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Khobragade SP
Department of Animal Husbandry and Dairy Science, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Padghan PV
Department of Animal Husbandry and Dairy Science, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Shinde AT
Department of Animal Husbandry and Dairy Science, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Sapna Ambhore
Department of Animal Husbandry and Dairy Science, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Corresponding Author:
Khobragade SP
Department of Animal Husbandry and Dairy Science, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Studies on process standardization and sensory properties of buffalo milk paneer blended with raw turmeric extract (*Curcuma longa* L.)

Khobragade SP, Padghan PV, Shinde AT and Sapna Ambhore

Abstract
This study was conducted for standardize the process of *paneer* by using buffalo milk and raw turmeric extract (*Curcuma Longa* L.) The stage of addition of raw turmeric extract in *paneer* preparation was optimized by adding of raw turmeric extract at different stage while preparing *paneer*. The raw turmeric extract was added in three different stages i.e. initially before heating of milk, after coagulation, partial drainage and chilling stage. The maximum mean score was found in *paneer* prepared by adding raw turmeric extract at initial stage before heating of milk. The *paneer* was prepared by considering treatment combination of buffalo milk and raw turmeric extract as 95%, 90% and 85% of buffalo milk and 5%, 10% and 15% of raw turmeric extract in treatments T_2, T_3 and T_4 and treatment T_1 taken as a control prepared from buffalo milk only. The object of using raw turmeric extract was to development of *paneer* by improving physio-chemical properties and increasing its shelf life. Sensory parameters (colour and appearance, flavour, body and texture, mouthfeel/smoothness overall acceptability) were analyzed using 9 point hedonic scale. On the basis of results, it was concluded that the T_2 treatment was highest score in turmeric extract used *paneer* i.e. 8.22 which was above the like very much. Thus as per the sensory evaluation overall average score for the finished product ranged in between 8.78 and 6.50.

Keywords: Buffalo milk, *Paneer*, *Channa*, Turmeric, *Curcuma longa*

Introduction
Paneer is a popular Indian soft cheese variety and indigenous dairy products, which occupy a prominent place among traditional milk products. About 5% of milk produce in India is converted into *paneer* out of 176.35 million tonnes during 2017-2018 (Anonymous 2017-18) [3]. According to the FSSAI rules, *chhana* or *paneer* is defined as a milk product obtained by precipitating a part of milk solids by boiling whole milk of cow and or buffalo or a combination thereof by addition of lactic acid, citric acid or any other suitable coagulating agent and subsequent drainage of whey (FSSAI, 2006) [7]. Spices offer a promising alternative for food safety. Inhibitory activity of spices and derivatives on the growth of bacteria, yeasts, fungi and microbial toxins synthesis has been well reported, so they could be used in food conservation as main or as adjuvant antimicrobial compounds in order to assure the production of microbiologically stable foods. Spices have been well known for their medicinal, preservative and antioxidant properties (Souza *et al*. 2005) [18]. Turmeric has a high medicinal value in the traditional medicinal system of South Asia, which includes aiding in wound healing, inflammatory condition and blood purification. (Aggrawal *et al.* 2007) [1]. Turmeric is a rhizomatous herbaceous perennial plant (*Curcuma longa*) of the ginger family. The medicinal properties of turmeric, the source of *curcumin* have been known for thousands of years however, the ability to determine the exact mechanism of action and to determine the bioactive components have only recently been investigated *Curcumin* (1,7-bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione), also called diferuloyl methane, is the main natural polyphenol found in the rhizome of *Curcuma longa* (turmeric) and in others curcuma spp. *Curcuma longa* has been traditionally used in Asian countries as a medical herb due to its antioxidant, anti-inflammatory, antimutagenic, antimicrobial and anticancer properties (Hewlings and kalam 2017) [10]. The present study was done to standardize the method of *paneer* preparation using buffalo milk and raw turmeric extract and also studied its sensory property.

Material and Methods
Buffalo milk
Already standardized fresh Buffalo milk was procured from local market of Latur city, of Natural

Milk Pvt., Ltd., Latur having 6.0 per cent fat and 9 per cent SNF.

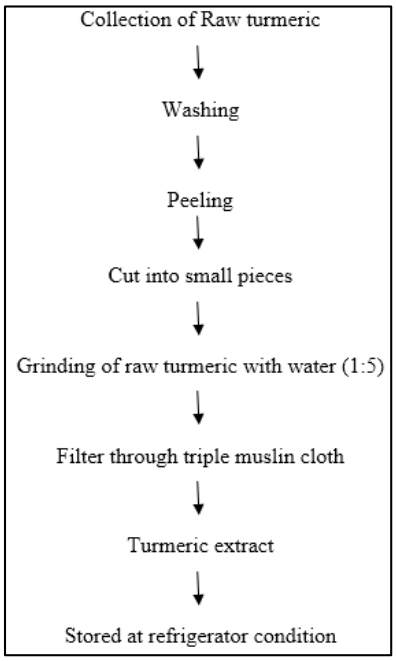
Raw Turmeric
The pure raw turmeric (Selam variety) required for preparation of *paneer* was obtained from local market of Latur city.

Chemicals
Analytical (AR) or guaranteed grade (GR) reagents were used in the chemical analysis.

Packing Material
Polythene bags (200 gauges) was obtained from local market and used for packaging the raw turmeric added *paneer*.

Equipment and Accessories
Equipments and accessories include stainless steel vessels of requisite capacity, knives, fruit extractor/mixture, muslin cloth, standard weight balance, thermometer, gas shegdi, *paneer* press machine, etc. used for preparation of *paneer*. Before using this material, it was properly cleaned and washed with detergent solution and all the precautionary measures was considered during the conduct of trials to avoid contamination.

Preparation of Raw Turmeric Extract
The fresh raw turmeric was collected and used for preparation of raw turmeric added *paneer*.



Flow diagram 1: Preparation of raw turmeric extract

Procedure
The fresh raw turmeric was collected, washed, peeled and cut into small pieces. After cutting raw turmeric pieces were grinded in the mixer for homogenous fine mixture by adding 1:5 ratio of water for extract filtration through muslin cloth.

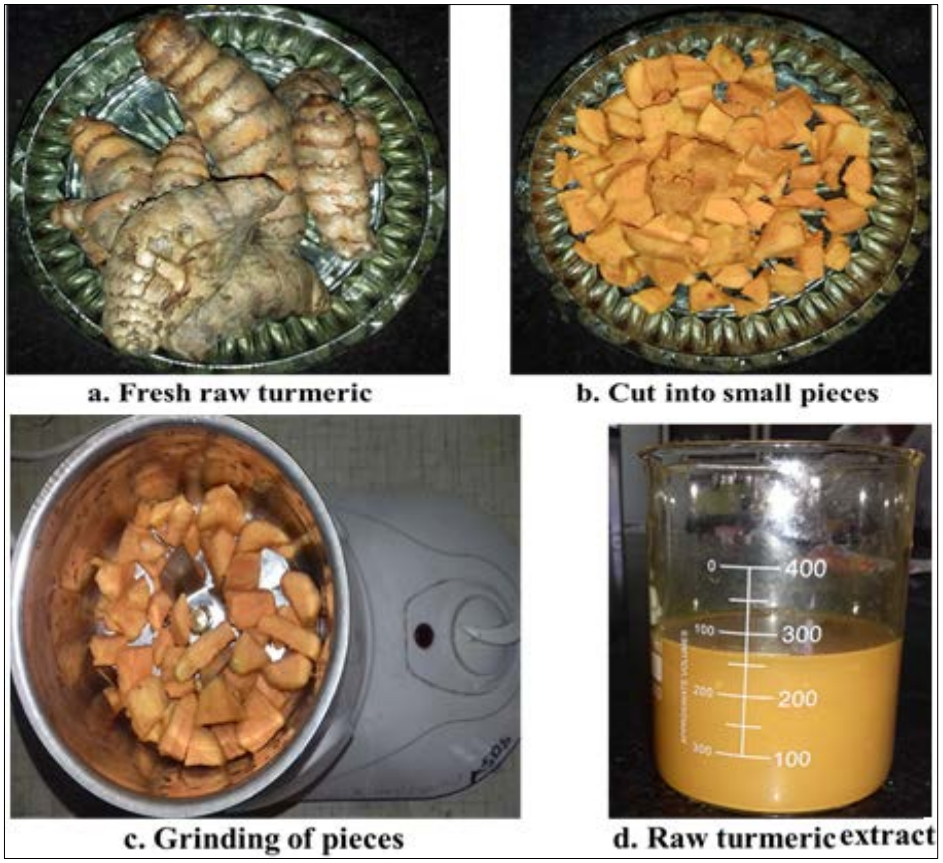
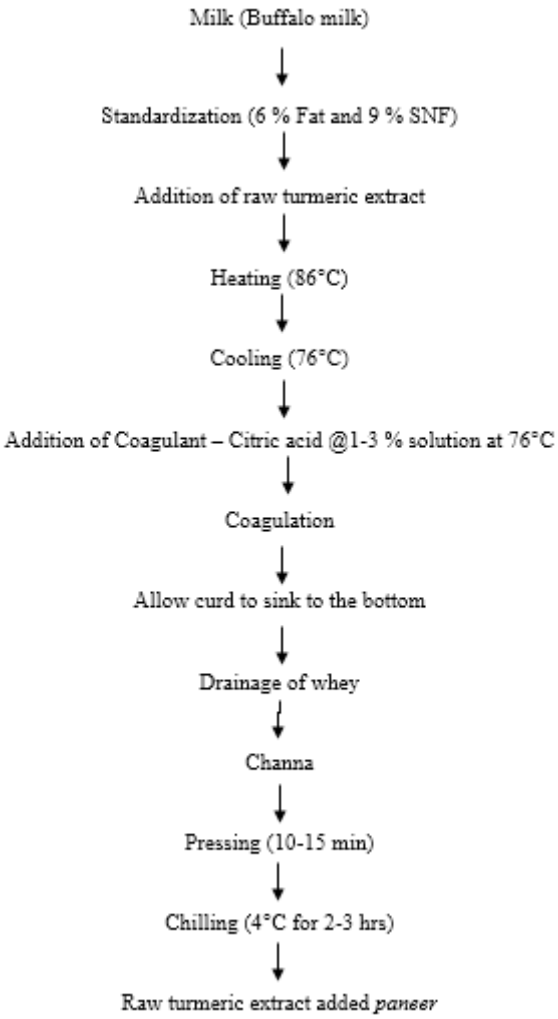


Fig 1: Preparation of raw turmeric extract

Preparation of *paneer* by using raw turmeric extract
The *paneer* was prepared as per the method suggested by Aneja *et al*. 2002 [2] with slight modification for addition of raw turmeric extract as shown in following flow chart.



Flow diagram 2: Preparation of raw turmeric extract added *paneer* (Aneja *et al*. 2002)

Procedure

The buffalo milk (6% fat and 9% SNF) was taken in pan then raw turmeric extract was added before heating and mixed properly through glass rod. Milk was heated to 86°C and cooled up to temperature 76°C. After cooling citric acid were added in milk @ 1-3 % at 76°C with stirring. After complete coagulation the stirring was stopped and allow the curd to sink to the bottom. The whey was then drained through a stainless steel strainer. The curd was collected and filled in stainless steel *paneer* hoope. The hoope used was circular blocks with holes on its side to facilitate the expulsion of whey. *Paneer* was pressed 10-15 minutes @ 3 kg/sq cm. The pressed block of curd was removed from the hoop, cut into pieces and immersed in chilled water (4°C) for 2 to 3 hours. The chilled *paneer* was then removed from water to drain out and packed in polythene bag and finally storage in refrigerator (5°C).

Optimization of stage of addition of raw turmeric extract in *paneer* preparation

The stage of addition of raw turmeric extract in *paneer* preparation was optimized by adding of raw turmeric extract at different stage while preparing *paneer*. The raw turmeric extract was added in three different stages i.e. initially before heating of milk, after coagulation and partial drainage and chilling stage.

It was observed that the *paneer* obtained in first stage in which raw turmeric extract was added initially before heating shown uniform yellowish colour natural body and texture and suitable firmness. Whereas the *paneer* obtained in second stage shown loose body texture, loose firmness and dark with un-uniform yellowish colour. And the *paneer* obtained in third stage (at chilling stage) shown yellowish colour in periphery only. All three samples of *paneer* examined for its colour and appearance, flavour, body and texture, mouthfeel/smothness by a panel of five judges using a nine-point Hedonic scale.

The sensory score obtained for these *paneer* samples are shown on table no. 1. It is observed from table no. 1 that all the sensory parameters were significantly affected in second and third stage where raw turmeric extract was added at after coagulation and partial drainage and at chilling stage, respectively. The flavor was not changed so much in three samples but colour and appearance, body and texture and smoothness changed much more.

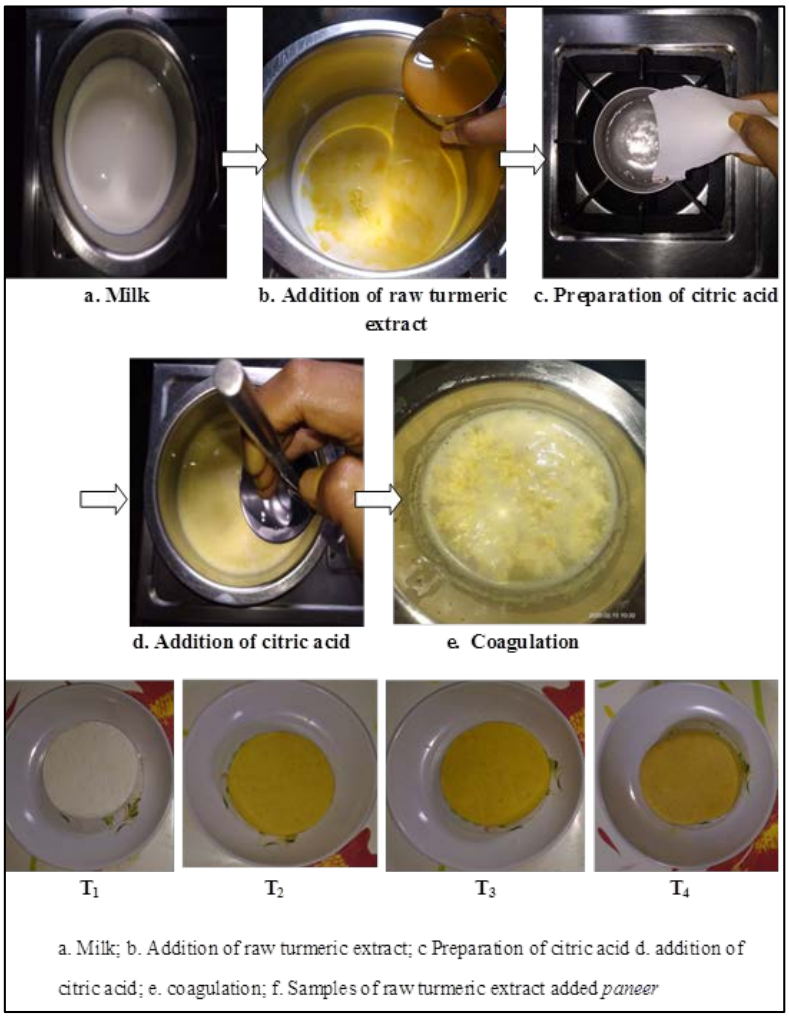


Fig 2: Preparation of raw turmeric extract added paneer

Sensory evaluation of the product

Various treatment combinations of the finished product were subjected to sensory evaluation by panel of judges using 9-point Hedonic scale (Gupta, 1976) [9]. The data analyzed statically by using Completely Randomized Design (CRD) as per Panse and Sukhatne (1985) [15]. The significance of result was evaluated on the basis of critical difference.

Table 1: Average sensory score of *paneer* samples prepared in different stage of addition of raw turmeric extract

Stage of Addition	Average sensory score				
	Colour and appearance	Flavour	Body and Texture	Smoothness	Mean
Initially before heating of milk	8.25 ± 0.56	7.81 ± 0.26	8.88 ± 0.12	8.75 ± 0.10	8.42
After coagulation and partial drainage	4.38 ± 0.60	6.25 ± 0.20	4.13 ± 0.56	4.25 ± 0.56	4.75
At chilling stage	5.19 ± 0.45	6.81 ± 0.70	5.25 ± 0.56	6.19 ± 0.56	5.86
SE± 0.34 CD@ 5% 1.05					

The values are the average of judge's observations

The maximum mean score was found in *paneer* prepared by adding raw turmeric extract at initial stage before heating of milk whereas minimum score was recorded in *paneer* in which adding raw turmeric extract was added after coagulation and partial drainage followed in *paneer* prepared by chilled in water added raw turmeric extract . This indicates that the raw turmeric extract addition was affected on sensory properties of *paneer* specially colour and appearance, body and texture and smoothness of *paneer*. Therefore, on the basis of primary sensory study the stage of raw turmeric extract addition was finalized at initial stage before hating of milk used for *paneer* preparation and *paneer* was prepared only by this method throughout the study. The treatment combination of buffalo milk and raw turmeric extract was finalized on the basis of primarily trial work.

The *paneer* was prepared by considering treatment combination of buffalo milk and raw turmeric extract the turmeric extract as 95%, 90% and 85% of buffalo milk and 5%, 10% and 15% of raw turmeric extract in treatments T_2, T_3 and T_4 and treatment T_1 taken as a control prepared from buffalo milk only.

Table 2: Treatment combination of buffalo milk and raw turmeric extract for *paneer* preparation

Treatment	Weight of Milk (%)	Raw turmeric extract E (%)
T_1- (Control)	100%	00
T_2	95%	5%
T_3	90%	10%
T_4	85%	15%

Yield of raw turmeric extract added *paneer*

The data on yield of raw turmeric extract added *paneer* is presented in table 3 The observation given in table 3 showed that the average yield of raw turmeric extract added *paneer* prepared under different treatments were 21.25, 20.87, 20.60 and 20.43 per cent for treatments T_1, T_2, T_3 and T_4, respectively.

Table 3: Yield of *paneer* from various treatment combinations

Treatments	Per cent recovery (yield of raw turmeric extract added *paneer*)				
	R-I	R-II	R-III	R-IV	Mean
T_1	21.22	21.25	21.27	21.25	21.25[a]
T_2	20.88	20.85	20.89	20.87	20.87[b]
T_3	20.65	20.69	20.66	20.65	20.60[c]
T_4	20.41	20.42	2045	20.44	20.43[d]
SE ± 0.009 CD at 5% 0.028					

The values with different small letters superscripts row wise differ significantly at 5% level of significance.

It is clear that the yield of raw turmeric extract added *paneer* decreased in turmeric extract added treatments might be due to the used of raw turmeric extract which may be affected on the coagulation of milk due to the change in pH, electrostatic repulsion and ionic bond of milk protein components along with enzyme deactivation. These factors are responsible for the protein precipitation (Walstra *et al*., 2006) [19]. Regarding recovery of milk solids during coagulation the different factors are responsible to recovery per cent was noticed by Sachdeva and Singh (1988b) [17] reported that the heat treatment of milk up to 90°C not only increased the recovery of total solids but also increased the yield of *paneer* and Kumar *et al.* (2014) [11] studied that yield of *paneer* mainly depends on the fat and SNF content of milk as well as on the moisture, fat and protein retained in the *paneer*.

Results and discussion

Colour and appearance

The colour and appearance score as influenced by the proportion of buffalo milk and raw turmeric extract levels have been recorded in table no. 4.

Table 4: Effect of different levels of raw turmeric extract on the colour and appearance score of *paneer*

Treatments	Colour and appearance score				
	R-I	R-II	R-III	R-IV	Mean
T_1	8.50	8.75	9.00	8.50	8.69[a]
T_2	8.25	8.00	8.50	8.75	8.38[b]
T_3	7.50	7.00	7.00	7.25	7.19[c]
T_4	7.00	6.75	7.00	6.50	6.81[d]
SE ± 0.131 CD at 5% 0.404					

The values with different small letters superscripts row wise differ significantly at 5% level of significance.

From above table no. 4, it is clear that the average score for colour and appearance was ranged between 8.69 to 6.81 for T_1 and T_4, found decreasing order due to the changed in colour in developed *paneer*. Generally the mind setup and traditional assumption regarding any thing if changed then the attitudes of persons also changed for this thing. In this case also, *paneer* prepared under control treatment (T_1) was found to be superior over the rest of the treatments due to the traditional feeling for milk and milk products have white creamy colour. Statistically the colour and appearance score for all the treatments were differ significantly with each other. The maximum score was found in T_1 whereas minimum score was recorded in T_4. T_2 treatment is better than T_3 and T_4. This indicates that the increased in proportion of raw turmeric extract in *paneer* increased yellow colour and appearance of *paneer*. It is observed that more levels of raw turmeric extract lowered the score of *paneer* for colour and appearance, but the colour and appearance secured the score for all treatments more than 6.80 means it was in between like slightly to like extremely on 9 point hedonic scale. The T_2 treatment was above the like very much. Lastly, colour and appearance of food products is the matter of practice. Similar feeling regarding in the development of other milk products were observed by the following researchers for colour change in their respective milk products. Buch (2014) [4] studied that colour and appearance score declined with increase in turmeric powder % in *paneer* from 8.2 (0.0%), 8.0 (0.2%), 7.8(0.4%), 6.9 (0.6%), 6.2 (0.8%) and 6.1 (1%).

Prasad (2017) [16] incorporated turmeric powder in burfi in which colour and apperence score decrease from 7.10 (0.5%) to 6.11 (1.5%). Mervat *et al*. (2017) [14] studied yogurt appearance score decrease significantly (p<0.5) by increasing turmeric powder concentrations from 8.8 (T_1), 8.3 (T_2), 7.6 (T_3), 7.4(T_4) and 7.7 (T_5).

Maji (2018) [12] *et al*. (2018) studied herbal lassi fortified with turmeric (*Curcuma longa* L.) extract decrease colour and appearance score with increase in turmeric extract from 7.66 control, 7.50 (1%), 7.45 (2%), 7.33 (3%) and 6.66 (4%) level.

The trends and observations noted in the present study are agreeable with the above findings.

Flavour

Table no. 5 showed the flavour score of raw turmeric extract added *paneer* when added with raw turmeric extract.

Table 5: Effect of different levels of raw turmeric extract on the flavour score of raw turmeric extract added *paneer*

Treatments	Flavour score				
	R-I	R-II	R-III	R-IV	Mean
T_1	9.00	8.75	8.50	9.00	8.81[a]
T_2	8.50	8.25	8.00	8.25	8.25[b]
T_3	7.75	8.00	7.75	7.75	7.81[c]
T_4	7.25	6.75	7.00	6.75	6.94[d]
SE ± 0.104 CD at 5% 0.319					

The values with different small letters superscripts row wise differ significantly at 5% level of significance.

Flavour is the main parameters for liking the product. In the present study there was a decreasing trend in the flavour score, it could be predicted that the product would be acceptable to consumer with the preference given to the control (T_1) which had a score of 8.81 followed by (T_2) 8.25, (T_3) 7.81 and (T_4) 6.94. Statistically the flavour score for all the treatments were differ significantly with each other.

Buch (2014) [4] studied that flavour score declined with increased in turmeric powder per cent in *paneer* from 7.9 (0.0%), 7.8 (0.2%), 7.9(0.4%), 7.2 (0.6%), 6.2 (0.8%), 5.8 (1%) in which 0.4% level was better.

Prasad (2017) [16] incorporated turmeric powder in burfi in which flavour score decreased from 7.05 (0.5%) to 5.92 (1.5%).

Mervat *et al*. (2017) [14] studied yoghurt flavor score decrease significantly (p<0.01) by increasing turmeric powder concentrations from T_1 to T_5.

Maji *et al.* (2018) [12] studied herbal lassi fortified with

turmeric (*Curcuma longa* L.) extract decreased flavour score with increase in turmeric extract from control 8.33 control, 8.2 (1%), 7.33 (2%), 6.0 (3%) and 4.33 (4%) level.
The results noted in the present study are agreeable with the above findings and this is might be due to the pungent bitter flavor of turmeric having numerous active constituents such as polyphenols, sesquiterpenes, diterpenes, triterpenoids, sterols, and alkaloids, Gupta *et al.* (2013) [8].

Body and texture
The body and texture of raw turmeric extract added *paneer* as influenced by the different levels of raw turmeric extract and score recorded on account of this is presented in table no. 6.

Table 6: Effect of different levels of raw turmeric extract on the body and texture score of raw turmeric extract added *paneer*.

Treatments	Body and texture score				
	R-I	R-II	R-III	R-IV	Mean
T_1	9.00	8.75	9.00	8.75	8.88 [a]
T_2	8.00	8.25	8.00	8.25	8.13[b]
T_3	7.25	7.50	7.25	7.00	7.25[c]
T_4	6.50	6.00	6.25	6.00	6.19[d]
SE ± 0.094 CD at 5% 0.289					

The values with different small letters superscripts row wise differ significantly at 5% level of significance.

The body and texture is the main parameter as far as the consumer appeal is concerned. As far the body and texture parameters were concerned, the addition of raw turmeric extract lowered the scores recorded. The body and texture score of T_2 (8.13) fairly good and acceptable. The results noted in the present study are agreeable with the findings of Buch (2014) [4] studied that body and texture score declined with increased in turmeric powder % in *paneer* from 7.9 (0.0%), 7.8 (0.2%), 7.6(0.4%), 6.9 (0.6%), 6.7 (0.8%), 6.4 (1%); Prasad (2017) [16] incorporated turmeric powder powder in burfi in which flavour score decreased from 7.11 (0.05%) to 6.80 (1.5%) ; Mervat *et al*. (2017) [14] studied yogurt body and texture score decrease significantly (p<0.05) by increasing turmeric powder concentrations from T_1 to T_5 and Maji *et al.* (2018) [12] studied herbal lassi fortified with turmeric (*Curcuma longa*) extract decrease flavour score with increase in turmeric extract from control 8.33 control, 8.25 (1%), 7.7 (2%), 7.0 (3%) and 7.0 (4%) level for body and texture while used turmeric in their research.

Mouthfeel/Smoothness
The sensory scores for mouthfeel and smoothness of raw turmeric extract added *paneer* as influenced by different levels of raw turmeric extract is recorded in table no. 7.

Table 7: Effect of different levels of raw turmeric extract on the mouthfeel/ smoothness score of raw turmeric extract added *paneer*.

Treatments	Mouthfeel/Smoothness score				
	R-I	R-II	R-III	R-IV	Mean
T_1	8.50	8.75	9.00	8.75	8.75[a]
T_2	8.00	8.25	8.00	8.25	8.13[b]
T_3	7.00	7.50	7.25	7.00	7.19[c]
T_4	6.00	6.00	6.25	6.00	6.06[d]
SE ± 0.091 CD at 5% 0.283					

The values with different small letters superscripts row wise differ significantly at 5% level of significance.

The taste scores of raw turmeric extract added *paneer* ranged 6.06 to 8.75 for T_4 to T_1. The raw turmeric added *paneer* prepared from buffalo milk (T_1) had maximum scores of 8.75 followed by 8.13 (T_2), 7.19 (T_3) and 6.06 (T_4), respectively. The results indicated that the mouthfeel/smoothness scores of T_1 and T_2, T_2 and T_3 and T_3 and T_4 were differed significantly over each other. It means that the smoothness of raw turmeric extract added *paneer* was not similar to the control. T_3 and T_4 combinations were less acceptable as compared to T_2.
Das *et al.* (2018) [5] studied on comparative study on evaluation of refrigerated (4±1ºC) storage stability of *paneer* incorporated with crude extract from indian curd, nisin and lactic acid. There was decreasing trend observed taste scores for all the products i.e. 7.17±0.05 (control), 7.11±0.06 (T1), 6.90±0.06 (T2), 6.94±0.06 (T3).
Devid (2012) prepared functional *paneer* from buffalo milk blended with coconut milk. The treatment combination was (95:05, 90:10, 85:15) of buffalo milk and coconut milk. The flavour and test score of *paneer* was 8.36(T_1), 7.78(T_2), 7.92(T_3) and 7.86 (T_4).
Martina *et al.* (2020) incorporated graded levels of turmeric (*Curcuma longa*) on different qualities of stirred yoghurt. The sample YTB1 (95:5) scored the highest for taste (8.87±0.49), while the sample YTA5 (75:25) within the stirred yoghurt group had the lowest score (5.23±1.07). The plain yoghurt scored (7.23±1.48) for taste. There was a decrease in the overall acceptability of taste as higher amount of turmeric was incorporated. This could be traceable to a very characteristic spicy taste of turmeric in the samples thus changing the samples' taste from sweet to somewhat bitter taste.
In the present investigation, a value for mouthfeel/smoothness was found to be comparable with the research findings recorded above.

Overall acceptability of raw turmeric extract added *paneer*
The overall acceptability score is the average score worked out from the score given by the judges for the different characteristics of the product i.e. colour and appearance, flavour, body and texture and mouthfeel/smoothness. Thus the average score worked out as overall acceptability score is presented in table 8.

Table 8: Overall acceptability of raw turmeric extract added *paneer* at different levels of raw turmeric extract

Treatments	Overall acceptability				
	R-l	R-1I	R-III	R-IV	Mean
T_1	8.69	8.81	8.88	8.75	8.78[a]
T_2	8.38	8.25	8.13	8.13	8.22[b]
T_3	7.19	7.81	7.25	7.19	7.36[c]
T_4	6.81	6.94	6.19	6.06	6.50[d]
SE ± 0.138 CD at 5% 0. 427					

The values with different small letters superscripts row wise differ significantly at 5% level of significance.

From the table no. 8 it is clear that the overall average score for the finished product including control ranged in between 6.50 and 8.78 i.e. for T_4 to T_1 treatment combinations. The mean scores of overall acceptability showed a decreasing trend with increase in level of raw turmeric extract. It is observed that more levels of raw turmeric extract lowered the score of *paneer* for overall acceptability, but all treatments secured the score more than 6.50 means it was in between like slightly to like extremely on 9 point hedonic scale and acceptable. The T_2 treatment was highest score in turmeric extract used *paneer* i.e. 8.22 which was above the like very

much. Lastly, sensory properties of food products are most important parameter in the chain of products development. Similar feeling regarding in the development of other milk products were observed by the following researchers for colour change in their respective milk products.

Buch (2014) [4] studied that overall acceptability score declined with increase in turmeric powder % in *paneer* from 8.0 (0.0%), 7.9 (0.2%), 7.8(0.4%), 6.9 (0.6%), 6.3 (0.8%) and 5.8 (1%).

Prasad (2017) [16] incorporated turmeric powder in burfi in which overall acceptability score decrease in turmeric added burfi. Maji *et al.* (2018) [12] studied herbal lassi fortified with turmeric (*Curcuma longa*) extract decrease overall acceptability score with increase in turmeric extract from control 8.30 control, 8.23 (1%), 7.33 (2%), 6.66 (3%) and 5.66 (4%) level. In the present investigation, a value for overall acceptability was found to be comparable with the research findings recorded above.

Conclusion

The raw turmeric extract added *paneer* can successfully impact on preserving, enhancing nutritional and health properties to *paneer*. The increased in percent of raw turmeric extract in *paneer* which affect positively on nutritional quality and health properties. Addition of 5 per cent extract in developed *paneer* like moderately on 9 point hedonic scale. It observed that increased in per cent of raw turmeric extract affect decreasing in sensory score of product.

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