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Effect of Time and Temperature on the Rheological Properties of Tomato *(Lycopersicon Esculentum)* Puree

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Abstract

The evaluation of rheological property and chemical analysis of Tomato puree was carried out in this project. The microbial analysis and shelf life evaluation was also done at the interval of 15, 30 and 45 days. The sensory evaluation was also carried out in this experiment. Tomato puree exhibited a non-Newtonian behaviour with a yield stress. The yield stress decreases with increasing temperature as well as with decreasing the solid content. Tomato puree without seed shows more viscosity and exhibited a thixotropic behaviour at low shear rate and changes to anti thixotropic behaviour at higher shear rate regardless of the temperature and solid content. The transient shear stress data of tomato puree containing seed showed a time independent behaviour. The control sample had no preservative in it and it lost its nutritional value within 15 days. The T1 had sugar and salt as preservative and had good sensory qualities but its life was up to 30 days. The T2 had Acetic acid as preservative in it. It had both shelf life and good nutritional value. To study the effect of temperature on the rheological properties of tomato puree, samples of 25% solids paste were maintained at rest for 15 min in the viscometer to equilibrate with the experimental temperature of 4, 37 and 60°C, before conducting the measurements. Temperature of the viscometer was controlled using thermostatic circulating water bath.

Index Terms: Tomato, puree, viscosity, physico-chemical analysis, microbial analysis time and temperature dependency.

Introduction

India is an agricultural country and has one of the world's largest populations. In our country is still not very well developed with result that the quantity and quality of produce is poor. After green revolution though the quantity has increased, this increased quantity is not sufficient to supply even 2/3rd of growing population.

Tomatoes (*Lycopersicon esculentum*) belong to family *salanaceae* and genus *lycopersicon*. The genus includes all native to South America. Cultivated tomato is an annual herb 0.7 to 2.0 tall erect thick solid item on spreading coarsely hairy with characteristic strong odour. Italy is the second largest processing tomato producer worldwide, second only to California, but its position is threatened by China.

World production of processing tomatoes has experienced a continuous decrease from 2009 to 2013 , declining from 42.3 million tons to the more modest figure of 33.2 million tons in 2013. On the other hand, the world consumption trend has settled at 38 million tons in 2014. Northern Italian tomato growers and processors have set the raw material base price for this year's tomato crop at EUR92 per tonne (USD104/tonne), the same rate as last year.

The tomato are grown extensively in India producing about 9.362 million tonnes with an area of about 535,000ha(2015). The leading states for tomato production in India are U.P, Karnataka, Maharashtra, Haryana, Punjab and Bihar in our country growing of vegetables are 4-8 times more remunerable than cereals and other field crops and also the vegetables cultivation generates more employment in the rural areas.

Tomato is popular because it supplies vit.C and add variety of colours and flavours to the food. Green tomatoes are also used for pickles and preservatives. It has many other uses as tomato seed contain24% oil and this is extracted from the pulp and residues in the canning industry (blood purifier).

In developing countries like India the consequences of micronutrient deficiency in human diet are extremely severe. As due to mal nutrition mental and physical development of generation of school children will certainly be hampered. Thus they may become burden for nation instead of its strength.

Tomato is cultivated for edible red fruit. Lycopene is found inside tomato which is responsible for red colours **Holder (1999).** Lycopene is the predominant carotenoid in tomatoes. Supplementation of tomatoes products containing lycopene has been shown to lower biomarkers of oxidative stress and carcinogenesis (Many factors affect the lycopene concentration in raw tomatoes, such as genetic soil and plant nutrition, handling maturity and seasonal variation.

The viscosity and other rheological properties depend partly on the morphology of the particles, composition and interactions of the polymers, as well as the processing conditions used to make the puree.

Dietary antioxidants inactivate reactive oxygen species, reduce oxidative damage lead to improve immune functions and reduce risk of infectious diseases. Increasing intake of dietary oxidant may help to maintain adequate antioxidants status and therefore, the normal physiological functions of living systems **Kaur and Kapoor (2007**).

Rheological properties of food products are important in quality control, storage and processing, stability measurements, and in predicting texture.

Materials and Methods

Materials

Fresh raw Tomatoes, sugar ,salt Acetic acid ascorbic acid ,2,6 dicholorophenol indophenols dye indicator, metaphosphoric acid , distilled water was used. Tomatoes were cleaned, washed, peeled and balanced. Than grinder was used for the preparation of tomato puree. After preparation, the tomato puree samples were sterilized by autoclaving at 120°C for 15 min and packed in glass bottle and aluminium pouch. The physico-chemical and microbiological qualities were evaluated just after preparation of tomato puree and at the interval of 0 days up to 45 days during storage at room temperature.

Methods

Preparation of puree

Tomatoes will be washed with the help of clean water so as to remove the dirt, other disease causing organism as the adhering pesticides. Then cut the top slice from the slide of the tomatoes, cross cut will be given only on the skin of other side of the tomatoes. Now water will be put in the big container to boil when the water started to boil all tomatoes will be put in the water and heat will be switched off. After that the pot will be covered. Tomatoes will be put in water for 5 min. The tomatoes will be removed from hot water and will be put in a pot with cold water for 5 min.After that tomatoes will be taken out and skin will be peeled off very easily by starting at the silt end. Skin will be removed from all tomatoes. Here the seed and juicy portion of the tomatoes will be used; tomatoes will be put in the blander and will be made into puree. The samples will be put in the glass bottles and in the aluminium pouch. The different preservatives will be used in different amount. The preservatives like sugar and salt, acetic acid and citric acid will be used. The control will also be prepared.

Treatment Combinations

Table 1: Treatment combination used for the preparation of puree

S. No	Preservatives	Tomato puree (with seed)	Tomato puree (without seed)
1	T1	No added preservative	No added preservative
2	T2	Salt and sugar	Salt and sugar
3.	T3	Acetic acid	Acetic acid
4.	T4	Citric acid	Citric acid

Determination of Ascorbic acid

Ascorbic Acid was determined by method described in Ranganna (1986)

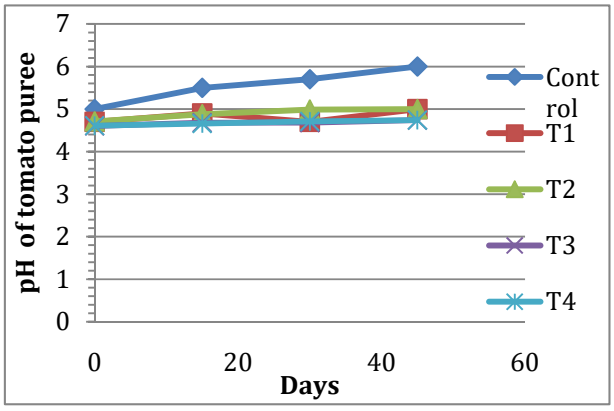

Figure 3.1: Graph showing pH of tomato puree

Determination of Viscosity of the samples

Viscosity was measured using Ostwald viscometer, stopwatch fluids. In this a reference fluid eg water was taken against the sample fluid and average time required by reference fluid to flow from the sections of viscometer was determined. Similarly obtain the average time for sample in passing the sections of the Ostwald viscometer. Repeats the process for accuracy.

Determination of total soluble solid (TSS) by Hand refractometer

Hand refractometer of 0-32°brix range, Puree, Muslin Cloth, Glass rod and distilled water.

Results and Discussions

Table 3.1 pH of the tomato puree

Days	C	T 1	T 2	T3	T4
0	5	4.7	4.71	4.60	4.61
15	5.5	4.9	4.88	4.68	4.66
30	5.7	4.7	4.99	4.68	4.71
45	6	5	5	4.74	4.75

C- control, T- treatment

Table 3.2: T.S.S of the tomato purees (°brix)

Days	C	T 1	T 2	T3	T4
0	14	14	15	21	22
15	14	14	15	21	22
30	14	14	15	21	22
45	14	14	15	21	22

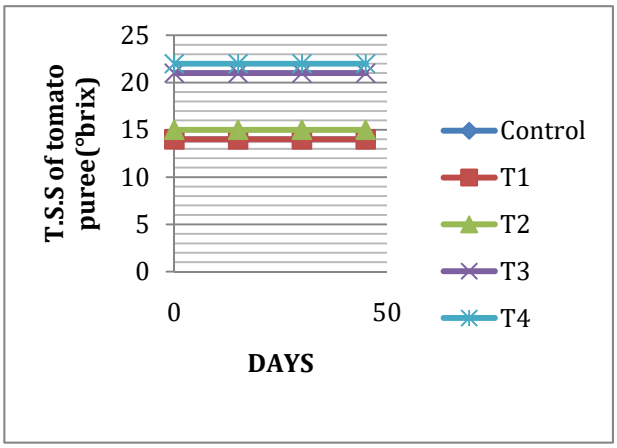

Figure 3.2: Graph showing total soluble solids of tomato puree

Table 3.3 Vitamin C (mg) of the Tomato puree

Days	C	T 1	T 2	T3	T4
0	21.79	24.60	25.64	23.70	25.63
15	21.66	24.40	25.44	23.62	25.51
30	21.64	24.20	25.42	23.59	25.42
45	21.59	24.20	25.32	23.59	25.36

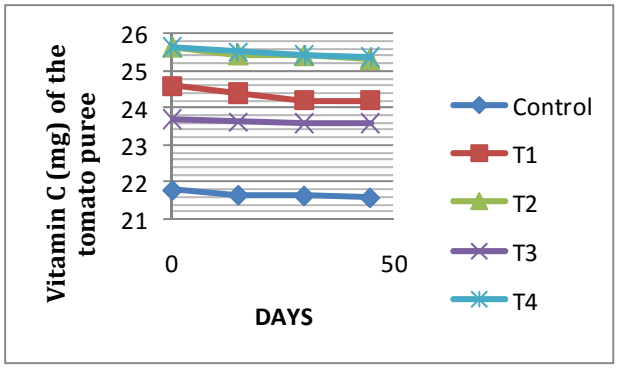

Figure 3.3: Graph showing Vitamin C of Tomato puree

Viscosity of Tomato puree containing seed and without seed

Approximately reference fluid (water) was placed in a Ostwald viscometer. Average time taken by sample to flow from the section AB of the Ostwald viscometer was noted down. Similarly the average time required by the sample in passing the section AB of the Ostwald viscometer was noted down. Two different samples of tomato puree were taken one containing seed and other without seed at different time and temperatures.

Table 3.5: Viscosity of Tomato purees (samples)

Storage time(weeks)	**Viscosity of puree (with seed)at 4°C**	**Viscosity of puree(without seed) at 4°C**
0	0.342	0.428
2	0.333	0.45
4	0.366	0.40
6	0.366	0.426
8	0.303	0.468

Table 3.6: viscosity of tomato puree

Storage time(weeks)	**Viscosity of puree(with seed)at 37°C**	**Viscosity of puree(without seed)at 37°C**
0	0.50	0.81
2	0.45	0.90
4	0.80	0.50
6	0.456	0.45
8	0.91	0.91

Table 3.4: Viscosity of puree

Storage time (weeks)	**Viscosity of puree(with seed) at 60°C**	**Viscosity of puree(without seed) at 60°C**
0	0.455	0.488
2	0.455	0.50
4	0.460	0.50
6	0.460	0.499
8	0.459	0.50

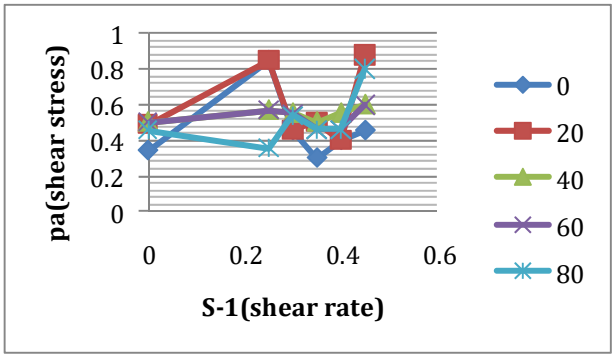

Figure 3.4: Graph showing Viscosity of puree (with seed) at 4, 37 and 60°C

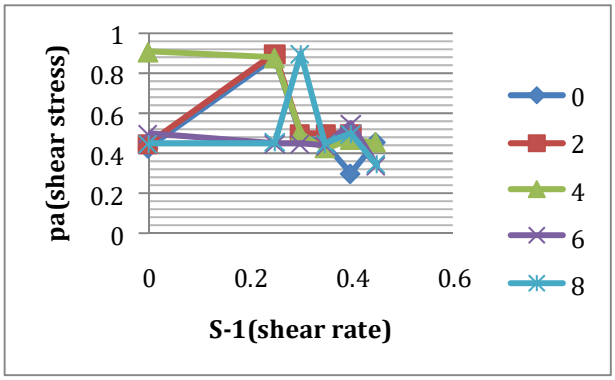

Figure 3.6: Graph showing viscosity of puree (without seed) at 4, 37 and 60°C

Tomato puree (with seed and without seed) with a solid content ranging from 5.57 to 25 wt% solids was prepared. The solution was placed within the viscometer. The test was carried out after attaining thermal equilibrium. The apparent viscosity η was measured as a function of shear rate S^{-1}. The shear rate was varied between 0.1 and 0.5 S^{-1}. The shear stress τ was calculated using:

$$\tau=\eta s^{-1}$$

Moreover, the apparent viscosity was measured as a function of shearing time, at constant values of shear rate of 2, 4, 6, 8. . To study the effect of temperature on the rheological properties of tomato puree, samples of 25% solids paste were maintained at rest for 15 min in the viscometer to equilibrate with the experimental temperature of 4, 37 and 60°C, before conducting the measurements. Temperature of the viscometer was controlled using thermostatic circulating water bath.

Conclusion

The sample which uses sugar and salt as preservative retains its colour and taste up to 15 days. The colour and taste were retained up to 30 days. The sample which uses acetic acid as preservative shows much better results than other samples. The sample containing seed at 4°C and at different intervals of time has less viscosity as compared to sample without seed. The increase in pH values with storage time may be due to increase low microbial activites with storage time. Viscosity was observed also to decrease significantly with storage time especially from second week of storage At 37°C viscosity of samples start increasing specially the sample containing no seed. And at 60°C viscosity was much better than other two temperatures. From this, it was concluded that as temperature increases viscosity decreases. The sample prepared without seed has more viscosity and it was near about same for 45 days. Tomato puree exhibited a non-Newtonian behavior with a yield stress.. The yield stress decreased with increasing the temperature as well as with decreasing the solid content.

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