



Optimizing Method for Manufacture of Tomato Flavoured Paneer using Response Surface Methodology

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ABSTRACT

Background: The Indian soft cheese variant known as paneer is a highly healthful and nutritious dairy product that serves as the foundation for a wide range of culinary specialties. One of the main factors reducing the likability of paneer by consumers is its bland flavour. By including natural compounds from herbs, spices and grasses while making paneer, this might be avoided. In light of these factors, various researchers have developed new types and varieties of paneer.

Methods: This investigation was planned and conducted to optimize the % fat in milk (ranging from 3 to 4.5%), level of tomato puree (5 to 10%) and coagulation temperature (70 to 80°C) for manufacture of tomato flavoured paneer (TFP) using response surface methodology. The sensory attributes of paneer viz., flavour, body and texture, colour and appearance and overall acceptability, were used as responses.

Result: The optimized process consisted of use of milk standardized to 3.7 per cent milk fat, addition of 10 per cent tomato puree (w/w of milk) and using a coagulation temperature of 78°C. The experimental tomato flavoured paneer (TFP) was prepared as per the suggestions from response surface methodology (RSM) and compared with control paneer (CP) prepared from standardized milk containing 4.5% milk fat and 8.5% MSNF. The fat, Fat in dry matter (FDM) and ash content of TFP were significantly ($P < 0.05$) lower than that of CP, whereas moisture, carbohydrate, titratable acidity, vitamin-C, total dietary fibers and anti-oxidant activity of TFP were significantly ($P < 0.05$) higher than CP. All the textural properties viz. hardness, springiness, cohesiveness, chewiness and gumminess of samples containing tomato products were significantly ($P < 0.05$) lower compared to control. The flavour score of TFP were at par ($P > 0.05$) with CP while body and texture, colour and appearance and overall acceptability score of CP was significantly ($P < 0.05$) higher compared to TFP.

Key words: Bland flavour, Likability, Response surface methodology, Tomato puree.

INTRODUCTION

The Indian soft cheese variant known as paneer is a highly healthful and nutritious dairy product that serves as the foundation for a wide range of culinary specialties. One of the main factors influencing how well-liked paneer is by consumers is its bland flavour. By including natural compounds from herbs, spices and grasses while making paneer, this might be avoided. In literature, researchers have developed new types and varieties of paneer. Considering this, FSSAI (2011) has permitted incorporation of spices and condiments and salt for flavoured paneer. Incorporation of such ingredients could help to improve the quality, flavour and shelf-life of paneer, making it more appealing to health-conscious consumers. Tomatoes (*Solanum lycopersicum*) are one of the most familiar vegetables in the global diet. Quantitatively, they are the most consumed non-starchy vegetable. Raw tomatoes and tomato-based products are rich in carotenoids like the red coloured lycopene, β -carotene, a pro-vitamin A molecule, phytoene and phytofluene. The conjugated forms of quercetin and kaempferol make up to 98 per cent of the total flavonols in tomatoes, which have a high flavonoid concentration (Walfisch *et al.*, 2003). It is believed that these tomato phytochemicals help lower the risk of human illnesses like cardiovascular disease (CVD) and prostate cancer (Canene-Adams *et al.*, 2005).

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Solhi *et al.*, (2020) formulated a processed cheese containing various quantity of tomato powder and reported that 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 another study Mehanna *et al.* (2017) produces a functional processed cheese incorporating tomato juice. Tomato juice was added at the rate of 10, 20 and 30% w/w of cheese. They concluded that good quality flavoured processed cheese can be made incorporating tomato juice @ 10% with 40 times more radical scavenging activity than control cheese without affecting sensory qualities. It is envisaged that incorporation of tomato in paneer will result in elevating its nutritional value by

increasing its Vitamin C, mineral and fiber content. Hence, the present study is planned to develop a value-added flavoured paneer using tomato. Other than tomato, multiple research work has been done on addition of phyto-ingredients like Ashwagandha (Felix *et al.*, 2022) and Curcumin and piperine (Godke *et al.*, 2025).

MATERIALS AND METHODS

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. Round or oval tomatoes weighing between 80 g and 95 g with a consistent, rich crimson to brick red coloration were selected. Tomato puree was prepared according to the method described in PM-FME training manual (FME, 2020). Using response surface method (RSM) and design expert 13.0.1 software, 20 trials were run for each to optimize the fat per cent in milk, temperature of coagulation (°C) and rate of addition of tomato puree (per cent w/w of milk). To create the final, standardised formula for the product, the optimised levels of each parameter were reproduced seven times each. The level of tomato puree, coagulation temperature and % fat of milk was selected based on preliminary trials which ranged from 5 to 10%, 70 to 80 °C and 3 to 4.5 % respectively.

According to the design matrix of the three factor RSM design, which was comprised of 20 tests, TFP was produced using varying levels of tomato puree (percentage of milk) at various coagulation temperatures (°C) and the

effect of rate of addition of tomato puree, coagulation temperature of milk and per cent fat of milk on sensory attributes of TFP were recorded. The experimental design matrix for sensory score of TFP is presented in Table 1.

Paneer was prepared from milk standardized to selected milk fat per cent. The milk was heated to 90° for 5 min and temperature was brought down to selected coagulation temperature. Tomato puree at 90 C was added at specified rate. After mixing for a minute, milk was coagulated using 1% citric acid solution heated at same temperature. The curd was then held for five minutes before draining of whey. The coagulum was collected in a clean muslin cloth and pressed at 2 bars for 20 min. in a stainless-steel hoop. The paneer block was submerged for two hours in pasteurized chilled water maintained at 4 to 6°C. Paneer blocks were taken out and allowed to drain for ten min. Paneer was packed in 12 m polyester + 50 µ LD/LLDPE laminated pouches and stored at 7±1°C. Fat content in milk was estimated by Gerber's method (IS: 1479, Part I, 1960). The total solids of milk were determined by the standard procedure IS: 12333 (1997). The titratable acidity of milk was determined by the method described in the IS: 1479 (Part II) (1961). Moisture content in paneer was determined by according to IS: 10484 (1983). The fat content of paneer samples was determined by the Mojonnier method as described in IS: 2785-1979 (Reaffirmed 1995). Protein content in paneer was determined by Kjeldahl method as per McSweeney and Fox, (1993) using kjel-plus digestion system (Model-KPS

Table 1: Experimental design matrix for sensory score of tomato flavoured paneer.

Run order	A	B	C	Flavour score (out of 9)	Body and texture score (out of 9)	Colour and appearance score (out of 9)	Overall acceptability (out of 9)
1	3.0	10.0	85	8.2	7.95	8.55	7.6
2	5.0	7.5	78	8	7.55	8.37	8.3
3	2.5	7.5	78	7.7	7.25	8.25	8.3
4	3.7	7.5	78	8.2	8.05	8.37	8.4
5	3.7	7.5	65	7.2	7.05	8.45	7.3
6	3.7	7.5	78	8.1	8.15	8.37	8.4
7	3.7	7.5	78	8.2	8.05	8.45	8.4
8	3.7	7.5	78	8	8.15	8.37	8.4
9	4.5	5.0	70	7.95	8.07	8.00	7.92
10	3.7	3.3	78	7.2	7.85	7.25	7.3
11	3.7	7.5	78	8.3	8.05	8.37	8.4
12	3.7	11.7	78	8.4	8.25	8.55	8.3
13	3.0	5.0	70	7.45	7.15	8.00	7.8
14	3.0	10.0	70	8.2	7.55	8.45	7.92
15	4.5	10.0	70	7.95	8.25	8.50	7.92
16	3.0	5.0	85	7.45	7.45	7.75	7.3
17	3.7	7.5	78	8.2	8.05	8.37	8.4
18	4.5	10.0	85	7.7	8.05	8.62	7.6
19	4.5	5.0	85	7.95	7.85	7.75	7.3
20	3.7	7.5	90	7.4	7.95	7.75	7.3

Note: A, B and C refer to the fat % in milk, rate of addition of tomato puree (% of milk) and coagulation temperature (°C) respectively.

006L) and kjel-plus semi-automatic distillation system (Model-Distil M) of M/s. Pelican Instruments, Chennai. Ash content of all the samples was determined by procedure described in Indian Standards (1981). For analysis of Vitamin-C the procedure reported by Osborne and Voogt (1978) was followed. Total Dietary Fiber (TDF) was estimated by method reported by Madhu *et al.* (2017). DPPH radical scavenging activity of paneer samples was determined by the method described by McCune and Johns (2002). Titratable acidity was determined by the procedure as described by IS (1981). The pH of paneer was determined as described by Indian Standards (1981). For sensory evaluation the paneer samples (~25 g rectangular pieces) were tempered to $10\pm 2^{\circ}\text{C}$ 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. For texture analysis compression testing of paneer samples was done with Lloyd Instrument, Hampshire, UK (Model No. 01/2962). All the textural measurements were conducted in a room maintained at $23\pm 1^{\circ}\text{C}$ temperature and $65\pm 1\%$ RH. Cubic samples of the experimental paneer with edges of 1.00 ± 0.06 cm was compressed up to 70 % of their initial size. Five cubic samples were used for each experimental paneer under study and the average value of these readings was reported.

Statistical analysis

Response surface methodology (RSM) was used for analysis of the data.

RESULTS AND DISCUSSION

Effect on flavour score

The P values and partial coefficients for all parameters at different levels and their interactions is shown in Table 2.

The values presented in Table 2 revealed that only rate of addition of tomato puree (B) had significant ($P<0.05$) positive effect on flavour score at linear level. These results are in accordance with results obtained by Solhi *et al.* (2020), who formulated the processed cheese containing tomato powder at the rate of 1, 2 and 4% and observed that processed cheese containing tomato solids at the rate of 4% had higher score.

Effect on body and texture score

As seen in Table 2, the P value for fat % of milk showed significant ($P<0.05$) positive effect on body and texture score. This could be attributed to decrease in the chewiness of paneer upon increasing in milk fat content as fat is an excellent cushioning agent. Rate of addition of tomato puree had the significant ($P<0.05$) positive effect on the body and texture score of tomato flavoured paneer. Such effect could be explained by presence of water-soluble fibres in tomato solids which increase the softness and reducing the chewiness of paneer by retaining more moisture. Coagulation temperature had the significant ($P<0.05$) positive effect on the body and texture score of Tomato flavoured paneer. It could be explained by increase in cohesiveness of products as there is better fusion of casein curd at higher temperatures. This mitigates the negative impact of insoluble fibres on body which could otherwise result in crumbly body.

Effect on colour and appearance score

The rate of addition of tomato puree (B) showed significant ($P<0.05$) positive effect on colour and appearance score while coagulation temperature (C) significant negative ($P<0.05$) effect on colour and appearance score. This could be elucidated by increase in colour intensity of paneer upon increase in rate of addition of tomato puree making the sample look more appealing. On contrary increasing temperature result in higher loss of soluble tomato solids along with the whey, simultaneously decreasing the intensity of colour. The results obtained are in validation

Table 2: P values and partial coefficients of regression equation of suggested models for sensory score of tomato flavoured paneer.

Parameter	Flavour score		Body and texture score		C and A score		Overall acceptability score	
	Partial coeff.	P value	Partial coeff.	P value	Partial coeff.	P Value	Partial coeff.	P value
A	0.06	0.34	0.20	0.0006	0.02	0.49	0.01	0.86
B	0.24	0.0014	0.15	0.0044	0.35	<0.0001	0.18	0.005
C	0.01	0.93	0.10	0.0334	-0.11	0.0111	-0.13	0.023
AB	-0.22	0.012*	-0.08	0.17	0.02	0.73	-0.02	0.81
AC	-0.03	0.67	-0.15	0.0169	0.00	0.95	-0.02	0.81
BC	-0.03	0.67	0.00	0.95	0.09	0.07	0.06	0.38
A ²	-0.06	0.27	-0.22	0.0003	0.00	0.95	-0.06	0.27
B ²	-0.08	0.16	0.01	0.82	-0.15	0.0013	-0.23	0.0007
C ²	-0.26	0.0007	-0.13	0.0078	-0.08	0.044	-0.41	<0.0001

*Significant at 5 % level ($P<0.05$) Note: A, B and C refer to the fat % in milk, rate of addition of tomato puree (% of milk) and coagulation temperature ($^{\circ}\text{C}$) respectively.

with those obtained by Yashvantha *et al.* (2020) who reported that the level of processed lemon rind showed significant ($P < 0.05$) negative effect on colour and appearance score of lemon-flavored paneer.

Effect on overall acceptability score

The P value for rate of addition of tomato puree showed significant ($P < 0.05$) positive effect on overall acceptability at linear level while and level of coagulation temperature showed significant ($P < 0.05$) negative effect on overall acceptability at linear level. The obtained results can be elucidated by effect of tomato solids and coagulation temperature on flavour and texture of paneer. Tomato solids providing the natural flavoring components of tomato and the soluble fibers which reduce the chewiness by virtue of its high moisture retention capacity thus improving flavour and texture of the product respectively. On contrary, high coagulation temperature expel unnecessary amount of water reducing the quantity of water-soluble organic acids and flavoring compounds of tomato simultaneously with increase in hardness and chewiness of paneer. standardization. The optimized process consisted of use of milk standardized to 3.7 per cent milk fat, addition of 10 per cent tomato puree (w/w of milk) and using a coagulation temperature of 78°C.

Comparison of proximate chemical composition of tfp with control paneer

Comparison of proximate composition, Vitamin-C and antioxidant values of TFP and CP is shown in Table 3. As seen in Table 3, the moisture content of TFP was significantly higher ($P < 0.05$) than that of CP. This could be credited to higher fat content in milk used for making CP. Another reason for such observation could be the presence of fibres in TFP resulting in improved moisture retention capacity as seen in Table 3. The fat content of CP was 24.65 per cent which was significantly ($P < 0.05$) higher than that of TFP 18.25 per cent. The higher fat content in control was due to higher fat content in milk used for preparing

control. Protein content of control was statistically at par with protein content of TFP. The obtained results are in contrast with results obtained for total solid content since protein content is directly proportional to total solid content. This could be attributed to higher ratio of fat in total solid content of CP in comparison to TFP. Identical results were obtained by Yashvantha *et al.* (2020) where average protein content of lemon flavoured paneer (17.13 per cent) was at par with protein content of CP (17.05 per cent). Carbohydrate content of TFP was significantly higher than that of control sample. This could be attributed to presence of high amounts of natural sugars in tomato puree and their retention in TFP after coagulation. Another possible reason for higher carbohydrate content of TFP in comparison to CP could be attributed to higher moisture content of TFP, as sugars are water soluble.

The ash content of TFP was significantly lower than that of control. This could be attributed to higher moisture content as well as higher titratable acidity of TFP compared to as mineral gets solubilized and lost in whey with decrease in pH of the sample. Similar results were obtained by Ahmed and Bajwa, (2019). who coagulated paneer using sour fruit juices. The average ash content of experimental samples made using amla juice was 1.27 per cent and lemon juice was 1.24 per cent. Both these values were significantly lower ($P < 0.05$) than that of CP at 1.30 per cent.

Titratable acidity of CP was significantly lower ($P < 0.05$) than that of TFP. This could be attributed to presence of various types of organic acids in tomato puree as well as higher moisture content of TFP. Since acids are water soluble, they are retained with water. A similar trend was obtained by Ahmed and Bajwa, (2019). the average per cent titratable acidity of experimental samples made using lemon juice (0.522 per cent) was significantly higher ($P < 0.05$) than that of CP (0.401 per cent). Vitamin-C and total dietary fiber content of TFP was 4 mg/100 g and 0.92 per cent of paneer respectively. While for CP these values were 0.05 mg/100g and 0.03 per cent of paneer respectively. In a study conducted by Ahmed and Bajwa (2019). The ascorbic

Table 3: Comparison of proximate composition, Vitamin-C and antioxidant values of TFP and CP.

Parameter	TFP	CP	t-stat value	P value
Moisture (%)	57.04 ^a	51.68 ^b	7.41	0.005
Milk fat (%)	18.25 ^a	24.65 ^b	5.96	0.009
Milk fat (% on dry matter basis)	42.48 ^a	51.04 ^b	9.48	0.002
Protein (%)	18.51 ^a	18.88 ^a	0.24	0.820
Carbohydrate (%)	3.72 ^a	2.30 ^a	10.31	0.002
Ash (%)	1.64 ^a	1.88 ^b	6.80	0.006
Titratable acidity (% lactic acid)	0.54 ^a	0.46 ^b	19.32	0.0003
Vitamin C (mg/100 g)	4.00 ^a	0.05 ^b	17.14	0.0004
Total dietary fiber (%)	0.92 ^a	0.03 ^b	19.86	0.0002
Antioxidant capacity as % DPPH inhibition	58.07 ^a	12.58 ^b	17.14	0.0004
Antioxidant capacity as trolox equivalent (μM/g)	41.17 ^a	11.35 ^b	3.40	0.042

Each observation is a mean $\pm$ SD of three replicate experiments (n=7); a-b Different superscript letters following numbers in the same row denote significant difference ($P < 0.05$) Tabulated t-value = 3.18 (Cal. t-value less than tabulated value).

acid content of experimental samples made using lemon juice and amla juice was 1.59 mg/100 g and 15.26 mg/100 respectively, while control sample made without any fruit juice had zero ascorbic acid content.

Antioxidant capacity of TFP expressed as per cent DPPH inhibition and trolox equivalent was 58.07 per cent and 41.17 $\mu\text{M/g}$ of paneer respectively. While in CP, antioxidant capacity as per cent DPPH inhibition and trolox equivalent was 12.58 per cent and 11.35 $\mu\text{M/g}$ of paneer respectively, which was significantly ($P < 0.05$) lower than that of TFP. Similar results were obtained in a study conducted by El-aziz *et al.* (2017) on processed cheese made incorporating tomato juice, the experimental cheese samples had higher radical scavenging activity (RSA) and gallic acid equivalent (GAE) compared to control samples *i.e.*, 73.6 per cent RSA and 6.2 mg/100 g GAE in experimental samples VS. 1.6 per cent RSA and 3.8 mg/100 g GAE in control samples. Mehanna *et al.* (2017) conducted a study to develop functional processed cheese containing tomato juice at various rates. They reported, the RSA of cheese samples increased progressively with rate of addition of tomato juice *i.e.*, 2.1, 80.28, 81.75 and 83.33 per cent for sample containing 0, 10, 20 and 30 per cent tomato juice respectively. Similarly, GAE of processed cheese also increased progressively with rate of addition of tomato juice *i.e.*, 5.2, 7.9, 9.8, 10.1 mg/100 g for sample containing 0, 10, 20 and 30 per cent tomato juice respectively. Thus, the result obtained with respect to antioxidant capacity is in agreement with those reported in literature.

Comparison of texture properties of TFP with CP

It can be seen from Table 4 that hardness value of TFP has statistically non-significant ($P > 0.05$) difference with the

hardness value of control was (18.92 N) even though the moisture content of TFP was significantly higher than CP *i.e.*, 57.04 per cent in TFP vs. 51.68 per cent in CP. According to literature, hardness values have been observed to be in negative correlation with moisture content of paneer. The possible reason for such contrast could be due to higher fat content in CP (24.65 per cent) compared to TFP (18.25 per cent) as fat is believed to be an excellent softening agent in food products. Similar results were obtained by Mehanna *et al.* (2017) who conducted a study to develop functional processed cheese containing tomato juice at various rates *i.e.*, 10, 20 and 30 per cent. They reported that there was no significant ($P > 0.05$) difference between firmness value of control sample made without incorporating tomato juice and all three experimental samples. Similar to hardness, chewiness value of CP (8.41 N.mm) was also statistically at par ($P > 0.05$) with the chewiness value of TFP (7.07 N.mm). This could be attributed to higher moisture content of TFP (57.04 per cent) compared to that of CP (51.68 per cent) mitigating the softening effect provided by higher fat content in CP as discussed earlier.

According to Table 5, TFP obtained the springiness values (2.54 mm) statistically at par ($P < 0.05$) with the springiness value of control (2.66 mm). Similar results were obtained by Yashvantha *et al.* (2020) where springiness value of lemon flavoured paneer was statistically at par ($P < 0.05$) with CP. Similarly, Gumminess value of TFP (2.73 N) was statistically at par ($P > 0.05$) with that of control (3.12 N).

Cohesiveness value of TFP (0.15) was statistically at par ($P > 0.05$) with the cohesiveness value of control (0.16) even though the moisture content of TFP was significantly higher than CP *i.e.*, 57.04 per cent in TFP vs. 51.68 per cent

Table 4: Textural properties of TFP and CP.

Parameters	TFP	CP	t-stat value	P value
Hardness (N)	18.37 ^a ±0.158	18.92 ^a ±0.172	0.42	0.69
Chewiness (N.mm)	7.07 ^a ±0.156	8.41 ^a ±0.072	0.90	0.42
Springiness (mm)	2.54 ^a ±0.108	2.76 ^a ±0.156	0.82	0.46
Gumminess (N)	2.73 ^a ±0.085	3.12 ^a ±0.177	0.90	0.42
Cohesiveness	0.15 ^a ±0.012	0.17 ^a ±0.007	1.30	0.26
Adhesiveness (N.mm)	0.51 ^a ±0.051	0.66 ^b ±0.050	3.37	0.03

Each observation is a mean $\pm$ SD of three replicate experiments (n=3); a-b Different superscript letters following numbers in the same row denote significant difference ($P < 0.05$) Tabulated t-value = 3.18 (Cal. t-value less than tabulated value).

Table 5: Average sensory score of TFP and CP.

Parameters	TFP	CP	t-stat value	P value
Flavour score	8.33 ^a	8.41 ^a	1.10	0.35
Body and texture score	8.08 ^a	8.41 ^b	2.10	0.12
Color and appearance score	8.66 ^a	8.83 ^b	5.65	0.01
Overall acceptability score	8.41 ^a	8.5 ^b	1.41	0.25

Each observation is a mean $\pm$ SD of three replicate experiments (n=3); a-b Different superscript letters following numbers in the same row denote significant difference ($P < 0.05$) Tabulated t-value = 3.18 (Cal. t-value less than tabulated value).

Table 6: Comparison of predicted v/s actual values of responses selected.

Response	Predicted value *	Actual value 1	Cal.t-value#	P value	Significance
Flavour score	8.32	8.34	0.49	0.63	NS
Body and texture score	8.23	8.25	0.16	0.87	NS
Colour and appearance score	8.58	8.56	0.16	0.87	NS
Overall acceptability score	8.38	8.31	1.08	0.31	NS

1 Sensory score on 9.0-point scale score card*.

Predicted values of Design Expert 13.0.1 package.

@ Actual values are average of seven trials of optimized product.

t-values found non-significant at 5 per cent level of significance.

NS = non-significant.

Tabulated t-value = 2.44 (Cal. t-value less than tabulated value).

in CP. This could be attributed to better fusion in casein matrix of TFP achieved by higher temperature of coagulation (78°C) compared with CP coagulated at 70°C. Ahmed and Bajwa, (2019). Obtained similar results during texture profile analysis of paneer coagulated using sour fruit juices. The cohesiveness value of experimental samples made using amla juice and lemon juice were statistically at par with cohesiveness value ($P < 0.05$) of CP. Adhesiveness value of TFP (0.51) was significantly lower ($P < 0.05$) in comparison with adhesiveness value of control (0.66). A opposite trend was obtained by Ahmed and Bajwa, (2019). tha the adhesiveness value of experimental samples made using amla juice and lemon juice were significantly higher ($P < 0.05$) than that of CP. These differences could be attributed to differences in composition, moisture content and processing conditions in both the studies.

Comparison of average sensory score of TFP with CP

It can be seen from Table 5 that flavour score of TFP had non-significant difference ($P > 0.05$) with CP. Bajwa and Ahmed. (2022) obtained similar results for paneer made using sour fruit juices. The flavour score of experimental samples made using amla juice and lemon juice were statistically at par with flavour score ($P > 0.05$) of CP. Body and texture score of control sample was significantly higher ($P < 0.05$) compared to body and texture score of TFP. This could be attributed to non-uniform texture of TFP courtesy insoluble solids particles present in tomato puree hindering the proper distribution of tomato puree in milk. Similar results were obtained by Ahmed and Bajwa, (2022) in case of paneer made using amla juice as coagulant. The body and texture score of panner made using amla juice (7.63) was significantly lower ($P < 0.05$) compared to that of CP (8.17). As per Table 6, the colour and appearance score of control sample was significantly higher ($P < 0.05$) compared to colour and appearance score of TFP. This can be explained by improper mixing of tomato solids especially insoluble tomato fibres in curd resulting into uneven shade of red colour on surface which was disliked by judges. Similar results were obtained by Ahmed Bajwa (2022) in case of paneer made using amla juice as coagulant. The colour and appearance score of panner made using amla

juice (7.13) was significantly lower ($P < 0.05$) compared to that of CP (8.35). In contrast to aforementioned result, the overall acceptability scores of TFP and CP had no significant difference ($P > 0.05$) with each other. The obtained results were in accordance with results obtained by Ahmed and Bajwa (2022) where overall acceptance score of panner made using amla juice (7.89) had non-significant difference ($P > 0.05$) with CP (8.15).

CONCLUSION

It can be concluded from the study that good quality tomato flavoured paneer with can be prepared from 3.7% fat milk, incorporating tomato puree @ of 10% of milk and coagulating at 78°C. It met the FSSAI standards for medium fat paneer with respect to moisture and FDM content. The Vitamin C, Total dietary fiber (TDF) content and antioxidant capacity of the product were significantly ($P < 0.05$) higher than control paneer prepared without addition of tomato solids. All the textural properties viz. hardness, springiness, cohesiveness, chewiness and gumminess of samples containing tomato products were significantly ($P < 0.05$) lower compared to control. The flavour score of TFP were at par ($P > 0.05$) with CP while body and texture, colour and appearance and overall acceptability score of CP was significantly ($P < 0.05$) higher compared to TFP. The overall acceptability of TFP was 8.41 indicating that it was liked very much to liked extremely on a 9.0-point hedonic scale score card.

Conflict of interest

All authors declare that they have no conflict of interest.

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