The Pharmaceutical and Chemical Journal, 2017, 4(3):1-9

Available online www.tpcj.org

Research Article

ISSN: 2349-7092
CODEN(USA): PCJHBA

Effect of Various Starches on the Physicochemical and Sensory Characteristics of Tomato Paste

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Abstract This research had been carried out to identify the effect of starches which are one of the most important value added food ingredient used in numerous food industries, on the physicochemical and sensory characteristics of tomato paste. In this study four types of starches including potato starch, rice starch, yam starch, and corn starch with 4% along with preservatives potassium meta bi sulfite(K_2O_5 $S_{2)}$ (0.1) percent and sodium benzoate (0.1) percent were added in tomato paste to determine their effect on physicochemical and sensory attributes of tomato paste. Starch added tomato paste samples were stored at ambient temperature for three months. The samples were analyzed for their Physico-Chemical parameters with an intervals of fifteen days. The total soluble solids (TSS) and percent acidity of stored tomato paste has been increased during storage. Whereas ascorbic acid and pH was decreased. Starches influenced moisture content during the entire storage period. Results of sensory evaluation reveled that sample having potato starch and corn starch remained acceptable even after for three months of storage.

Keywords Starches, TomatoPaste, Physicochemical, Sensory, Preservatives

Introduction

Tomato (*Lycopesicon esculentum*) belongs to family Solanaceae which is widely used in fresh as well as in the preparation of different food products. As tomato presents a vital part of human fast because it contains an important source of antioxidant like carotenes, Lycopene, vitamin C, organic acids and phenolics compounds [1, 2]. Beta carotene and lycopene, using in diet can lower the rate of cardiovascular disease and it inhibits gastrointestinal and epithelial cell cancer [3]. The tomatoes are mainly eaten for its contribution to provide carbohydrate (4.1g), the dry matter content of tomato derivatives contain 65% sugars especially glucose and fructose (EEC 1764/86). Tomato contains a little protein (1.1g) which works as functional protein in tomato fruit. The other nutrients like lipids (.2g), fibers (.5g), ash (.7g) and some minerals, calcium, phosphorous, iron, zinc, iodine with 14mg, 27mg, 0.7mg 0.1 mg and 10ppm respectively [4]. Tomatoes are perishable fruits and it rapidly deteriorates after ripening. They are available in plenty at a particular period of time in specific regions often resulting in market excess. Due to excess during peak season large quantity of tomato gets spoiled almost 30 to 40 percent of tomato lose due to the lack of post `harvesting which includes handling, infrastructure, processing, storage facilities and quick transportation to the market [5]. Tomatoes have a lower shelf life and cannot be stored for longer period of time. This problem can be resolve by making products of tomato. One of the methods to extend shelf life of tomato is to convert into paste. It has been observed that tomato stored at high temperature can damage this product. To compete with this problem food processors make a tomato pulp stored at refrigeration (4^oC - 10^oC) to as low 20^oC [6].

Starches are produced from the plant source which is used as value added food ingredient in different food industries. Wheat, rice and corn from cereals and Potato, cassava or tapioca from the tubers are the good source of starch. Commonly the plants which contain higher amount of food starch are corn, potato, wheat, cassava and rice

out of these plants potato contains highest starch followed by cassava which is one of the most important starchy root crops [7].

Starch may also called biological energy agents which plays a multifunctional role in food products. It enhances the texture, inhibit moisture, it also increases the consistency and stability of the product. It can be used for soft coatings, crisp coatings, smooth or pulpy texture, and to spell out moisture. Emulsion process in food products can also be stabilize by adding starch in that product [8]. Dry starches contain 6 to 16 percent moisture content which depends on methods used to obtain starch. Starch containing 13% water amount is good while those having high level of moisture can escort to microbial growth and minimize starch quality. The maximum moisture content approved for safe storage by most of the starch producing countries is 13% [9, 10]. Dry starches contain Lipids, which are more important component that has a strong effect on the quality of starch. The starch lipid formation or starch surfactants improve the textural properties of various foods. The starch-lipid interaction is particularly important in cereal starches, which port lipids to visible extent [11].

Materials and Methods

Tomatoes free from diseases and better quality were purchased from the vegetable market of Peshawar city and brought to Food science and Technology lab of Agricultural University Peshawar and tomato paste were prepared. Fresh, mature and free from diseases tomatoes were separated for further processing while damaged and immature tomatoes were discarded. Selected tomatoes were cleaned, removed dust, and washed them with tape water to minimize the microbial load. All of the tomatoes were blanched in open stainless steel kettle up to desirable temperature and sieves were used which have 0.32 inch in diameter and then juice was extracted after blanching of tomatoes. The juice was then concentrated to desirable Brix^{o} with the addition of 0.1% salt to get tomato paste.

Treatments

To = Tomato paste.

T1 = tomato paste + potassium metabisulphite (0.1%) sodium benzoate (0.1%) + corn starch (4%).

T2 = tomato paste + potassium metabsulphite (0.1%) sodium benzoate (0.1%) + potato starch (4%).

T3 = tomato paste + potassium metabisulphite (0.1%) sodium benzoate (0.1%) + rice starch (4%).

T4 = tomato paste + potassium metabisulphite (0.1%) + sodium benzoate (0.1%) + yam starch (4%).

Physico-chemical Analysis

Total soluble solids (TSS)

The Brix^{0} is the main technical parameters of tomato concentrates. It represents the degree of concentration of tomato paste. The total soluble solids of tomato paste sample were determined using an instrument (refrectrometer) as prescribed by [12].

Moisture

The moisture of the sample was determined by reported method [12]. Drying the sample in an oven at 105 °C till constant weight is obtained.

Titratable acidity

Titratable acidity was analyzed according to reported method [12].

pH

pH of the sample was measured manually by pH meter.

Ascorbic acid

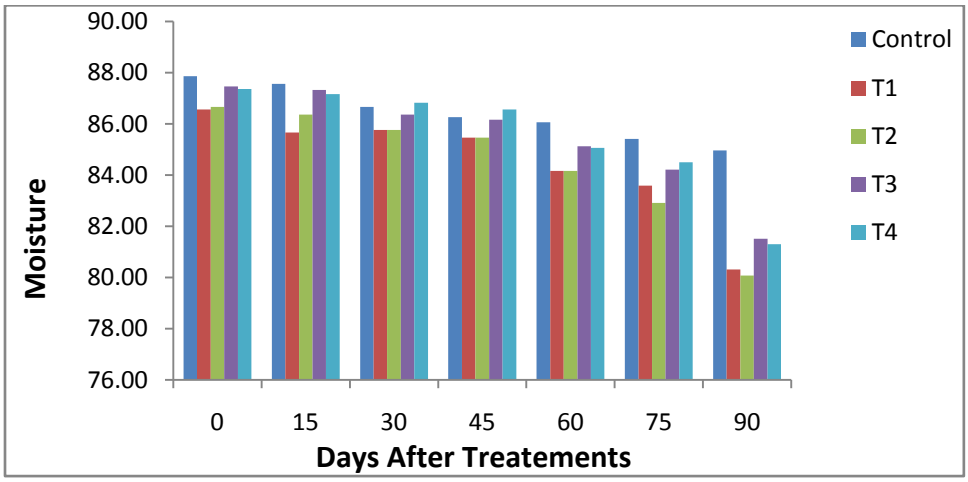
Ascorbic acid was determined by the method as reported in [12].

Sensory evaluation

Hedionic scale was used to carry out the sensory evaluation of tomato paste. Using this scale, color, flavor, texture, and overall acceptability of tomato paste were analyzed. To perform these test ten judges from department were chosen. Questionnaires were prepared and given questionnaires to each of the judge to record their views and observations. The Performa contain marks from 9-1. 9 is for extremely like and 1 for dislike extremely and so on.

Results and Discussion

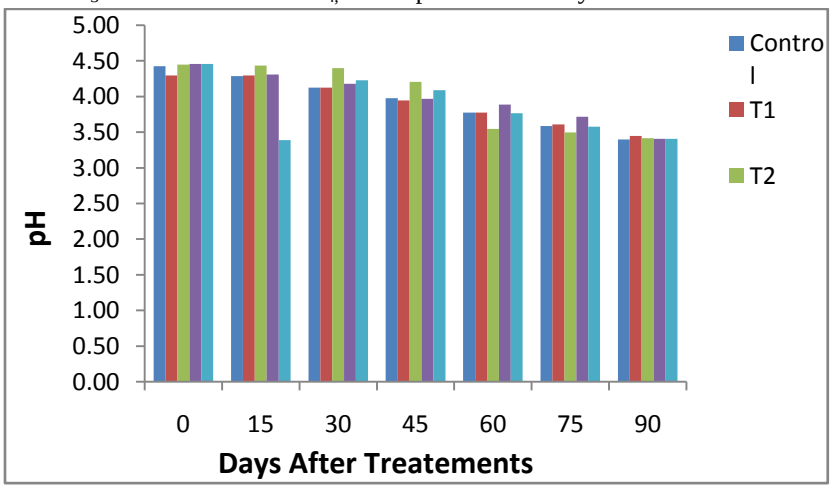
Moisture: The moisture content reduces from initial day till 90 days. In Control to T_4 the moisture content at first day was 87.9%, 86.6%, 86.7%, 87.46%, and 87.4% which gradually decline to 85.00%, 80.31, 80.08, 81.51, and 81.30 over the period of 90 days (Graph.1). The highest moisture percent decrease in T_2 (7.7%) followed by T_1 (7.37%) and lowest was recorded in T_0 (3.29) followed by T_3 (6.82) of four different tomato paste.



Graph 1: Effect of starches and storage time on moisture (%) of tomato paste

The data resemble with the [13], who determined moisture content in tomato paste by means of infrared photothermal radiometry and inverse photopyroelectric technique. From his results it's revealed that the moisture content of tomato paste ranged from 80 to 60%. He clarified more by comparing the valves of water absorbing power of Potato starch granule (10.44g H_2Og^{-1}), tapioca (10.06g H_2Og^{-1}) and corn (7.92g H_2Og^{-1}) starches. Which showed that potato starch granule absorbed high moisture than other starches. The water holding capacity of these starches is different because of their hydroxyl groups which are responsible for making hydrogen bond and covalent bond between starch chains [14]. The other factor which may involve in the variation of water binding capacity, is degree of availability of water binding sites among the starches which make them difference from each other [15]. [16] also reported that cereal starches absorbed less moisture than root starches.

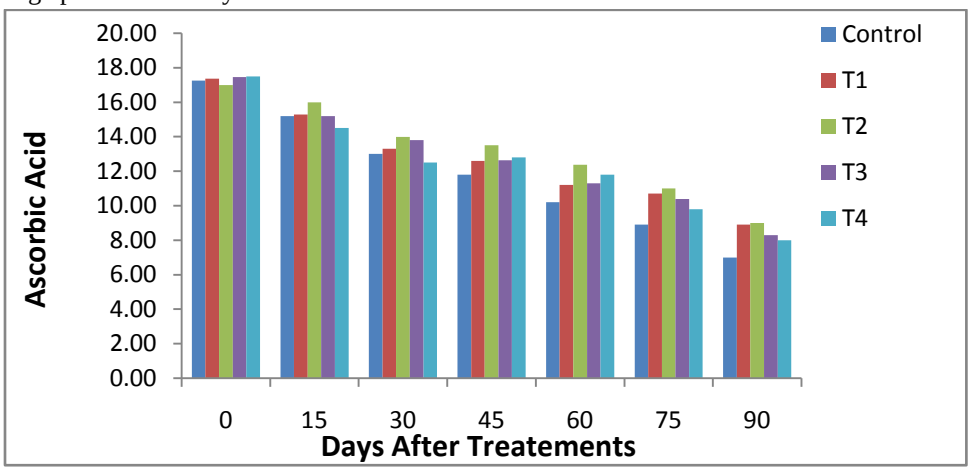
pH: Treatment and storage interval had significant effect on pH. Overall the pH decreased in all tomato paste sample. It was noted that there was impact of biochemical changes during storage. There was decreased in pH at different rates. The pH of tomato paste sample is shown in graph 2. The pH values of all tomato paste sample were in the range of 4.43 to 4.6 at initial day but it gradually decreased from 4.43 to 3.40 in T_0, 4.30 to 3.45 in T_1, 4.45 to 3.42 in T_2, 4.46 to 3.41 in T_3 and 4.46 to 3.41 in T_4, over a period of 90 days.



Graph 2: Effect of starches and storage intervals on pH of tomato paste.

Ascorbic acid

Tomato fruit is good source of vitamin C (round about 140mg/100g). The level of vitamin C in tomato paste sample T_0 to T_4 was 17.26, 17.36, 17.00, 17.46, and 17.50, at the day of preparation which is decreased to7.00, 8.90, 9.00, 8.30, and 8.00, respectively over the periods of ninety days. (Graph: 3).T_0 has highest loss of vitamin C with (59.44%) followed by T4 with (54.28%) and lowest value was decreased in T_2 (47.06%) followed by T_1 (48.73%) during the storage period of 90 days.

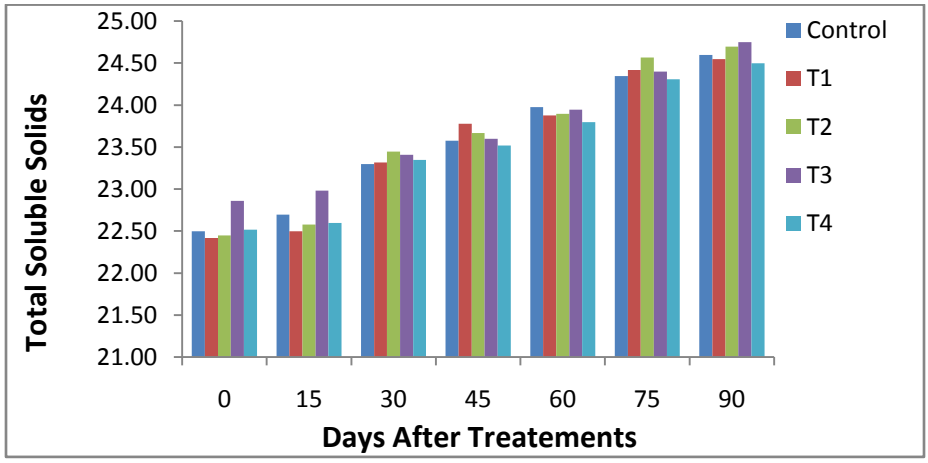


Graph 3: Effect of starches and storage time on ascorbic acid (mg/100g) of tomato paste

According to the results large quantity of vitamin C is lost during the processing and storage. This declining of vitamin C also had been studied by [19] and found the same values in their research work. Heat and oxygen are the main factors behind causing the loss of vitamin C in tomato processing.

TSS

It was observed that Total Soluble Solids of tomato paste treated with different starches increased with storage time. The storage time and treatment significantly effect on TSS of tomato paste. Increasing TSS has been shown in Graph: 4.There was an increase in the TSS of tomato paste with varied rates. The TSS in brix^{o}of all tomato paste at initial day revealed the following results, T_0 (22.50), T_1 (22.42), T_2 (22.45), T_3 (22.53), and 22.53 in T_4 which gradually increased to 24.60, 24.55, 24.70, 24.75 and24.50 respectively in 90 days. Graph: 4.The highest TSS was noticed in T_2 (9.10%) followed by T_3 (8.96%) and lowest increase was recorded in T_4 (8.08%) followed by T_0 (8.53%).



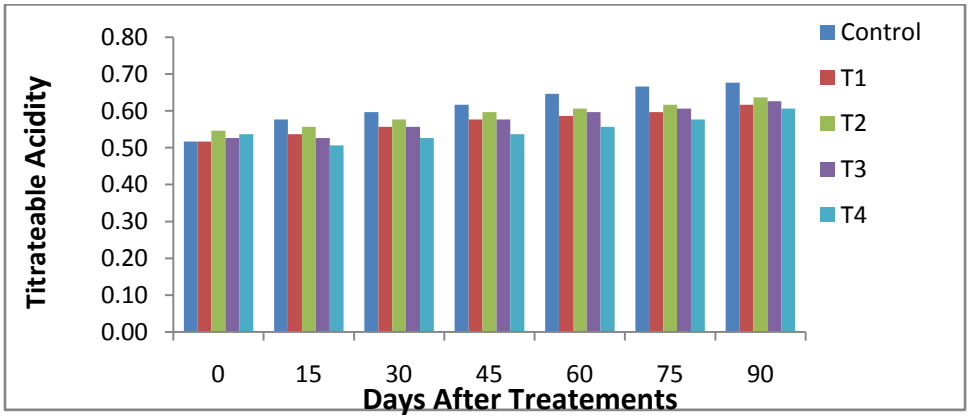
Graph 4: Effect of starches and storage time on total soluble solids (Brix^o) of tomato paste

Similar results were found by [19] which were in the range of 25-26% and he stated that the Brix^0 of the tomato pastes ranged from 22.73 to 30.68%. TSS is increase during storage because of acid hydrolysis of polysacchrides

especially gums and pectins [20]. Total soluble solids (TSS) increased during the storage period of the stored pulp samples [21]. Increase in TSS can be attributed to the conversion of starch to soluble sugars during storage [22].

Titrateable acidity

Titrateable acidity from T_0 to T_4 of different tomato paste sample in storage for ninety days of time showed increased at varied rated. The increased in titrateable acidity is shown in Graph: 5. Titrateable acidity of T_0 to T_4 was 0.52, 0.52, 0.55, 0.53, and 0.54 at the day of preparation which increased to 0.68, 0.62, 0.64, 0.63 and 0.61 respectively. The highest mean value of treatment was 23.52 in T_0follwed by T_1 and lowest mean for treatment was noticed in T_4 followed by T_2. The mean for storage was 0.53 to 0.63. In T_0 23.5% acidity increased which was highest record followed by T_3 (17.4%). The lowest fall was recorded in T_4 (11.4%) followed by T_2 (14.0%).



Graph 5: Effect of starches and storage time on total acidity (%) of tomato paste

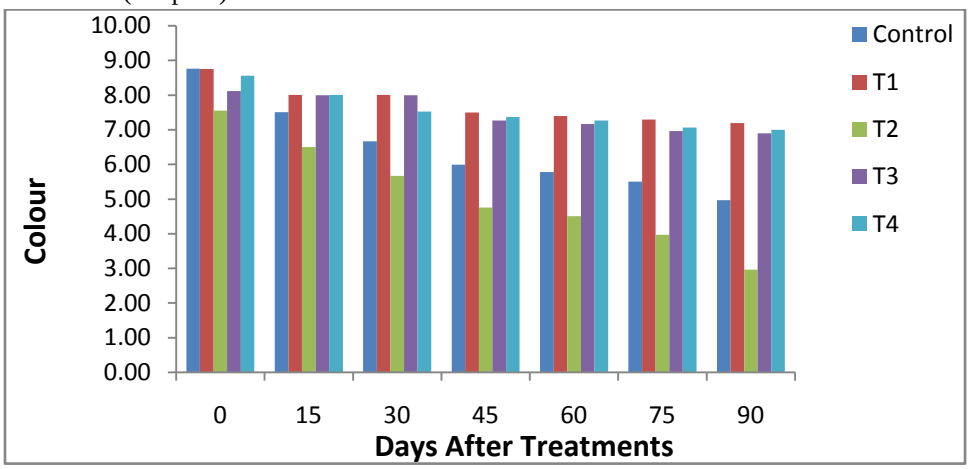
The same results were noticed by [23] who reported a slightly increase in tomato juice. When reducing sugars are pectic acids are formed by the breakdown of peptides bond and cause increasing acidity [24]. The concentration of weakly ionized acids into salts cause acidity enhancement and his happens when polysaccrides broken into uronic acid and pectin[25, 6].

Sensory evaluations

Sensory evaluations of the preserved tomato paste were carried out for color, flavor, texture and overall acceptability.

Color:

The treatment given to sample and storage interval give a significant effect ($p \leq 0.05$) on color of tomato paste. Scores for color of tomato paste slightly decline during storage. The scores given by the judges for the color of T_0 to T_4 was 8.77, 8.76, 7.56, 8.12, and 8.56 on initial day which reduced to 6.48, 7.74, 5.14, 7.50 and 7.55 in 90 days of storage period shown in (Graph:6).

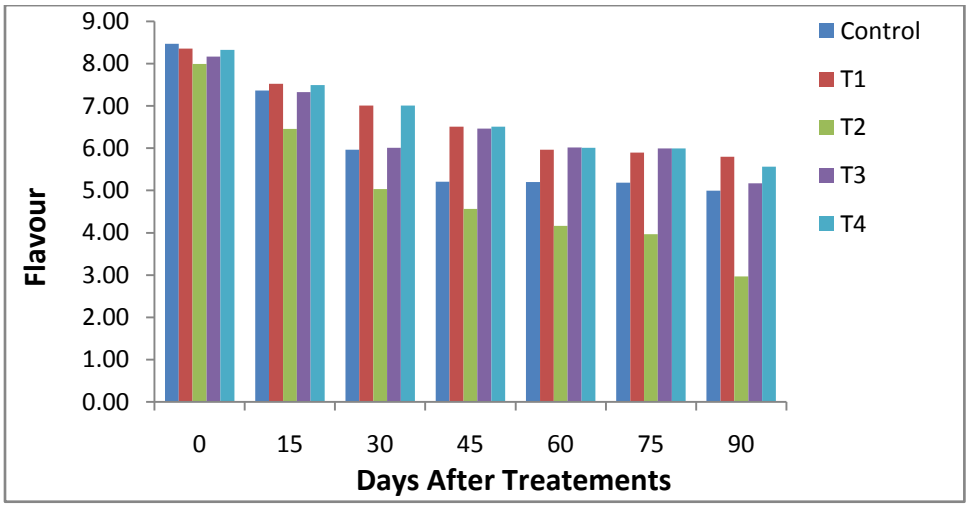


Graph: 6 Effect of starches and storage time on the color of tomato paste

These results are in comparison with consequence of [27] who observed same score for his tomato paste sample on sensory evaluation.

Flavor

Rating for flavor in tomato pastes were decreased during storage as compare to fresh tomato paste prepared at initial day. The scores for T_0 to T_4 at first day were 8.5, 8.36, 8.00, 8.2, and 8.33 which reduced to 5.00, 5.80, 3.0, 5.2, and 5.6 respectively in 90 days of storage period. (Graph: 7).The highest storage mean was recorded in T_1 (6.73) followed by T_4 (6.70) and lowest treatment mean score achieved by T_2 (5.04) followed by T_0 (6.07). The maximum decrease was noticed in TP_2 62.5% followed by T_0 (41.1%) over the period of 90 days.

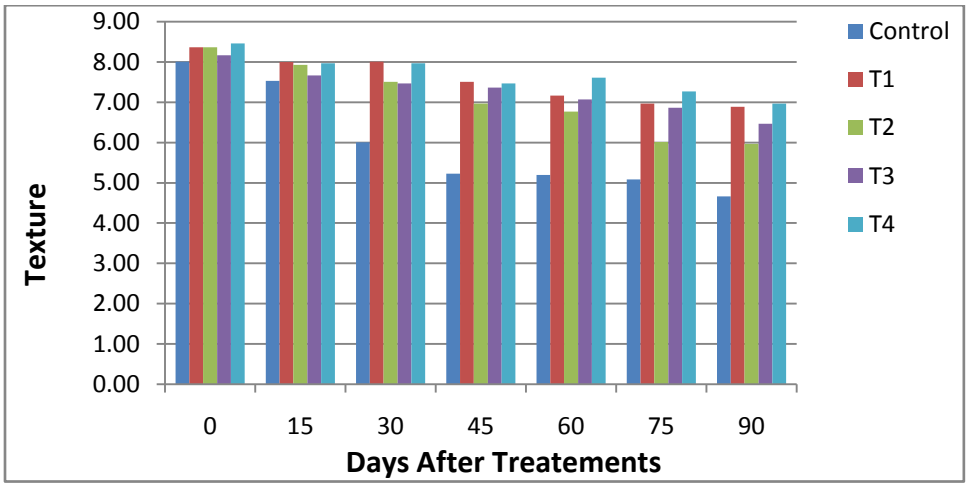


Graph 7: Effect of starches and storage time on the flavor of tomato paste

The statistical analysis showed that the results of the different treatments and storage intervals have highly significant ($p \leq 0.05$) effect on flavor of tomato paste [27]. also found the same score of tomato paste sample stored at room temperature. The Millard reaction is the major factor causing off flavor in fruits and vegetables [28].Changes in flavor and color is the serious problem in industrial management to quality detoriation during storage [29].

Texture

The score for texture of tomato paste given by judges gradually decline during storage. At initial day the scores for all tomato paste sample (T_0 to T_4) were 8.01, 8.4, 8.4, 8.2, and 8.46 which reduced to 5.00, 6.89, 6.00, 6.50, and 7.0 in duration of 90 days (Graph: 8). The maximum decrease was found in controlled sample (37.5%) followed by T_2 (28.57%). The minimum fall has been observed in T_1 (17.9%) followed T_4 (17.25).

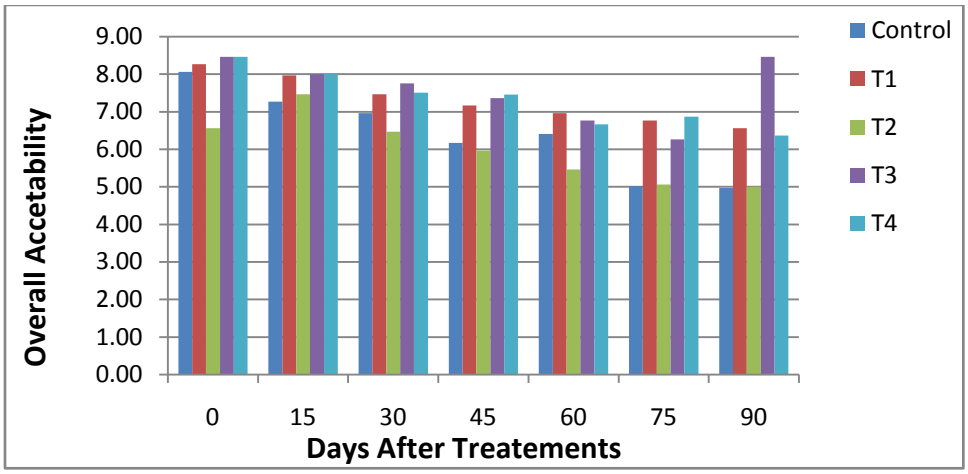


Graph: 8 Effect of different starches and storage time on the texture of tomato paste

The statistical analysis showed that the treatments and storage interval has significant ($p \leq 0.05$) effect on texture of the tomato paste sample over the period of 90 days. This was in agreement with [30], who used tomato powder as thickening agent and analyzed the consistency of tomato ketchup [31]. The viscosity of tomato product depends on fiber, protein and fat content.

Overall acceptability:

Addition of starches with 0.4% concentration had affected the sensory properties. The five different tomato paste samples were preserved by adding 0.4% of starches with 0.2% preservatives KMS (0.1) +S.B (0.1) at ambient temperature and were analyzed for overall acceptability by choosing a panel of judges. This revealed the following results. At the day of preparation the scores of tomato paste samples (T_0 to T_4) were 8.1, 8.3, 8.07, 8.5 and 8.5 which decreased to 5.0, 6.6, 5.01, 6.1, and 6.4 respectively in 90 days of time (Graph: 9). The highest decrease was found in controlled condition (38.2%) while lowest was noticed in T_1 (20.4%).



Graph: 9 Effect of starches and storage time on the overall acceptability of tomato paste

These results were confirmed by [32], who added the different stabilizer to analyzed the quality of tomato paste and found same results. In a similar study [33] observed the tomato paste preserved with KMS and stabilizer either individually or in combination with other preservatives retains maximum overall acceptability, maintains maximum nutrients stability and negligible microbes.

Conclusion

This research work concluded that starch has been modify by means of physical or chemical process because starches really offer incredible number of functional benefits to variety of foods such as stabilizer, thickening agent, and binder in tomato paste. Addition of starches (4%) with preservatives PMS (0.1) and S.B (0.1), plays a vital role in increasing the shelf life of tomato paste with minimum damage to the product.these starches along with preservatives had considerably affected the physico-chemical properties of tomato paste samples with an increase in titratable acidity to decrease in PH, decrease in ascorbic acid, and decrease in moisture content with enhancement in (TSS^{O}) during the storage for three months time. Addition of starches gives a remarkable effect on the sensory attributes of tomato paste.

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