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Evaluation of Suitability of Tomato Solids as a Preservative in Flavoured Paneer

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: In this study paneer was prepared incorporating tomato solids in the form of tomato puree in paneer. As a result, antibacterial, antiviral, and antioxidant actions are anticipated. Therefore, this investigation was done to compare the shelf life of the tomato flavoured paneer with control. The present study was conducted to compare the shelf life of tomato flavoured paneer (TFP) and control paneer (CP) i.e. prepared without addition of tomato solids.
Study Design: TFP was prepared incorporating tomato puree @10% w/w of milk from standardized milk. CP was prepared without incorporation of tomato puree. Two factorial Completely Randomized Design model was used to compare both product during storage. The data presented in table is a mean ± SD of 3 replicate experiments.
Place and Duration of Study: Dairy Technology Department, SMC College of Dairy Science, Kamdhenu University, Anand, Gujarat, India, between July 2022 and July 2023.

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Methodology: Control paneer (CP) was prepared from standardized milk (4.5% fat/8.5% MSNF). TFP and CP were packed in laminated pouches and stored at 7±1°C. The sensory attributes, acidity, free fatty acid, tyrosine content, peroxide value, aerobic plate count, yeast and mold count and coliform count of stored samples were monitored at an interval of every 3rd day.
Results: Throughout the storage period there was a greater increase in free fatty acid and tyrosine value of TFP compared to CP while peroxide value of TFP remained lesser than CP. There was a significant ($P<0.05$) increase in APC while coliform, yeast and mold count was found to be absent throughout the storage period. TFP had lower initial sensory scores compared to CP, however it retained all flavour, body and texture, colour and appearance and overall acceptability score better throughout storage in comparison to CP.
Conclusion: The shelf-life of TFP and CP was 15 d when stored at 7±1°C in 12 µ polyester + 50 µ LD/LLDPE laminated pouches.

Keywords: Flavoured paneer; shelf life; tomato.

ABBREVIATIONS

TFP : Tomato Flavoured Paneer
CP : Control Paneer
DPPH : α, α-diphenyl-β-picrylhydrazyl

1. INTRODUCTION

Studies on shelf-life can give manufacturers and customers crucial information to guarantee a high-quality product during the storage term. Both manufacturers and consumers have historically valued food's shelf life as a key component. The shelf life of a food product is described by the Institute of Food Science and Technology as "the period of time during which the food product will remain safe; be certain to retain its desired sensory, chemical, physical, microbiological, and functional characteristics; and, where appropriate, comply with any label declaration of nutrition data, when stored under the recommended conditions." Safety comes first when determining a food's shelf life, then quality, which includes physical, chemical, and sensory characteristics.

Paneer has a short shelf life and starts to lose its freshness after two to three days when kept in the refrigerator since it is a high moisture product that contains between 52 and 55 % moisture. According to reports, tomato solids are a good source of sugars, minerals, organic acids, dietary fibres, and phenolics, which have a variety of health benefits, including anti-inflammatory, anti-cancer, anti-bacterial, and antiviral properties [1]. Thus, tomato solids can be used to enhance the shelf life of paneer in terms of microbial quality and freshness. Some researchers have used tomato solids in various forms in attempt to enhance the nutritional quality and shelf life of various dairy products.

Nassarawa et al. [2] reviewed various ways the principles of hurdle technology such as combination of controlled atmosphere storage (cas), passive and active modified atmosphere packaging (map), cold storage, waxing, and chlorine treatment can be applied in the preservation of the freshness and quality of tomato as a case study with a view to extend its shelf life and preserve the freshness and quality of the tomato. Rai and Singh [3] utilized whey for preparation of a nutritious delicious soup blending it with equal amount of tomato juice.

Solhi et al. [4], formulated a processed cheese containing various quantity of tomato powder. During the 90 days of storage, the rheological, chemical, and sensory properties of every sample of processed cheese containing varying amounts of tomato powder (0 %, 1 %, 2 %, and 4 % w/w) were assessed. There was a progressive increase in lycopene content and antioxidant activity (% inhibition by DPPH) of cheese samples with increase in level of addition of tomato powder. The processed cheese containing tomato powder had higher proteolysis and lower lipolysis and pH compared the control sample. Generally, proteolysis, lipolysis and pH of the processed cheese does not increase during the storage. Sensory analysis showed that the maximum scores of flavours, colour and total acceptance belonged to the processed cheese containing tomato powder at the rate of 2 % w/w. Incorporation of tomato powder decreased the rigidity and increased the spreadability of the processed cheese progressively which are positive attributes for the processed cheese.

In one study, dried tomato flavoured probiotic cream cheese containing Lactobacillus paracasei was developed [5]. Probiotic microorganism L. paracasei (LYO 50 DCU, Danisco) was added at

the rate of 2 % of skim milk. Dried tomato powder (Variety Speciale Limeira) at the rate of 18.4 % w/w of curd were added and thoroughly mixed. The resultant product was stored for 21 days at 4º C and analyzed for sensory, chemical and microbial characteristics. Both sample with dried tomato and control had initial probiotic population greater than 108 CFU/g. However, cheese supplemented with dried tomato can only be characterized as potentially probiotic as it retained probiotic count of 107 CFU/g throughout entire storage period. The probiotic cream cheese supplemented with dried tomato retained 107 CFU/g probiotic throughout the 21 days storage period without affecting its acceptability. Upon consumer survey it was found that it had very good acceptance, 82.6 % consumer that if available in market, they will certainly buy this product. In this study tomato flavoured paneer was prepared incorporating tomato puree @ 10 % w/w of milk. As a result, antibacterial, antiviral, and antioxidant actions are anticipated. Therefore, this investigation was done to compare the shelf life of TFP to control.

2. MATERIALS AND METHODS

2.1 Raw Materials

Fresh, raw mixed (cow and buffalo) whole milk, was procured from Anubhav Dairy, Anand. Citric acid, and calcium chloride of Loba-Chemical Pvt. Ltd. were used. Tomato variety Avinash was used in this study.

2.2 Process of Manufacture of TFP

Milk that had been standardized to 3.7 % fat and 8.5 % MSNF were taken. The milk was heated to 90°C for 5 min. Afterward, it was cooled to 80°C. At this point, processed tomato puree (@ 10 % w/w of milk) heated to 80°C was added, and it was swirled for one minute. Tomato puree was prepared according to the process outlined by IIFPT training manual, FME [6]. The composition of puree was: total solids: 12.19%; protein: 1.61%; total lipid: 0.97%; ash: 0.713%; carbohydrates: 8.83% and total dietary fiber: 2.3 % respectively.

Citric acid (1.0 % solution heated at 78 °C) was used to coagulate the milk at 78°C. The milk was slowly stirred after the coagulant was applied to separate the clear whey from the curd. Whey had a pH of between 5.4 and 5.6 at this point. After allowing the coagulum to rest for five min., the whey was drained through a sterile, clean cotton cloth. We took precautions to keep the whey' temperature above 70 ºC. Following collection, the curd was moved to a rectangular, sterile, stainless-steel hoop (15x10x9 cm^3) that was lined with a fresh, sterile muslin cloth. 2 to 3 kg/cm^2 of pressure was applied to the coagulum for 15 to 20 min. The paneer block that had been compressed was taken out of the hoop and submerged in pasteurized chilled water (3 to 5 ºC) for two h. The paneer blocks were taken out of the cold water and placed on a clean stainless-steel dish to let the water drain for ten min. The chilled block of paneer was packed in 12 μ polyester + 50 μ LD/LLDPE laminated pouches and storage related changes occurring at refrigeration temperature (7±1°C). Every third day of storage at refrigeration temperature (7±1°C) stored samples of paneer were examined for chemical changes, sensory changes, and microbial quality. The average composition of Tomato flavoured paneer and control paneer is presented in Table 1.

2.3 Chemical Analysis

Fat content of milk was estimated by Gerber's method FSSAI [7]. The total solids of milk were determined Steiger and Martens [8]. The titratable acidity of milk was determined by the method described by the FSSAI [7]. Moisture content in paneer was determined by according to FSSAI [7]. The fat content of paneer samples was determined by the Mojonnier method as described in FSSAI [7]. Protein content in paneer was determined by Kjeldahl method as per AOAC (1980), using Kjel-plus digestion system (Model-KPS 006L) and Kjel-plus semi-automatic distillation system (Model-Distil M) of M/s. Pelican Instruments, Chennai. For analysis of Vitamin-C the procedure reported by Osborne and Voogt [9] was followed. Total Dietary Fiber (TDF) was estimated by method reported by Madhu et al. [10]. DPPH radical scavenging activity of paneer samples was determined by the method described by Mc Cune and Johns [11]. Titratable acidity was determined by the procedure as described by IS (1981). Free fatty acids (FFAs) of paneer samples were determined by the method described by Koniecko [12]. Tyrosine value of paneer samples were estimated by the method as described by Lowry et al. [13] with some modification. The peroxide value of paneer samples was determined by the method as described in FSSAI manual on analysis of milk and milk products [7].

Table 1. Proximate composition of tomato flavoured paneer and control paneer

Parameter	Tomato flavoured paneer	Control paneer
Moisture (%)	57.04	51.68
Milk Fat (%)	18.25	24.65
Milk Fat (% on dry matter basis)	42.48	51.04
Protein (%)	18.51	18.88
Titratable acidity (% lactic acid)	0.54	0.46
Vitamin C (mg / 100g)	4.00	0.05
Total Dietary Fiber (%)	0.92	0.03
Antioxidant capacity as % DPPH inhibition	58.07	12.58
Antioxidant capacity as Trolox equivalent (µM/g)	41.17	11.35

2.4 Sensory Evaluation

The paneer samples (~25 g rectangular pieces) were tempered to 10±2°C before judging. In a sensory evaluation laboratory of the Dairy Technology Department, sensory analysis was performed. The sensory panel (n=10) was composed of staff members and post graduate students working in the institution. The flavour, body and texture, colour and appearance and overall acceptability scores were evaluated using the 9-point hedonic scale. When a product's overall acceptability score was less than 7, it was rejected.

3. RESULTS AND DISCUSSION

3.1 Changes in Chemical Parameters

3.1.1 Changes in titratable acidity

As seen in Table 2, the treatments applied to the samples had statistically no significant (P>0.05) impact on how acidic they were. Opposite to this, storage time had a significant ($P<0.05$) impact on variations in titratable acidity values for both samples. Additionally, a treatment's interaction effect with the storage period revealed a significant ($P<0.05$) effect. The titratable acidity of control paneer significantly increased during storage. The rise in titratable acidity was gradual in TFP. The titratable acidity of TFP was found to be somewhat lower than that of control over the course of storage. This behaviour can result from the TFP's addition of tomato solids. Because tomatoes contain some antibiotic chemicals, microbial growth was stopped and TFP's titratable acidity increased to lesser extent. The findings are consistent with the Gediya [14], who also noted that after 16 days of refrigeration, the titratable acidity of experimental paneer containing amla solids increased significantly (P<0.05) from 0.765 % LA to 0.973 % LA. The use of Amla juice in the manufacturing of paneer could be the reason for the increase in early titratable acidity. Similar trends were observed by Mehanna et al. [15] in case of processed cheese made by incorporating tomato juice. Control had highest pH than other treatments and pH gradually decreased by addition of different ratios of tomato juice. In another study, Yashvantha et al. [16] observed similar trend in titratable acidity values during storage study of lemon flavoured paneer made using lemon rind solids. Titratable acidity of the control sample increased from 0.457% LA on the 0^{th} day to 0.693 % LA on the 16^{th} d. In the case of TFP, titratable acidity increased from 0.550 % LA on 0^{th} day to 0.712% LA on 16^{th} d. Both treatments given to the samples and storage period showed a significant (P<0.05) effect on the titratable acidity of the samples.

3.1.2 Changes in free fatty acids content

The samples' free fatty acid content was not significantly affected by applied treatment differences (P>0.05) (Table 2). However, the FFAs values of both TFP and control were significantly affected by the storage duration ($P<0.05$). Similarly, the interaction between treatment and storage period also had a significant ($P<0.05$) impact on changes in FFAs values for both samples. The observed trend is consistent with the findings of Solhi et al. [4]. The FFAs level of processed cheese containing tomato solids did not increase significantly ($P<0.05$) during initial half of storage, however there was a significant increase at the end of storage period. According to Solhi et al. [4] the FFAs level of processed cheese containing tomato solids were significantly lower compared to control cheese throughout entire storage period. The FFAs levels decreased progressively upon increase in tomato solid levels from 1 to 4 %. Similarly, in another study the FFAs level of lemongrass paneer increased after storage

under refrigeration, going from a starting value of 0.035 % oleic acid to 0.28 % oleic acid at the end of the 23rd day of storage, according to Joseph [17]. As a result, the findings of this study indicate that FFAs content increased similarly during the period of refrigeration. However, no studies on the variations in FFAs (% oleic acid) of TFP produced by adding tomato solids during storage for comparison have been documented in the literature.

3.1.3 Changes in tyrosine content

According to statistics shown in Table 2, the variations in the tyrosine value of both samples were significantly (*P<0.05*) influenced by treatment, storage period and interaction effect between treatments and storage period. For both samples, a rise in tyrosine value was seen. Tyrosine levels have increased, which suggests that all of the samples have undergone proteolysis as a result of the expansion of microorganisms that produce proteases. At the end of the storage period, it was found that the tyrosine value in the case of TFP was higher than that of the control sample. This demonstrated that the TFP sample underwent more proteolysis than the control sample. This might be because tomato solids contain proteolytic enzymes. The observed trend is parallel with the trend observed by Solhi et al. [4]. The tyrosine level of processed cheese containing tomato solids increase significantly (*P<0.05*) during entirety of storage period. According to Solhi et al. [4] the tyrosine level of processed cheese containing tomato solids were significantly higher than that of control cheese without tomato solids throughout entire storage period. The tyrosine levels increased progressively upon increase in tomato solid levels from 1 to 4 %. According to Joseph [17], the tyrosine content of paneer with a lemongrass flavour increased from 3.64 mg/100g at the beginning of storage to 23.38 mg/100g at the conclusion of the 23rd day. As a result, the findings of this investigation demonstrate a similar upward trend in tyrosine value over the course of the chilled storage period.

3.1.4 Changes in peroxide value

According to statistics given in Table 2, the variations in the peroxide value of both samples were significantly influenced by treatment, storage period, and the interaction effect between treatments and storage period (*P<0.05*). At the end of the storage period, it was found that the peroxide value in the case of TFP was lower than that of the control sample. This demonstrated that TFP underwent less oxidation than the control sample. This may be because tomato solids contain lycopene, a possible antioxidant. Similar trend was observed by Singh and Immanuel [18] in case of mixed milk paneer made incorporating turmeric powder. The peroxide values increased gradually during the storage in case of control sample while the rate of change in peroxide is non-significant (*P>0.05*) in case of samples containing turmeric.

3.2 Changes in Microbial Counts

As seen in Table 3, treatment (T) and storage period (P) had a significant (*P<0.05*) impact on aerobic plate count (APC). However, the APC of paneer was not significantly affected by the interaction between treatment (T) and storage period (P) across the storage duration (*P*>0.05). Over the storage period, the APC count of the TFP was lower than that of the control paneer. This may be due to the antibacterial and antiviral characteristics of tomato solids. Sugars, minerals, organic acids, dietary fibres, and phenolics are all found in tomato solids and provide a variety of health benefits, including antioxidant, antimutagenic, antibacterial, and antiviral properties (Adams et al., 2006). Joseph [17] found that both control and experimental sample's APC gradually increased during the storage period. Fresh control sample APC was 0.06 ± 0.11 log cfu/g and rose to 98.93 ± 0.9 log cfu/g on day 18. Further storage resulted in slime production, and samples with lemongrass added to them developed a slimy coating on day 23 of storage. Same trends were observed by Yashvantha et al. [19] in a study conducted to assess the efficacy of lemon rind as preservative. APC count of control and experimental samples increased significantly (*P*<0.05) with increase the storage period. Fresh control paneer sample had APC count of 3.80 $\log_{10}$ cfu/g which increased significantly (*P*<0.05) to 5.12 $\log_{10}$ cfu/g after 12 d, 5.35 $\log_{10}$ cfu/g after 16 d under refrigeration storage. Fresh lemon flavoured paneer had APC count 3.71 $\log_{10}$ cfu/g which increased significantly (*P*<0.05) to 5.13 $\log_{10}$ cfu/g after 16 d under refrigeration storage. However, no studies on the variations in Aerobic Plate Count (APC) of TFP made by adding Tomato Solids during storage for comparison have been published in the literature. All samples of paneer were determined to be free of yeast and mold during the storage period. All samples of paneer were determined to be free of coliform during the storage period.

Table 2. Changes in chemical parameters of TFP and CP during storage at 7±1º C

Type of paneer (T)	Storage period in days (P)						Average for Treatment(T)
	0	3	6	9	12	15	
				Titratable acidity (% LA)			
CP	0.453 ± 0.010	0.520± 0.013	0.576±0.009	0.653±0.027	0.702±0.070	0.733±0.080	0.607
TFP	0.541±0.016	0.564±0.007	0.594±0.03	0.624±0.01	0.657±0.009	0.711±0.070	0.615
Average for Period(P)	0.497	0.542	0.585	0.639	0.680	0.722	
CD (0.05): T=NS, P=0.018, T×P=0.026							
				FFAs content (% oleic acid)			
CP	0.16±0	0.16±0	0.16±0	0.21±0.04	0.29±0.04	0.32±0.07	0.22
TFP	0.24±0	0.24±0	0.24±0	0.27±0.04	0.29±0.04	0.35±0.04	0.27
Average for Period(P)	0.2	0.2	0.2	0.24	0.29	0.33	
CD (0.05): T=0.026, P=0.045, T×P=NS							
				Tyrosine content (mg/100g)			
CP	10.25±1.21	11.07±0.51	12.27±0.67	16.25±1.60	28.25±0.11	35.11±0.40	28.19
TFP	11.13±0.49	12.27±0.53	14.05±1.13	32.01±1.90	46.41±1.78	53.27±0.46	18.87
Average for Period(P)	10.69	11.67	13.16	24.13	37.33	44.19	
CD (0.05): T=0.90, P=1.57, T×P=2.22							
				Peroxide value (milliequivalent O_2/kg)			
CP	0.08±0.00	0.08±0.00	0.08±0.00	0.08±0.00	0.13±0.02	0.15±0.02	0.1
TFP	0.08±0.00	0.09±0.00	0.09±0.00	0.09±0.00	0.09±0.02	0.11±0.02	0.087
Average for Period(P)	0.08	0.08	0.08	0.08	0.11	0.13	
CD (0.05): T=0.009, P=0.016, T×P=0.023							

Each observation is a mean ± SD of 3 replicate experiments; T=Type of paneer; P=Storage Period

[a-b] Different superscript letters following numbers in the same column denote significant difference (P<0.05)

Table 3. Changes in Aerobic Plate Count (log_{10} cfu/g) of TFP and CP during storage at 7±1ºC

Type of paneer (T)	Storage period in days (P)						Average for Treatment(T)
	0	3	6	9	12	15	
CP	3.86±0.07	4.15±0.07	4.46±0.04	4.75±0.04	4.99±0.07	5.26 ± 0.07	4.58
TFP	3.82±0.03	4.06±0.03	4.30±0.03	4.62±0.02	4.116±0.01	5.15 ± 0.02	4.47
Average for Period(P)	3.84	4.10	4.34	4.69	4.93	5.20	
CD (0.05): T=0.041, P=0.072, T×P=NS							

Each observation is a mean ± SD of 3 replicate experiments; T=Type of paneer; P=Storage Period

Table 4. Changes in sensory score (9 point hedonic) of TFP and CP during storage at 7±1ºC

Type of paneer (T)	Storage period in days (P)						Average for Treatment(T)
	0	3	6	9	12	15	
				Flavour score			
CP	8.42±0.12	8.42 ±0.12	8.08 ±0.12	7.67 ±0.236	7.17 ±0.236	6.67±0.225	7.736
TFP	8.33 ±0.12	8.25 ±0.204	8.08 ±0.12	8.00±0.12	7.50±0. 118	7.00±0. 117	7..861
Average for Period(P)	8.37	8.33	8.08	7.83	7.83	6.83	
CD (0.05): T=NS, P=0.22, T×P=NS							
				Body and texture score			
CP	8.41±0.12	8.41±0.12	8.41±0.12	8.08±0.12	8±0	7.33±0.24	8.11
TFP	8.08±0.12	8.08±0.12	8.08±0.12	8.00±0.01	7.66±0.33	7.26±0.24	7.85
Average for Period(P)	8.25	8.25	8.25	8.042	7.83	7.25	
CD (0.05): T=0.1, P=0.17, T×P=NS							
				Colour and Appearance score			
CP	8.83±0.23	8.83±0.23	8.33±0.23	8.33±0.23	8.0±0.0	8.0±0.12	8.39
TFP	8.66±0.23	8.66±0.23	8.16±0.23	8.16±0.23	8.00±0.02	8.00±0.01	8.28
Average for Period(P)	8.75	8.75	8.25	8.25	8.00	8.00	
CD (0.05): T=0.90, P=1.57, T×P=2.22							
				Overall acceptability score			
CP	8.50±0.00	8.50±0.02	8.16±0.12	8.08±0.12	8.00±0.236	7.16±0.23	8.07
TFP	8.41±0.02	8.41±0.02	8.25±0.12	8.08±0.12	7.66±0.00	7.33 ±0.23	8.03
Average for Period(P)	8.46	8.46	8.20	8.08	7.83	7.25	
CD (0.05): T=NS, P=0.22, T×P=NS							

Each observation is a mean ± SD of 3 replicate experiments; T=Type of paneer; P=Storage period

3.3 Effect of Storage Period on Sensory Characteristics

3.3.1 Changes in flavour score

As seen in Table 4, the type of paneer and the length of storage had a significant (*P<0.05*) impact on the paneer flavour ratings. The interaction between paneer type (T) and storage period (P) was statistically non-significant (*P>0.05*). Comparative to TFP, the control flavour score exhibited a sharp decline. The tomato solids in TFP may have contributed to the higher flavour rating since they could have masked the emergence of off flavours in the sample. The results were in accordance with results observed by Yashvantha te al. [19] during storage study of lemon flavoured paneer made using lemon rind solids. The experimental samples containing lemon rind solids had lower flavour score compared to control samples. However, at the end of storage the lemon flavoured paneer retained better score than control sample. According to Joseph [17], the flavour rating of lemongrass paneer dropped from 8.23 on day one to 6.47 on day 23 of storage. The trend discovered in the present study is consistent with tendencies found in the literature. However, no studies on the variations in flavour score of TFP made by adding tomato puree during storage for comparison have been documented in the literature.

3.3.2 Changes in body & texture score

The statistical analysis revealed a significant (*P<0.05*) relationship between the storage time (P) and the body and texture scores of the control and TFP. However, the statistical analysis also revealed a non-significant (*P>0.05*) difference between body and texture scores of the control and TFP. The treatment applied to samples and the interaction between treatment and storage period had a non-significant (*P*>0.05) effect on the body and texture score of both control and TFP. Control sample only showed a significant decrease in body and texture score on 9th day while TFP retained the score up to 9th day and greatly decreased on 12th day only. The samples tended to become drier but with a more brittle body as storage time went on. Both the control and the sample began to exhibit visible whey syneresis after the 15th day. A slimy coating formed on the upper surface of the control at day 18. In the case of TFP, no slimy layer was seen; instead, the top surface hardened and became mealy, which may have been caused by the loss of surface moisture. Thus, after the sixth withdrawal, both samples were rejected. This shows that both the control and the sample were able to keep their body and texture through the 15th day. The results were in accordance with results observed by Yashvantha et al.[19] during storage study of lemon flavoured paneer made using lemon rind solids. The CP and TFP had an initial body and texture scores of 32.57 and 32.45 respectively. The body & texture score of CP and TFP paneer during storage tend to decrease significantly (*P<0.05*) with the increase in storage period. But at the end of storage period (16th day) there was no significant (*P*>0.05) difference in the body and texture score of control and TFP.

3.3.3 Changes in colour and appearance score

The colour and appearance scores of both samples were not significantly (*P>0.05*) affected by the both treatment (T) and interaction between period and treatment (T x P) for each sample. In comparison to TFP, the score for the control sample had an early fall i.e., at the conclusion of the 9th day of storage. This can be a result of the control paneer's surface slime development. After the storage time, TFP and the control both had the at par score. The control sample started to take on a more intense yellow hue as the storage period went on. The TFP, on the other hand, kept its initial brick red coloration, which might have affected the sensory panel's judgement when awarding points for both samples. Additionally, both samples displayed surface mould growth on 18th day of storage thus at the sixth withdrawal, they rejected samples. The results were in accordance with trend in colour and appearance observed by Yashvanthaet al. [16] during storage study of lemon flavoured paneer made using lemon rind solids. The fresh experimental samples containing lemon rind solids had colour and appearance score at par with control samples without lemon rind solids. However, at the end of storage, on 16th day, the lemon flavoured paneer retained significantly better score (*P*<0.05) than control sample.

3.3.4 Changes in overall acceptability

As shown in Table 4 the general acceptability of control and TFP was significantly (*P<0.05*) impacted by the storage duration. However, the treatment used on each sample had a non-significant (P>0.05) impact on overall acceptability of paneer. Similar trends in overall acceptability score of observed by Yashvantha et

al. [16] during storage study of lemon flavoured paneer made using lemon rind solids. The fresh experimental samples containing lemon rind solids had overall acceptability score at par with control samples made without lemon rind. However, at the end of storage, on 16th day, the lemon flavoured paneer retained significantly higher score (P<0.05) than control sample. The CP initially had a marginally higher overall acceptability score than the TFP. However, after storage, TFP continued to be more generally acceptable than the control. This could be as a result of the TFP's late development of staleness and slime formation on the surface as well as its resistance to colour change. The antioxidant and antibacterial properties of tomato solids are responsible for this. Similar findings were reported by Gediya [14], who noted that paneer made using amla juice as a coagulant could be stored for up to 16 days at a cold temperature when packaged in Met-Polyester/Polyfilm pouches (85 µm). Suthar [20] also noted that paneer in vacuum packaging may be kept chilled (1-2°C) for up to 15 days in a polythene bag (80 µm). However, Joseph [17] also noted that lemongrass-flavored paneer packaged in LDPE pouches had a 23-day shelf life at 7±2 ºC. However, there is no published research on shelf-life study of TFP.

4. CONCLUSION

The aggregate sensory scores show that both the control paneer and the TFP had a 15-day shelf life at refrigeration temperature. The product has a shelf life of 15 days when stored at 7±1°C in 12 µm polyester + 50 µm LD/LLDPE laminated pouches, as similar to 15 days for control paneer (CP) made from standardised milk, according to the findings of this study. Additionally, it complied with FSSAI's microbiological criteria. The FSSAI stipulates that the yeast and mould count microbiological criterion that distinguishes between marginally acceptable quality and unacceptable quality should not be higher than 150/g. Up until the 15th day of storage, paneer samples complied with these criteria.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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