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EFFECT OF SODIUM ALGINATE, GUAR GUM AND LEMON GRASS IL BASED COATINGS ON POST-HARVEST QUALITY OF TOMATOES DURING AMBIENT STORAGE

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Abstract

Tomato is the second most key vegetable for processing, preparations dishes and the rest. Manifold literature evidence asserts that edible coating with certain chemicals have a significant effect on ameliorating shelf life by abating respiration and transpiration rate. Novelty of this research was to evaluate the effectiveness of edible coating using sodium alginate and guar gum with lemon grass essential oil to extend shelf life of tomatoes *cv* arka shreshta at ambient condition (22±2)°C. Also, make utilise less cost effective post-harvest treatment in order to mitigate losses by farmers. Tomatoes were coated by sodium alginate (1%, 1.5%, 2%) and guar gum (0.5%, 1%, 1.5%) individually along with 0.1% lemon grass and uncoated fruits were used as control samples. The effectiveness of edible coating in quality and shelf life was evaluated by estimating physiological weight loss, TSS, titrable acidity, firmness, microbial analysis, sensory evaluation during storage (12 days). The results found that coating with sodium alginate 1.5% along with 0.1% lemon grass showed best results in all parameters compare to control samples. Coated fruits extended shelf life up to 12 days but control fruits deteriorated within 9 days of storage.

Key words: Edible coating, shelf life; tomato; sodium alginate; guar gum; lemon grass essential oil; ambient storage.

Introduction

The tomato is the one of the important vegetables crop of world as well as India, tomato (*Solanum lycopersicum*) belongs to the family Solanaceae. Also, it is referred as poor man's orange and has lot many health-benefiting compounds. It is major sources of minerals, vitamins and organic acid, electrolytes, phytonutrients and rest.

According studies under Indo-US project on post-harvest losses Assessment of tomato post-harvest loses ranged from 22-27 percent. It is key to mitigate problems through post-harvest technology and management also mandatory in order to fulfil the current demands.

Due to physiological changes during post-harvest storage lead to unfit for consumption. Shelf life could be ameliorated if such changes are abated during storage and transportation. So, efforts to increase shelf life of tomato should focus on decreasing the metabolic and respiration rate in harvested fruits. Manifold research evidence has shown that edible coating can regulate the process of ripening of fruit during storage and transport.

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The guar gum also referred as guaran is a galactomannan polysaccharine which is extracted from guar beans that has stability attributes which will helps the fruits and vegetables to retain appearance and expand storage life (A. Ghosh *et al*., 2014). On the other hand, sodium alginate it is a sodium salts from angelic acid, extracted from brown algae (M. Lench and M miller, 2014) and temperature independent chemical. Coating of sodium alginate play a major key role in stabilising chemical and physiological properties during storage tenure also act as barriers for exchange between the fruit and environment.

Tomato being a climacteric fruit which undergoes different changes in firmness, sweetness, acidity and changes in pigmentation during ripening by activity of the diverse enzymes PG. Investigation is to study the effect of sodium alginate and guar gum edible coating at different concentration levels on tomato variety *cv*. arka shreshta when stored and analysed under ambient conditions.

Materials and Methods

Geographical Location and Climate

The experiment was carried out at Amity University, Uttar Pradesh, India. Harvested tomato fruits *cv*. arka shreshta of breaker stage, uniform size, maturity free from visible damage were collected from farmer.

Treatments

Seven post-harvest treatments *viz*, coating with sodium alginate (*SA) 1% (T1), *SA 1.5% (T2), *SA 2% (T3) and guar gum (*GG) 0.5% (T4), (*GG) 1% (T5), (*GG) 1.5% (T6) along with 01% lemon grass oil and Control (T7: treated with water) with three replications used and statistical analysis was done by following complete randomized design. The entire experiment was conducted at ambient condition (20±2°C).

*Sodium Alginate

*Guar gum

Physiological Loss in Weight

The samples of each treatments were weighed The calculations were made by using formula and studied during 12 days storage as mentioned below:

$$\text{PLW (\%)} = \frac{\text{Initial weight of fruit} - \text{final weight}}{\text{Initial weight}} \times 100$$

Total Soluble Solids

The juice was extracted by squeezing the fruit. The extracted sample was taken and tested under Hand refractometer (Erma japan). TSS was determined by regular interval as determined by using refractometer and expressed in 0Brix.

Titrable acidity

The acidity of the fruits is estimated by the method of Ranganna who describe about estimation of titrable acidity. 10 gram of the sample is crushed in pestle mortar and make up the volume to 100 ml in 250 ml conical flask and titrated against standard 0.1 Normal NaOH using phenolphthalein indicator. The titrable acidity was expressed in percentage and calculated using formula.

Firmness

The firmness of the fruit is measured by the pocket penetrometer. Fruits were selected randomly from the replication. To measure the firmness, two fruits were punctured with a constant force and uniform depth. The average of the three fruits within the replication was taken and expressed in grams.

Microbial Analysis

Microbial counts were analysed by using serial dilution agar plate method and it follows by mixing of 1ml of bacterial sample into 9 ml sterile distilled water in one test tube subsequently it transferred into different number of taste tubes 10^{-6} or 10^{-7}. At the cessation final taste tube was taken and mixed with autoclaved and agar mediated plates then incubated at 37°C for 24-48 hrs.Colonies were observed and counted then tabulated. This was done at every three days interval from the day of storage.

Colony-forming unit is measure of viable bacterial or fungal cells. And it can be calculated by using the formula mentioned below.

$$\frac{\text{CFU}}{\text{mL}} = \frac{\text{no. of colonies} \times \text{dilution factor}}{\text{volume of culture plate}}$$

Sensory Evaluations

The sensory evaluation of tomato fruits was carried out by a panel of six semi- trained judges. Analysis of fruits was carried out at every day from the date of storage.

The sensory traits such as colour, flavour (taste) and texture of fruits were evaluated on 9 point hedonic scale using the score card mentioned below. The mean of scores given by the judges were used for statistical analysis.

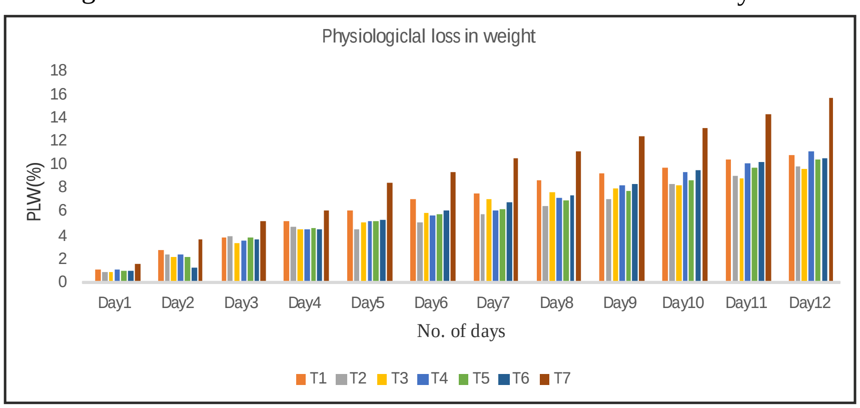

Fig. 1: Effect of post-harvest treatment on PLW of tomato cv arka shreshta (22±2°C).

Statistical Analysis

The design followed was completely randomized design (CMD). Experiment has seven treatments with three replications. The data obtained from the investigation was subjected to statistical analysis of variance by factorial CMD using WASP-1.

Results and Discussion

Sodium alginate and guar gum coating was well adhered on surface of fruits as a result fruits improved

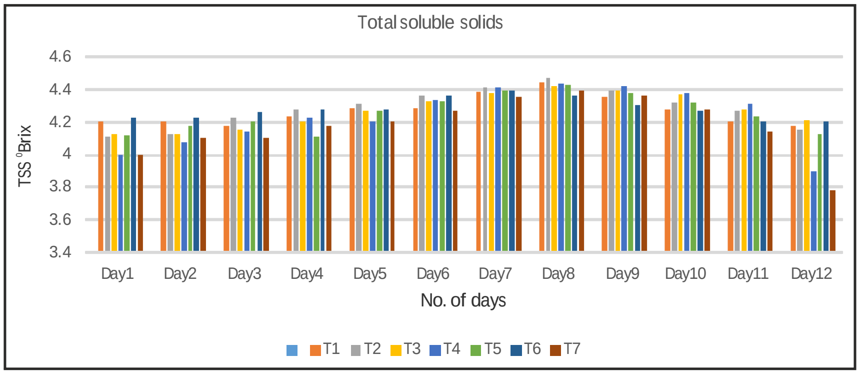

Fig. 2: Effect of post-harvest treatment on TSS of tomato cv arka shreshta (22±2°C)

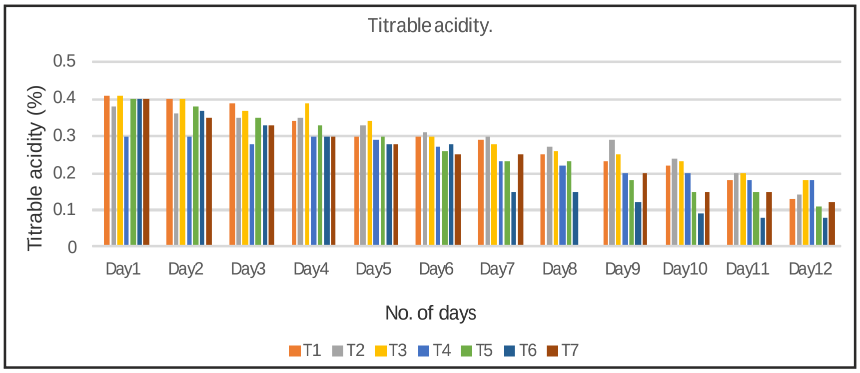

Fig. 3: Effect of post-harvest treatment on Titrable acidity of tomato cv arka shreshta (22±2°C).

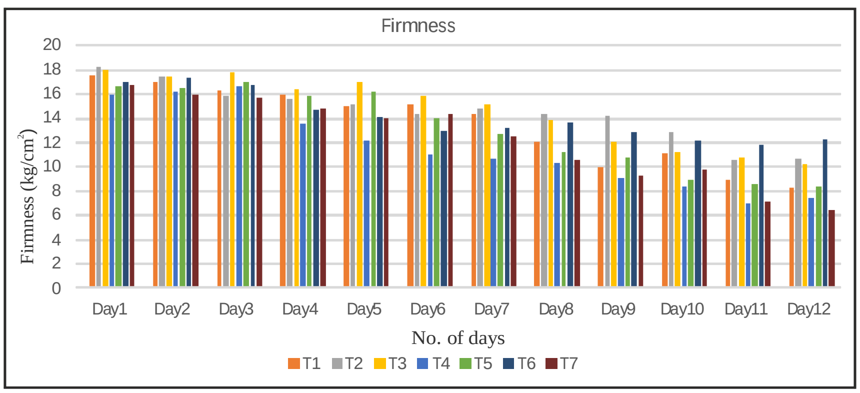

Fig. 4: Effect of post-harvest treatment on Firmness of tomato cv arka shreshta (22±2°C).

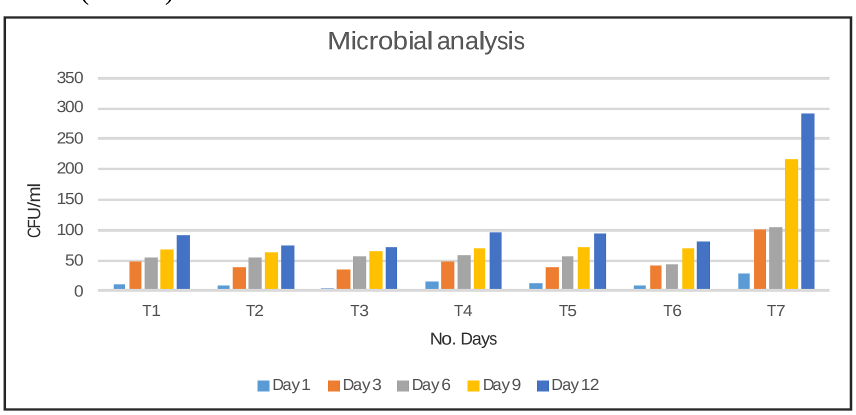

Fig. 5: Effect of post-harvest treatment on Microbial analysis of tomato cv arka shreshta (22±2°C).

appearance by double times. All tomatoes fruits shrank during the 12 day of storage tenure. While in control fruits shrank very rapidly as storage time reach 6^{th} day after storage.

Physiological loss in weight

The fig. 1 shows the change on tomato fruits from day 1^{st} to 12^{th} of storage time (Table 1, Fig. 1). Control fruits showed faster shrivel and moisture loss when compare to coated fruits. It shows coating with sodium alginate and guar gum have a significant effect on physiological loss in weight. The minimum physiological loss in weight was recorded in T2 1.5% sodium alginate (SA) with the mean value of 5.64% followed by T3 (2% SA) mean value of 5.91% and gaur gum showed higher weight loss percentage compare to sodium alginate among them minimum was found T6 1.5% guar gum (GG) with the mean value of 6.01%.

The coated fruits shows less physiological weight loss since coating abated the process of respiration, transpiration process and also ethylene biosynthesis. Tomato shows high rate of metabolism in ambient condition. The reduction in weight loss probably due to effect of coating as semi permeable barrier against oxygen, carbon dioxide, moisture and solute movement, thereby reducing respiration, water loss and oxidation reactions (Baldwin *et al.*, 1999; Park, 1999). The key fact behind rise in weight loss in tomatoes might be the generation heat and production of end-products from anaerobic fermentation (Weichmann, 1987). The fundamental mechanism of weight loss from fresh fruits and vegetables is by vapour pressure at different locations (Yaman and Bayoindirli, 2002). Relatively maximum weight loss was observed in T1, T4 and T5 respectively. Control tomatoes exhibited higher weight loss among all treatments having 9.2% as a mean value.

The tendency of water loss at early first eight-day was gradual but after the

Table 1: Effect of edible coating on PLW, TSS and Titrable acidity for 12 days at 22±2°C.

Physiological loss in weight (%)					Total soluble solids (brix°)				Titrable acidity (%)			
Treatments	**Day 1**	**Day 4**	**Day 8**	**Day12**	**Day 1**	**Day 4**	**Day 8**	**Day 12**	**Day 1**	**Day 4**	**Day 8**	**Day 12**
T1	1.08	5.14	8.67	10.8	4.23	4.24	4.45	4.18	0.41	0.34	0.25	0.13
T2	0.79	4.74	6.5	9.83	4.20	4.28	4.44	4.18	0.38	0.35	0.27	0.14
T3	0.81	4.43	7.69	9.65	4.13	4.2	4.42	4.21	0.41	0.39	0.26	0.18
T4	1.06	4.50	7.22	11.2	4.00	4.18	4.26	4.14	0.30	0.30	0.22	0.18
T5	0.98	4.57	6.97	10.5	4.11	4.23	4.44	3.9	0.40	0.33	0.23	0.11
T6	0.90	4.51	7.46	10.6	4.00	4.28	4.36	4.2	0.40	0.30	0.15	0.08
T7	1.51	6.07	11.2	15.7	4.12	4.28	4.53	4.38	0.40	0.30	0.21	0.12
S.Em±	0.01	0.06	0.08	0.11	0.01	0.02	0.02	0.19	0.04	0.02	0.01	0.01
C.D at 1%	0.27	0.73	0.910	0.87	0.42	0.57	0.71	0.51	0.08	0.06	0.04	0.03

8th day of storage, the fruits exhibited a rapid rouse in water loss especially in ambient (Reza Tabatabaekoloor, 2014). Water loss from the fruit is driven by the water gradient between the internal fruit space and fruit surrounding air. (Katsiferis *et al.,* 2008).

Total Soluble Solids

Results during storage asserts that the TSS content of tomatoes were accelerated up to certain period and after that showed slightly declined in all treatments (Fig. 2, Table 1). Maximum TSS was found in T2 with the mean 4.28 0Brix followed by T6 having mean 4.28 0Brix. On the other hand the lowest TSS was found in T7 (control) that is 4.17 0Brix. Possibly increasing TSS is due to conversion of complex molecules into simple monomers. Not continue to increase further and subsequently a decline in these parameters is predictable as they along with other organic acids are primary substrate for respiration. (Naik *et al*., 1993). Decreasing of respiration slowdown the synthesis and utilisation of metabolites as a resulting in lower TSS (Yaman and bayoindrili, 2002).

Titrable Acidity

The titrable acidity of coated and uncoated fruits during storage was inclined with storage days with time of Storage (Table 1, Fig. 3). The highest mean value of titrable acidity was recorded in T2 that is 0.29 followed by 0.28 in T6. However, the data of all coated fruits statistically from day 1st to 12th day of storage. The lowest mean was observed in control fruits T7 it is of about 0.24 says that coating delayed ripening process by giving an opaque coating around the fruit. Since organic acids, such as malic or citric acid, are primary substrates for respiration, a reduction in acidity seen in highly respiring fruits (El-Anany *et al.*, 2009). The higher titrable acidity level in control fruits represents that delayed ripening by giving a barrier against O_2 uptake around the fruits. (X. Ruelas-chacon *et al.*, 2017). The decrease in acidity in the fruits during the storage is because of the fact that organic acid might be consumed rapidly during respiration or during conversion of acid into sugar these outcomes of (Swati, G. *et al.*, 2012). Retention of titrable acidity has been reported previously for various coated fruits (Yaman and Bayoindirli, 2002); Tanada-Palmu and Grosso, 2005).

Firmness

The firmness of tomato fruits decrease throughout the storage and recorded significant difference among the treatments (Table 2, Fig. 4). Normally during the storage, fruits loose the firmness owing to biochemical and physiological process leading to tissue softening (Rojas-Grau *et al.*, 2008). That is increasing respiration consequently the firmness value will reduce, it is probably

Table 2: Effect of edible coating on Firmness and Microbial analysis for 12 days at 22±2°C.

Firmness (kg/cm²)					Microbial analysis (CFU/ml)				
Treatments	**Day 1**	**Day 4**	**Day 8**	**Day12**	**Day1**	**Day 3**	**Day 6**	**Day9**	**Day12**
T1	17.6	15.9	12.0	8.3	1.1×10^7	4.7×10^7	5.8×10^7	$7.6\times10^{7+}$	9.1×10^7
T2	18.3	15.6	14.4	10.7	0.8×10^7	3.9×10^7	5.5×10^7	6.7×10^7	7.4×10^7
T3	18.0	16.4	13.9	10.2	0.3×10^7	3.5×10^7	5.7×10^7	6.4×10^7	7.7×10^7
T4	15.9	13.5	10.3	7.5	1.4×10^7	4.4×10^7	5.9×10^7	7.0×10^7	9.7×10^7
T5	16.6	15.8	11.3	8.4	1.3×10^7	3.9×10^7	5.6×10^7	7.2×10^7	9.3×10^7
T6	17.0	15.7	13.6	12.3	0.9×10^7	3.1×10^7	4.4×10^7	7.0×10^7	8.1×10^7
T7	16.8	14.8	10.6	6.4	2.8×10^7	1.01×10^8	1.06×10^8	2.17×10^8	2.92×10^8
S.Em±	0.22	0.17	0.14	0.11	0.053	0.126	0.191	0.230	0.289
C.D at 1%	1.27	1.18	1.02	0.90	0.26	0.480	0.665	0.793	0.920

Table 3: Effect of edible coating on manifold sensory evaluations for 12 days 22±2ºC.

Sensory evaluation																
Colour and appearance					**Flavour**				**Texture**				**Overall acceptability**			
		D'4	**D'8**	**D'12**		**D' 4**	**D'8**	**D'12**		**D' 4**	**D'8**	**D'12**		**D' 4**	**D'8**	**D'12**
T1	1.66	2.33	4.33	1.66	1.66	3.66	6.33	2.33	1.66	3.00	4.33	1.66	1.66	3.00	4.33	2.33
T2	1.66	4.33	6.33	3.66	2.33	3.00	7.00	3.66	2.33	4.33	7.00	4.33	2.33	3.00	7.00	3.66
T3	2.33	3.66	5.66	3.66	2.33	4.33	6.33	3.66	2.33	4.33	7.00	3.66	2.33	4.33	6.33	3.66
T4	1.66	3.00	5.66	1.66	1.66	4.33	5.66	2.33	1.66	3.00	5.66	1.66	1.66	2.33	5.66	2.33
T5	2.33	3.00	6.33	2.33	2.33	4.33	6.33	2.33	1.66	3.00	7.00	2.33	2.33	3.00	6.33	2.33
T6	2.33	3.66	7.00	4.33	1.66	4.33	8.33	3.66	2.33	4.33	6.33	4.33	2.33	3.66	7.00	4.33
T7	1.00	2.33	3.66	1.00	1.00	4.33	4.33	1.00	1.00	4.33	3.66	1.00	1.00	2.33	3.66	1.00
S.Em±	0.01	0.01	0.02	0.01	0.01	0.02	0.03	0.01	0.01	0.02	0.05	0.018	0.37	0.02	0.05	0.025
C.D at 1%	0.33	0.51	0.80	0.60	0.41	0.74	1.03	0.69	0.46	0.81	1.01	0.47	0.38	0.74	0.92	0.70

due to enzymatic activity during ripening process (F. santoso *et al.*, 2013). The maximum retention of firmness was seen in T2 (1.5% SA) with the mean value of 14.51 Kg/cm^2, followed by T3 with the mean 14.50 Kg/cm^2 and in case of T6 was 14.06 Kg/cm^2. On the contrary the least firmness was noticed in T7 with the mean 12.27 Kg/cm^2. Control fruits lost their firmness soon as after 6th day of storage. Softening of fruits is due to the changes in physical and mechanical properties of the tissue based on changes in the chemical structure of the cell walls polysaccharides and other changes during ripening (Rojas-Grau *et al.*, 2007). And it is biochemical process involving the hydrolysis of polysaccharides by enzymes (O. Yaman *et al.*, 2002).

Microbial Analysis

The microbial counts for each treatments increased

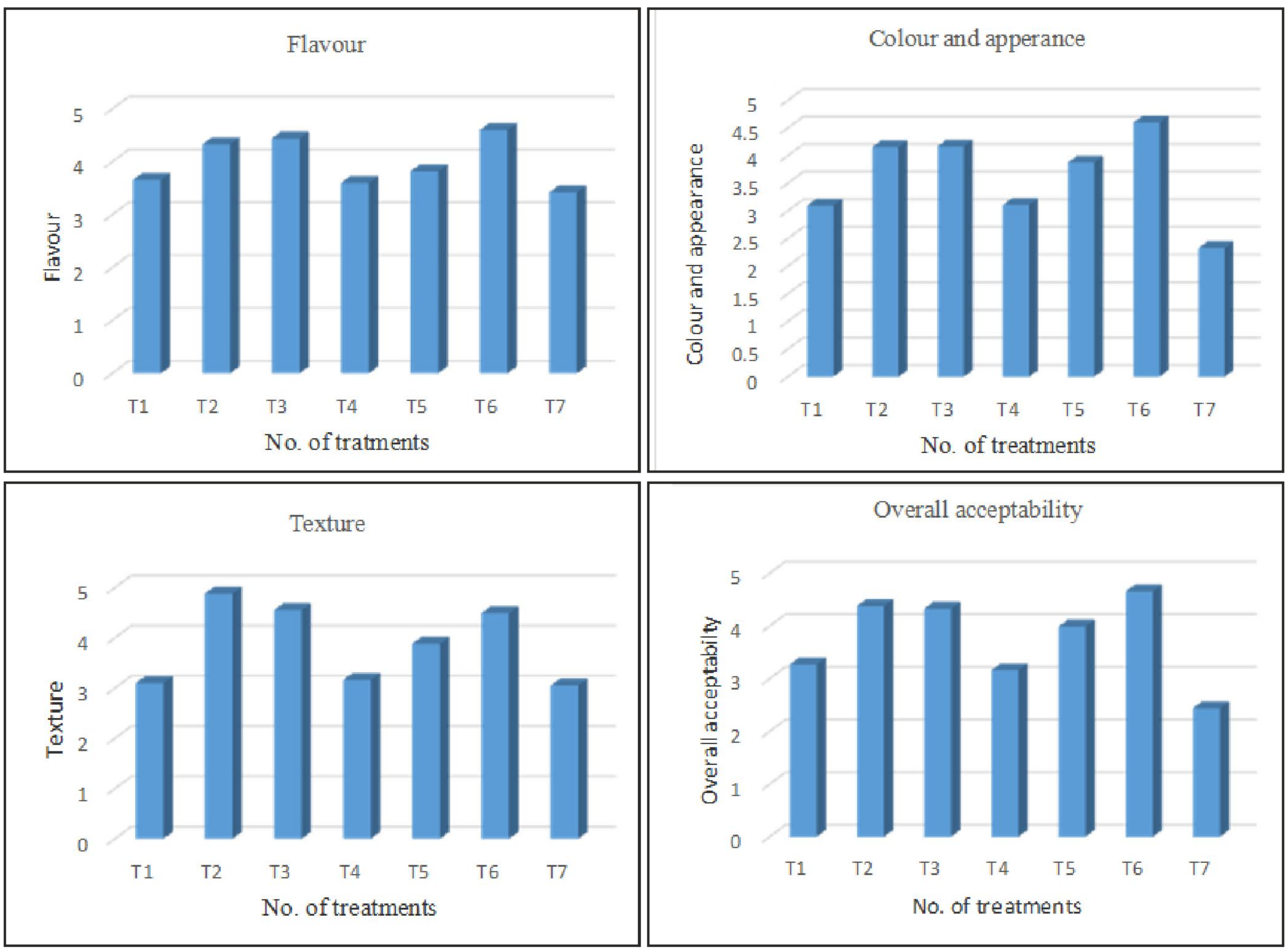

Fig. 6: Effect of post-harvest treatment on colour and appearance, Texture, Flavour, Overall acceptability (sensory evaluation) of tomato cv arka shreshta (22±2°C) during 12 days storage.

as storage tenure progressed but significantly different among treatments as well as days from 1st to 12th day of storage. (Table 2, Fig. 5). The colony farming unites (CFU/ml) in control fruits were significantly higher than the coated samples (Table 2). The less microbial colonies were found in T3 with the mean (5.85×10^7 CFU/ml) followed by T2 (5.82×10^7 CFU/ml). The mean value CFU/ml for control sample was 1.79×10^8. Edible coating act as water, gases and nutrients barrier against microbial entities, which are indispensable for growth and development of microbes. (Zhejiang, R.Y. *et al*., 2003). Also, further protective coating provides an additional barrier to microbial contamination during storage (X. Ruelas-chacon *et al*., 2017).

Sensory Evaluation

Sensory evaluation for coated and uncoated fruits were examined during storage and difference in colour and appearance, flavour, texture and overall acceptability (Table 3, Fig. 6) has been noticed. In the beginning days of storage there were no much significant differences were recorded. Differences were noticed as storage days extended from 4 to 8 days (Table 3). During ripening the chlorophyll pigment is decreased and accumulation of carotenoids, particularly lycopene gives the red colour to ripen tomatoes (Khudairi, 1972). During ripening high CO_2 levels abate the ethylene biosynthesis, which can delay colour changes (Buescher, 1979). Authors envisaged that application of coating had a significant effect on flavour (A. Ali *et al*., 2010). Good results with respect to colour, appearance and flavour were seen in T3 fruits followed by T6, these results collaborate well with fruit softening occurs considerably during ripening mainly as a result of degradation of the middle lamella of the cell wall of cortical parenchyma cells (Perkins, 2010). T2 followed by T3 fruits gave best results in texture and also in overall acceptability. Nadir results were seen in T7 fruits in all parameters.

Conclusions

This research revealed that coating on tomatoes cv. arka shreshta with sodium alginate and guar gum delayed the ripening process by reducing respiration rate of fruits. It also suggests that sodium alginate particularly T2 (1.5%) showed efficient results in case of physiological loss in weight, TSS, titrable acidity, Firmness, microbial analysis compare to other treatments and guar gum treatments except colour and appearance and flavour evaluations at ambient condition (22±2°C).

Sodium alginate is biodegradable, cost efficient and mainly easily applied and used especially by the farmers during long transportation or storage. Also, it is available readily in market. It is remunerative for commercial utilisation to improve storability.

For further studies, Post-harvest treatments at different storage conditions and with packaging materials may be tried in tomato. Large scale trials involving the best treatments of present experiments can be tried to confirm the results. Approaches such as incorporation of antimicrobials, texture enhancers along with edible coatings may improve quality, shelf life and functionality especially in fresh cut fruits.

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