Tomato Juice

Fully-ripened fruits were selected, discarding all green blemished and over-ripe fruits. A good quality juice should be of deep- red colour having the characteristic taste and flavour of tomato being uniform in appearance and have high nutritive value. It is prepared by using tomato juice, sugar, salt, citric acid

(1 g per litre of juice) and sodium benzoate
(1 g per litre of juice).

Extraction of juice

Tomato juice was extracted by hot pulping method. Fully- ripe, red tomato fruits after washing, sorting and trimming were cut and chopped into pieces. These pieces were heated at 70 to 90° C for 3-5 minutes (blanched) to soften and then pulping was done to extract pulp/juice by the help of pulper. Salt, sugar and citric acid were added during homogenization. The juice was heated at 82 to 88 °C for a minute. Sodium benzoate was added to the juice before filling hot into the bottles. After sterilization in boiling water for 30 minutes followed by cooling, the bottles were stored at ambient temperature. Details are given in the Flow sheet- I.

To study the physico-chemical composition of tomato fruits

Physical composition

Data pertaining to physico-chemical composition of tomato fruit is presented in Table 4.1. Data showed that the average weight of tomato was 44.20 g. The average diameter and length of fruit were observed as 6.0 cm and 8.0 cm, respectively. The shape of the fruit was oval.

The average volume, specific gravity, juice and pomace per cent of tomato fruits recorded were 47.0

FLOW SHEETPREPARATION OF TOMATO JUICE

TOMATOES
(fully ripe, red)
↓
WASHING
↓
CUTTING AND CHOPPING
(4-6 pieces)
↓
HEATING AT 70-90°C FOR 3-5 MINUTES
(to soften)
↓
PULPING OR EXTRACTION OF JUICE
(mechanically or by sieving)
↓
ADDITION OF SALT, SUGAR AND CITRIC ACID
↓
HOMOGENIZATION
(to a uniformly thick consistency)
↓
HEATING AT 82-88 ° C FOR A MINUTE
↓
FILLING HOT INTO BOTTLES
↓
STERILIZATION IN BOILING WATER FOR 30 MINUTES
↓
COOLING
↓
STORAGE AT AMBIENT TEMPERATURE
(in cool and dry place)

Physico-chemical composition of tomato fruit

S. No.	*Characters*	*Mean value*
A.	Physical parameters	
1.	Fruit weight (g)	44.20
2.	Diameter of fruit (cm)	6.0
3.	Length of fruit (cm)	8.0
4.	Fruit colour	Deep- red
5.	Fruit shape	Oval
6.	Volume of fruit (ml)	47.0
7.	Specific gravity	1.07
8.	Juice per cent	72.64
9.	Pomace per cent	27.35
B.	Chemical parameters	
1.	Total soluble solids (%)	4.16
2.	Acidity (%)	0.54
3.	TSS/Acid ratio	7.70
4.	Ascorbic acid (mg/100 g)	15.87
5.	Reducing sugar (%)	2.25
6.	Non-reducing sugar (%)	1.68
7.	Total sugar (%)	3.94
8.	Lycopene content (mg/100 g)	3.18

Table 1
Organoleptic evaluation of tomato juice during recipe standardization

Treatments	Treatment combinations	Colour	Appearance	Aroma	Taste	Overall acceptability
T_1	S_1T_1 (7.5g sugar with 3.0 g salt)	5.10^{a}	6.00^{c}	5.60^{a}	5.00^{b}	5.12^{a}
T_2	S_1T_2 (7.5g sugar with 5.0 g salt)	6.13^{b}	6.40^{d}	6.00^{b}	6.00^{c}	6.15^{b}
T_3	S_1T_3 (7.5g sugar with 7.0 g salt)	6.43^{c}	6.60^{e}	7.00^{g}	7.60^{i}	6.95^{d}
T_4	S_2T_1 (10g sugar with 3.0 g salt)	6.10^{b}	6.60^{e}	6.00^{b}	6.20^{d}	6.25^{bc}
T_5	S_2T_2 (10g sugar with 5.0 g salt)	6.53^{c}	7.00^{f}	6.80^{f}	7.40^{h}	6.95^{d}
T_6	S_2T_3 (10g sugar with 7.0 g salt)	7.13^{d}	7.20^{g}	6.40^{d}	8.00^{j}	7.20^{d}
T_7	S_3T_1 (12.5g sugar with 3.0 g salt)	7.07^{d}	7.00^{f}	6.60^{e}	7.00^{g}	6.95^{d}
T_8	S_3T_2 (12.5g sugar with 5.0 g salt)	6.10^{b}	6.60^{e}	6.20^{c}	6.80^{f}	6.45^{bc}
T_9	S_3T_3 (12.5g sugar with 7.0 g salt)	5.13^{a}	4.60^{a}	5.60^{a}	4.80^{a}	5.05^{a}
T_{10}	S_4T_1 (15g sugar with 3.0 g salt)	6.10^{b}	6.40^{d}	6.20^{c}	6.40^{e}	6.30^{bc}
T_{11}	S_4T_2 (15g sugar with 5.0 g salt)	7.00^{d}	6.40^{d}	$6.47d^{e}$	6.40^{e}	6.55^{c}
T_{12}	S_4T_3 (15g sugar with 7.0 g salt)	5.00^{a}	5.00^{b}	6.00^{b}	5.00^{b}	5.25^{a}
	Mean	6.15	6.32	6.24	6.38	6.26

	SEm±	CD(%)	SEm±	CD(%)	SEm±	CD(%)	SEm±	CD(%)	SEm±	CD(%)
Sugar	0.03	0.10	0.03	0.10	0.03	0.09	0.03	0.10	0.06	0.21
Salt	0.03	0.08	0.03	0.08	0.03	0.08	0.03	0.08	0.07	0.18
Sugar x Salt	0.06	0.17	0.06	0.17	0.04	0.16	0.05	0.17	0.12	0.36

Note: The superscript letter indicates that the treatment means with same letter are at par at 5 % level of significance while the mean with different letters are significantly different at 5 % level. These letters have been affixed based on CD value comparisons of treatment means.

ml, 1.07, 72.64 per cent and 27.35 per cent, respectively.

Chemical composition

Data with respect to chemical composition of tomato fruit is presented in Table 4.1. The results revealed that total soluble solids, acidity, TSS/acid ratio and ascorbic acid recorded during the course of investigation were 4.16 per cent, 0.54 per cent, 7.70 and 15.87 mg/100g, respectively.

Reducing sugar, non-reducing sugar, total sugar and lycopene content recorded were 2.25 per cent, 1.68 per cent, 3.94 per cent and 3.18 mg/100 g, respectively.

Standardization of recipe for tomato juice

Organoleptic evaluation of tomato juice during recipe standardization

A panel of five judges did organoleptic evaluation of tomato juice prepared from different recipes. The organoleptic scores are presented in Table 4.2.1 and Fig. 4.1.

Colour

The different treatments as recipes for tomato juice recorded organoleptic score for colour between 5.0 to 7.13. The highest score (7.13) was obtained by recipe T_6(10.0 g sugar with 7.0 g salt) which was found statistically at par with T_7 and T_{11} at 5 % level of significance having organoleptic rating "like moderately". The rest of the recipes recorded lower score than the acceptable score 7.0.

Appearance

The different treatments as recipes for tomato juice recorded organoleptic score for appearance between 4.60 to 7.20. The highest score for appearance was recorded by the treatment T_6(7.20) which was significantly superior to all the other treatments. Treatments T_5 and T_7 scored the acceptable score of 7.0 and rest of the recipes were below acceptable score.

Aroma

The acceptable score for aroma was gained by the recipe T_3 (7.00),which was significantly superior than the other recipes involved in the study. The rest of the recipes recorded below acceptable score of 7.0.

Taste

The highest score for taste of tomato juice during recipe standardization was recorded by the treatment T_6 (8.00),which was significantly superior than rest of the treatments at 5 % level of significance. The treatments T_3, T_5 and T_7 also recorded acceptable score for taste of tomato juice.

Overall Acceptability

Among all the recipes, only T_6gained highest score of acceptability (7.20) and was statistically similar with recipes T_3, T_5 and T_7. All the recipes recorded below acceptable score of 7.0 except T_6.

Total soluble solids (%) of tomato juice during recipe standardization

The tomato juice prepared was subjected to analysis for determination of total soluble solids. Average data are presented by corresponding Table 4.2.2 and shown through Fig.4.2.

During recipe standardization, the highest total soluble solids (5.04 %) were recorded in the recipe T_6which was significantly superior to other recipes involved in the study. However, this recipe was found statistically at par with T_{12} at 5 % level of significance. The minimum total soluble solid (3.31 %) was recorded in the recipe T_1.

RESULT AND DISCUSSION

To study the physico-chemical composition of tomato fruits

The important physico-chemical characteristics like colour, shape, diameter, length, juice per cent, volume of fruit, total soluble solids, acidity, ascorbic acid, reducing sugar, total sugar, non-reducing sugar were recorded in the fresh tomato fruits before processing (Table 4.1).

Physical composition

In the present study, the average weight of tomato was 44.20 g. The fruits of tomato selected for the study were oval in shape and deep-red in colour. The

Table 2
Total soluble solids (TSS) of tomato juice during recipe standardization

Treatments	Treatment combinations	Total soluble solids (%)
T_1	S_1T_1 (7.5g sugar with 3.0 g salt)	*10.49[a]
		(3.31)
T_2	S_1T_2 (7.5g sugar with 5.0 g salt)	11.12[d]
		(3.73)
T_3	S_1T_3 (7.5g sugar with 7.0 g salt)	11.94[e]
		(4.27)
T_4	S_2T_1 (10.0g sugar with 3.0 g salt)	11.04[c]
		(3.63)
T_5	S_2T_2 (10.0g sugar with 5.0 g salt)	12.10[f]
		(4.39)
T_6	S_2T_3 (10.0g sugar with 7.0 g salt)	12.96[h]
		(5.04)
T_7	S_3T_1 (12.5g sugar with 3.0 g salt)	10.83[b]
		(3.55)
T_8	S_3T_2 (12.5g sugar with 5.0 g salt)	11.11[d]
		(3.72)
T_9	S_3T_3 (12.5g sugar with 7.0 g salt)	12.65[g]
		(4.78)
T_{10}	S_4T_1 (15g sugar with 3.0 g salt)	10.84[b]
		(3.56)
T_{11}	S_4T_2 (15g sugar with 5.0 g salt)	12.01[e]
		(4.34)
T_{12}	S_4T_3 (15g sugar with 7.0 g salt)	12.92[h]
		(5.00)
	Mean	11.67
		SEm± CD(%)
Sugar		0.01 0.04
Salt		0.01 0.03
Sugar x Salt		0.02 0.07

Note:

1. The asterisk (*) indicates the mean arcsine-transformed value.
2. The superscript letter indicates that the treatment means with same letter are at par at 5 % level of significance while the mean with different letters are significantly different at 5 % level. These letters have been affixed based on CD value comparisons of treatment means.
3. Figures in parenthesis are inverse transformed value of the corresponding mean arcsine-transformed values.

average diameter and length of fruits were observed as 6.0 cm and 8.0 cm, respectively. Similar finding with fruits oval in shape and fruit diameter range of 3.8 - 5.7 cm were recorded by Saimbhi *et al.* (1995).

The average juice and pomace per cent of tomato recorded were 72.64 and 27.35 per cent, respectively.

Chemical composition

Data with respect to chemical composition of tomato revealed that total soluble solids, titrable acidity, TSS/acid ratio and ascorbic acid recorded during the course of investigation were 4.16 per cent, 0.54 per cent, 7.70 and 15.87 mg/100 g, respectively. Similar results were also reported by Saimbhi *et al.*

(1995), Kaur *et al.* (2004) and Kaur *et al.* (2005). Abdel Rahman-AHY (1982) also reported that the fresh tomato fruit contains 16.5 mg/100 g ascorbic acid.

The characteristic sweet-sour taste of tomato and its overall flavour intensity may be due to reducing sugars, free acids, their ratio as well as some volatile substances as also reported by Petro-Turza (1986).

Reducing sugar, non-reducing sugar, total sugar and lycopene content recorded were 2.25 per cent, 1.68 per cent, 3.94 per cent and 3.18 mg/100 g, respectively. Similar results were also reported by Kaur *et al.* (2005), who recorded lycopene content 0.29 to 3.31 mg/100g of fresh fruit. Similarly, Wawrzyniak *et al.* (2005) reported that lycopene content of fresh tomatoes ranged from 1.21 to 6.43 mg/100 g.

Standardization of recipe for tomato juice

Organoleptic evaluation of tomato juice during recipe standardization (by hedonic scale ratings)

The data (Table 4.2.1 & Fig. 4.1) on organoleptic evaluation for acceptability of tomato juice during recipe standardization revealed that the treatment T_6 recorded highest score for colour (7.13), appearance (7.20), taste (8.0) and overall acceptability (7.20). However, T_3 recorded highest organoleptic score for aroma (7.0). The rest of the recipes recorded lower score than the acceptable score of 7.0 for overall acceptability. El Gharably *et al*. (2004) reported that enriched tomato drinks had the highest sensory evaluation scores.

The organoleptic evaluation is complemented with sugar and organic acid analysis (Bucheli *et al*., 1999). Dubey *et al*. (2009) also reported highest organoleptic score of guava RTS prepared with recipe 10 % pulp, 12 % TSS and 0.3 % acidity.

Total soluble solids (%) of tomato juice during recipe standardization

The highest total soluble solids (5.04 %) of tomato juice (Table 4.2.2 & Fig. 4.2) during recipe standardization were recorded in the recipe T_6 which were found significant to rest of the recipes involved in the study, while the lowest TSS (3.31 %) was observed in T_1.

CONCLUSION

Fully- ripened fruits of tomato were procured from the local market for the preparation of value-added products viz., tomato juice, tomato puree, tomato paste and tomato cocktail. Different recipes were prepared for tomato juice with different levels of sugar and salt under Completely Randomized Design with two factor factorial experiment. The prepared juice was organoleptically tested by a panel of five judges to find out the acceptable recipe. After standardization of recipe of tomato juice, the acceptable juice was kept for further storage study.

Physico-chemical composition of tomato fruits

- The average weight, diameter and length of of tomato fruit were 44.20 g, 6.0 cm and 8.0 cm, respectively. The shape of the fruit was oval. The average juice and pomace per cent of tomato fruits recorded were 72.64 per cent and 27.35 per cent, respectively.
- The total soluble solids, acidity, TSS/acid ratio and ascorbic acid of fresh tomato recorded during the course of investigation were 4.16 per cent, 0.54 per cent, 7.70 and 15.87 mg/100g, respectively.
- The reducing sugar, non-reducing sugar, total sugar and lycopene content recorded were 2.25 per cent, 1.68 per cent, 3.94 per cent and 3.18 mg/100 g, respectively.

Standardization of recipe for tomato juice

- The highest score for colour, appearance, taste and overall acceptability was obtained by the recipe T_6 (10.0g sugar with 7.0 g salt) and for aroma with T_3 (7.5g sugar with 7.0 g salt). The rest of the recipes recorded lower score than the acceptable score 7.0.
- The highest total soluble solids (5.04 %) during recipe standardization of tomato juice was recorded in the recipe $T_{6,}$ which was foundstatistically at par with $T_{12,}$ while the minimum total soluble solid (3.31 %) was recorded in the recipe T_1.

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