

# Development and quality evaluation of low fat functional paneer

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## ABSTRACT

An experiment was conducted to utilize skim milk for the preparation of low fat paneer, a value added product. Low fat paneer was prepared by using whey protein concentrate (WPC) and inulin as fat replacers. Full fat control paneer (C1) was prepared from buffalo milk standardized to 5 per cent fat and 9 per cent SNF. Skim milk control paneer (C2) was prepared from skim milk standardized to 0.3 per cent fat and 9 per cent SNF. WPC was incorporated at 0.25 (T1) and 0.5 per cent levels (T2). Inulin was used at the level of 1.5 (T1) and 2 per cent (T2) for the preparation of low fat paneer. The prepared paneer samples were evaluated for physico-chemical, microbiological and organoleptic qualities. Incorporation of WPC had significantly increased the yield as well as moisture content of low fat paneer. Inulin at 2 per cent level had increased the yield of low fat paneer. Both WPC and inulin had improved the sensory acceptability of low fat paneer prepared from skim milk.

**Key words:** Paneer, Whey protein concentrate, Inulin, Low fat paneer, Fat replacers

## INTRODUCTION

Milk has long been recognized as an ideal and nearly perfect food for all sections of the society. Paneer is an indigenous dairy product obtained by acid coagulation of hot whole milk with subsequent drainage of whey. It is a rich source of milk protein and fat available at a comparatively lower cost. However, it is not preferred by the modern health conscious consumers due to its high fat content. As per the data published by WHO (1965), high intake of fat rich dairy products increased the risk of cardio vascular diseases because of high proportions of saturated fatty acids. This offers an opportunity for development and commercial manufacture of low fat paneer suitable for persons suffering from lifestyle related diseases. Since fat is

largely responsible for the desirable flavor, body and texture of paneer, reducing the fat content will lead to several sensory quality defects such as rubbery, chewy and hard body. These defects could be prevented by the use of fat replacers in low fat products.

Fat replacers are the substances with the same functions, stability, physical and chemical characteristics as regular fat but with low calories. They help to improve the organoleptic qualities of low fat dairy products. Whey protein concentrates (WPC) are protein based fat replacers that have the potential to improve the organoleptic qualities of low fat dairy products. Inulin is a carbohydrate based fat replacer and dietary fiber extracted from chicory root. It also improves the flavor, body and texture of low-fat foods.

## **MATERIALS AND METHODS**

### **Preparation of paneer**

Paneer was prepared as per the procedure suggested by Sachdeva (1983). Milk was heated to 90°C and promptly cooled to 70°C. Then it was coagulated by using 1 per cent citric acid. Then the coagulum was pressed and the yield of paneer was recorded. Full fat control paneer was prepared from milk standardized to 5 per cent fat and 9 per cent SNF (C1). Skim milk control paneer (C2) was prepared from skim milk standardized to 0.3 per cent fat and 9 per cent SNF. Low fat paneer was prepared by incorporating WPC at 0.25 (T1) and 0.5 per cent (T2) levels. Inulin was incorporated at 1.5 (T1) and 2 per cent (T2) levels for the preparation of low fat paneer.

### **Analysis of the paneer**

#### **Chemical analysis**

Control and treatment groups of paneer were analyzed for yield, fat, moisture, total solids, and titratable acidity. The fat percent of paneer was analyzed by the procedure suggested by BIS (1977). Moisture and total solids contents of paneer were determined as per the procedure described in BIS (1983). The titratable acidity was determined as per AOAC (2000).

### **Microbiological quality of paneer**

Standard plate count, coliform count and yeast and mould count of paneer samples were determined according to the procedure described by BIS (1980).

### **Sensory evaluation**

The fresh paneer samples were evaluated for their sensory characteristics such as color and appearance, flavor, body and texture and overall acceptability as per the method recommended by BIS (2003). The data obtained from various studies were subjected to statistical analysis by following the procedure described by Snedecor and Cochran (1994). Six replications were done in each category. The statistical studies were carried out for comparing physical, chemical, microbiological and sensory parameters of low fat paneer with control. Duncan's Multiple Range Test (DMRT) was carried out for pair wise comparison if 'F' values are found to be significant in ANOVA.

## **RESULTS AND DISCUSSION**

### **Physico-chemical quality of low fat paneer incorporated with whey protein concentrate**

Table 1 represents the physico-chemical analysis of low fat paneer incorporated with whey protein concentrate

**Table 1: Physico- chemical analysis of low fat paneer incorporated with WPC (Mean±S.E)**

Parameters (%)	Full fat control(C1)	Skim milk control(C2)	Skim milk paneer incorporated with 0.25%WPC(T1)	Skim milk paneer incorporated with 0.5%WPC(T2)
Yield	18.00±0.50 <sup>a</sup>	13.46±0.57 <sup>b</sup>	14.21±0.61 <sup>bc</sup>	15.73±0.61 <sup>c</sup>
Fat	19.42±0.33 <sup>a</sup>	4.58±0.20 <sup>b</sup>	4.17±0.33 <sup>b</sup>	4.25±0.21 <sup>b</sup>
Moisture	54.53±0.37 <sup>a</sup>	56.56±0.74 <sup>a</sup>	55.43±0.51 <sup>a</sup>	59.03±1.25 <sup>b</sup>
Total solids	45.47±0.37 <sup>a</sup>	43.43±0.73 <sup>a</sup>	44.53±0.50 <sup>a</sup>	39.78±1.19 <sup>b</sup>
Titratable acidity	0.43±0.03 <sup>a</sup>	0.47±0.02 <sup>a</sup>	0.45±0.02 <sup>a</sup>	0.47±0.02 <sup>a</sup>

Means within a row bearing different letters as superscript differ significantly.

Means within a row bearing same letters as superscript are homogenous.

### Yield

The mean yield of control and treatment groups of (C1, C2, T1 and T2) paneer was 18.00±0.50, 13.46±0.57, 14.21±0.61, 15.73±0.61 respectively. The yield of treatment groups of paneer and skim milk control paneer were significantly lower than full fat control paneer. Addition of WPC had increased the yield of paneer. Lo and Bastion (1998) had reported similar results in low-fat Havarti cheese.

### Fat

The mean fat percentage of control and treatment groups of paneer samples were 19.42±0.33 (C1), 4.58±0.20 (C2), 4.17±0.33 (T1) and 4.25±0.21 (T2) respectively. The fat content of treatment groups of paneer and skim milk control was significantly lower than full fat control. Incorporation of WPC had reduced the fat content of treatment groups of paneer when compared to skim milk paneer. Bhatt (2013), observed that there was a decrease in fat recovery with increase in the level of WPC in low fat paneer.

### Moisture

The mean moisture content of paneer samples were 54±0.37 (C1), 56.56±0.74 (C2), 55.43±0.51 (T1) and 59.03±1.25 (T2) per cent respectively. There was a significant difference in moisture content between treatment groups and full fat control paneer. Skim milk control paneer (C2) and T1 did not show any significant difference in moisture content whereas, T2 showed significant variation from C2 and T1. Narayanarao (2005) had reported an increase in moisture content in low fat paneer incorporated with whey protein concentrate. In this study also incorporation of WPC at 0.5 per cent level had significantly increased the moisture content of paneer.

### Total solids

The mean values of total solids per cent in paneer samples were 45.47±0.37 (C1), 43.43±0.73 (C2), 44.53±0.50 (T1) and 39.78±1.19 (T2) respectively. The total solids content in treatment groups and skim milk control paneer were significantly different from full fat control. Bhatt (2013) had reported that there was an increase in

total solid recovery in low fat paneer when WPC was incorporated at the rate of 0.2 per cent. However, higher levels of addition of WPC resulted in decrease in total solid recovery.

In the present study also addition of WPC at 0.25 per cent had slightly increased the total solid content but incorporation at 0.5 per cent level had decreased the total solids content.

### Titrateable acidity

The mean titrateable acidity of full fat and skim milk control paneer were

0.43±0.03 and 0.47±0.02 per cent lactic acid respectively. The titrateable acidity of treatment groups of paneer were 0.45±0.02 and 0.47±0.02 per cent lactic acid respectively. There was no significant difference in titrateable acidity between control and treatment groups of paneer. Narayanarao (2005) reported that the pH and titrateable acidity in low fat paneer did not differ much by the addition of WPC.

### Microbiological quality

Table 2 represents the results of microbiological analysis of low fat paneer incorporated with whey protein concentrate

**Table 2: Microbiological quality of low fat paneer incorporated with WPC (Mean±S.E)**

Microbiological analysis	Storage days	Full fat control (C1)	Skim milk control (C2)	Skim milk paneer incorporate with 0.25%WPC (T1)	Skim milk paneer incorporated with 0.5%WPC (T2)
SPC	0 <sup>th</sup> day	3.98±0.05 <sup>a</sup>	4.05±0.02 <sup>a</sup>	3.98±0.05 <sup>a</sup>	3.99±0.04 <sup>a</sup>
	4 <sup>th</sup> day	4.14±0.03 <sup>b</sup>	4.11±0.04 <sup>a</sup>	4.08±0.02 <sup>a</sup>	4.09±0.04 <sup>a</sup>
	7 <sup>th</sup> day	4.25±0.01 <sup>c</sup>	4.23±0.02 <sup>b</sup>	4.19±0.03 <sup>b</sup>	4.21±0.02 <sup>b</sup>
Yeast and mould	0 <sup>th</sup> day	1.15±0.07 <sup>a</sup>	1.26±0.09 <sup>a</sup>	1.23±0.08 <sup>a</sup>	1.13±0.09 <sup>a</sup>
	4 <sup>th</sup> day	1.48±0.06 <sup>a</sup>	1.38±0.09 <sup>a</sup>	1.39±1.39 <sup>a</sup>	1.35±0.09 <sup>a</sup>
	7 <sup>th</sup> day	1.57±0.04 <sup>a</sup>	1.45±0.07 <sup>a</sup>	1.59±0.08 <sup>a</sup>	1.60±0.03 <sup>a</sup>
Coliform count	0 <sup>th</sup> day	0.96±0.21 <sup>a</sup>	0.72±0.23 <sup>b</sup>	0.88±0.18 <sup>a</sup>	0.72±0.23 <sup>b</sup>
	4 <sup>th</sup> day	0.22±0.22 <sup>a</sup>	0	0.33±0.33 <sup>ab</sup>	0.23±0.17 <sup>a</sup>
	7 <sup>th</sup> day	0	0	0	0

Means within a row bearing different letters as superscript differ significantly.

Means within a row bearing same letters as superscript are homogenous.

### **Standard plate count**

The mean standard plate count of full fat control paneer (C1) was  $3.98 \pm 0.05$ ,  $4.14 \pm 0.03$  and  $4.25 \pm 0.01$  log cfu/g respectively for the 0<sup>th</sup>, 4<sup>th</sup> and 7<sup>th</sup> day of storage. For C2 paneer the values were  $4.05 \pm 0.02$ ,  $4.11 \pm 0.04$  and  $4.23 \pm 0.02$  log cfu/g respectively. The values for T1 paneer were  $3.98 \pm 0.05$ ,  $4.08 \pm 0.02$  and  $4.19 \pm 0.03$  log cfu/g respectively. For T2 paneer, the mean values were  $3.99 \pm 0.04$ ,  $4.09 \pm 0.04$  and  $4.21 \pm 0.02$  log cfu/g respectively. A progressive increase in SPC was noticed during storage in all paneer samples. However, the counts were within the legal limit until seven days of storage.

### **Yeast and Mould count**

The mean yeast and mould count of full fat paneer was  $1.15 \pm 0.07$ ,  $1.48 \pm 0.06$  and  $1.57 \pm 0.04$  logcfu/g for the 0<sup>th</sup>, 4<sup>th</sup> and 7<sup>th</sup> day of storage respectively. For C2 the counts were  $1.26 \pm 0.09$ ,  $1.38 \pm 0.09$  and  $1.45 \pm 0.07$  log cfu/g respectively. For treatment group one (T1) the mean values were  $1.23 \pm 0.08$ ,  $1.39 \pm 1.39$  and  $1.59 \pm 0.08$  log cfu/g respectively. In treatment group two (T2), the mean values were  $1.13 \pm 0.09$ ,  $1.35 \pm 0.09$  and  $1.60 \pm 0.03$  log cfu/g respectively. Addition of WPC had not altered the yeast and mould count of paneer. Even though the yeast and mould count

increased during storage, it was within the legal limit until seven days of refrigerated storage in all groups of paneer samples.

### **Coliform count**

The coliform count of paneer samples were taken during the 0<sup>th</sup>, 4<sup>th</sup> and 7<sup>th</sup> day of refrigerated storage. Coliform count were absent in all paneer samples on 7<sup>th</sup> day of storage. The coliform count on 0<sup>th</sup> and 4<sup>th</sup> day of storage in full fat control paneer (C1) were  $0.96 \pm 0.21$  and  $0.22 \pm 0.22$  log cfu/g respectively. For C2 paneer, the values were  $0.72 \pm 0.23$  and  $0.00 \pm 0.00$  log cfu/g respectively. For T1 paneer the values were  $0.88 \pm 0.18$  and  $0.33 \pm 0.33$  log cfu/g respectively. For T2 the values were  $0.72 \pm 0.23$  and  $0.23 \pm 0.17$  log cfu/g respectively. Coliform count did not show any significant difference between control and treatment groups of paneer. It was within the acceptable limit prescribed by FSSAI until seven days of refrigerated storage. The absence of coliform organisms on 7<sup>th</sup> day of storage might be due to developed acidity which might have prevented the growth of coliform.

### **Sensory evaluation**

Table 3 represents the sensory scores of low fat paneer incorporated with whey protein concentrate

**Table3. Sensory scores of WPC added low fat paneer(Mean  $\pm$  S.E)**

Parameters	Full fat control(C1)	Skim milk control (C2)	Skim milk paneer incorporate with 0.25%WPC (T1)	Skim milk paneer incorporated with 0.5%WPC (T2)
Color and appearance	9.6 $\pm$ 0.21 <sup>a</sup>	6.83 $\pm$ 0.40 <sup>b</sup>	8.00 $\pm$ 0.45 <sup>c</sup>	8.33 $\pm$ 0.33 <sup>c</sup>
Body and texture	39.17 $\pm$ 0.40 <sup>a</sup>	31.17 $\pm$ 0.91 <sup>b</sup>	34.33 $\pm$ 1.38 <sup>bc</sup>	35.00 $\pm$ 1.63 <sup>c</sup>
Flavour	48.33 $\pm$ 0.71 <sup>a</sup>	42.00 $\pm$ 1.51 <sup>a</sup>	45.17 $\pm$ 1.11 <sup>a</sup>	45.83 $\pm$ 1.40 <sup>a</sup>
Overall score	97.17 $\pm$ 1.25	80.00 $\pm$ 1.65	88.50 $\pm$ 2.31	88.17 $\pm$ 2.59

Means within a row bearing different letters as superscript differ significantly.

Means within a row bearing same letters as superscript are homogenous.

The mean appearance and color, body and texture, flavor and overall scores of control paneer were 9.6 $\pm$ 0.21, 39.17 $\pm$ 0.40, 48.33 $\pm$ 0.71 and 97.17 $\pm$ 1.25 respectively. The corresponding values for C2 were 6.83 $\pm$ 0.4, 31.17 $\pm$ 0.91, 42.00 $\pm$ 1.51 and 80.00 $\pm$ 1.65 respectively. The values of T1 paneer were 8.00 $\pm$ 0.45, 34.33 $\pm$ 1.38, 45.17 $\pm$ 1.11 and 88.50 $\pm$ 2.31 respectively. For T2 paneer the values were 8.33 $\pm$ 0.33, 35.00 $\pm$ 1.63, 45.83 $\pm$ 1.40 and 88.17 $\pm$ 2.59 respectively. The sensory scores were improved due to the incorporation of WPC. The body and texture of paneer added with WPC was superior to that of paneer prepared without WPC. This

could be attributed to more softness in paneer due to the retention of moisture. Similar findings were also reported by earlier researchers. Narayanarao (2005) observed that the overall acceptability of low fat paneer incorporated with 2 per cent WPC was higher than control. Bhatt (2013) reported that the hardness values of WPC incorporated paneer samples were significantly lower than skim milk control paneer.

#### **Physico-chemical quality of low fat paneer incorporated with inulin**

Table 4 represents the physico-chemical analysis of low fat paneer incorporated with inulin

**Table 4: Physico- chemical analysis of low fat paneer incorporated with inulin (Mean±S.E)**

Parameters (%)	Full fat control (C1)	Skim milk control (C2)	Low fat paneer incorporated with 1.5% inulin (T1)	Low fat paneer incorporated with 2% inulin (T2)
Yield	17.90±0.48 <sup>a</sup>	12.40±0.44 <sup>b</sup>	12.62±0.41 <sup>b</sup>	13.48±0.60 <sup>b</sup>
Fat	19.50±0.34 <sup>a</sup>	4.58±0.20 <sup>b</sup>	4.25±0.21 <sup>b</sup>	4.13±0.11 <sup>b</sup>
Moisture	54.53±0.37 <sup>a</sup>	57.26±0.23 <sup>b</sup>	57.36±0.23 <sup>b</sup>	59.28±0.29 <sup>c</sup>
Total solids	45.47±0.37 <sup>a</sup>	42.74±0.22 <sup>b</sup>	42.64±0.23 <sup>b</sup>	40.72±0.29 <sup>c</sup>
Titratable acidity	0.48±0.48 <sup>a</sup>	0.48±0.01 <sup>a</sup>	0.48±0.01 <sup>a</sup>	0.49±0.49 <sup>a</sup>

Means within a row bearing different letters as superscript differ significantly.

Means within a row bearing same letters as superscript are homogenous.

### Yield

The mean yield of control and treatment groups (C1, C2, T1 and T2) of paneer were 17.90±0.48, 12.40±0.44, 12.62±0.41 and 13.48±0.60 per cent respectively. The yield of treatment groups of paneer and skim milk control paneer was significantly lower than full fat control paneer. Kantha (2005) also reported a linear and significant increase in the yield, with increasing levels of inulin in low fat paneer.

### Fat

The mean fat percentage of control and treatment groups of paneer samples were 19.50±0.34 (C1), 4.58±0.20 (C2), 4.25±0.21 (T1), and 4.13±0.11 (T2) respectively. The fat per cent of treatment groups of paneer and skim milk control paneer were significantly lower than full fat control paneer. The decrease in fat content in inulin added samples might be due to the increase in moisture content caused by the water binding capacity of inulin. Similar findings were reported by the earlier researchers. Megha (2014) reported that

the addition of inulin in goat milk yoghurt decreased the fat percentage. She also reported that the decrease in fat percentage was proportional to the level of addition of inulin. Teresa Grzelak (2016) reported that the addition of inulin to food products did not change their organoleptic features, but it allowed the reduction of fat content in the final product.

### Moisture

The mean moisture content of paneer samples were 54.53±0.37, 57.26±0.23, 57.36±0.23 and 59.28±0.29 per cent respectively. There was a highly significant difference in moisture content between the treatment groups and full fat control paneer. Skim milk control paneer (C2) and treatment group one (T1) did not show any significant difference in moisture content; whereas, T2 showed significant variation from T1 and C2 Paneer samples prepared by incorporation of inulin had higher moisture content than skim milk paneer prepared without inulin. According to Kantha (2005), inulin had been reported to have the capacity to retain 1-2 gm moisture per each gram of inulin.

## Total solids

The mean values of total solids content in paneer samples were  $45.47 \pm 0.37$  (C1),  $42.74 \pm 0.22$  (C2),  $42.64 \pm 0.23$  (T1) and  $40.72 \pm 0.29$  (T2) per cent respectively. The total solids content of treatment groups and skim milk control paneer showed significant difference from full fat control paneer. Addition of inulin had increased the moisture content and thereby reduced the total solids content.

## Titratable acidity

The mean titratable acidity of control groups of paneer (C1 and C2)

were  $0.48 \pm 0.48$  and  $0.48 \pm 0.01$  per cent lactic acid respectively. The titratable acidity of treatment groups of paneer were  $0.48 \pm 0.01$  and  $0.49 \pm 0.49$  per cent lactic acid for T1 and T2 respectively. The titratable acidity of treatment groups did not show any significant variation from control paneer. Kantha (2005) also found that there was no significant difference in titratable acidity between control and experimental samples incorporated with inulin.

## Microbiological quality of paneer

Table 5 represents the microbiological quality of low fat paneer incorporated with inulin

**Table 5: Microbiological quality of low fat paneer incorporated with inulin (Mean $\pm$ S.E)**

Microbiological analysis	Storage days	Full fat control (C1)	Skim milk control (C2)	Skim milk paneer incorporate with 1.5% inulin (T1)	Skim milk paneer incorporated with 2 % inulin (T2)
SPC	0 <sup>th</sup> day	$4.05 \pm 0.01^a$	$3.98 \pm 0.05^a$	$3.98 \pm 0.04^a$	$3.99 \pm 0.04^a$
	4 <sup>th</sup> day	$4.14 \pm 0.03^b$	$4.11 \pm 0.033^a$	$4.08 \pm 0.02^a$	$4.09 \pm 0.03^a$
	7 <sup>th</sup> day	$4.23 \pm 0.02^c$	$4.25 \pm 0.01^c$	$4.18 \pm 0.02^b$	$4.20 \pm 0.02^b$
Yeast and mold	0 <sup>th</sup> day	$1.26 \pm 0.09^a$	$1.26 \pm 0.09^a$	$1.26 \pm 0.09^a$	$1.18 \pm 0.08^a$
	4 <sup>th</sup> day	$1.33 \pm 1.33^a$	$1.33 \pm 0.08^{ab}$	$1.39 \pm 0.09^a$	$1.48 \pm 0.06^b$
	7 <sup>th</sup> day	$1.49 \pm 0.04^a$	$1.51 \pm 0.05^b$	$1.51 \pm 0.08^a$	$1.49 \pm 0.07^b$
Coliform count	0 <sup>th</sup> day	$0.88 \pm 0.18^a$	$0.72 \pm 0.23^a$	$0.22 \pm 0.22^a$	$0.72 \pm 0.23^b$
	4 <sup>th</sup> day	0	$0.22 \pm 0.22^a$	0	$0.17 \pm 0.19^{ab}$
	7 <sup>th</sup> day	0	0	0	0

Means within a row bearing different letters as superscript differ significantly.

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## Standard plate count

The mean standard plate count of full fat control paneer was  $4.04 \pm 0.01$ ,  $4.14 \pm 0.03$  and  $4.23 \pm 0.02$  log cfu/g respectively for 0<sup>th</sup>, 4<sup>th</sup> and 7<sup>th</sup> day of storage. The corresponding values of C2 paneer were  $3.98 \pm 0.05$ ,  $4.11 \pm 0.03$  and  $4.25 \pm 0.01$  log cfu/g

respectively. The values of T1 paneer were  $3.98 \pm 0.04$ ,  $4.07 \pm 0.02$  and  $4.18 \pm 0.02$  log cfu/g respectively. For T2, the mean values were  $3.99 \pm 0.04$ ,  $4.08 \pm 0.03$  and  $4.20 \pm 0.02$  log cfu/g respectively. Standard plate count of paneer samples showed a significant increase during storage. However, all the samples of paneer met with the legal standards.

### Yeast and Mould count

The mean yeast and mould count of full fat paneer were  $1.26 \pm 0.09$ ,  $1.33 \pm 1.33$  and  $1.49 \pm 0.04$  log cfu/g respectively for 0<sup>th</sup>, 4<sup>th</sup> and 7<sup>th</sup> day of storage. For C2 the counts were  $1.26 \pm 0.09$ ,  $1.33 \pm 0.08$  and  $1.51 \pm 0.05$  log cfu/g respectively. For treatment group one (T1), the mean values were  $1.26 \pm 0.09$ ,  $1.39 \pm 0.09$  and  $1.51 \pm 0.08$  log cfu/g respectively. In treatment group two (T2), the mean values were  $1.18 \pm 0.08$ ,  $1.48 \pm 0.06$  and  $1.49 \pm 0.07$  log cfu/g respectively. Yeast and mould count showed a progressive increase during storage. However, it was within the legal limit until seven days of storage. Yadav *et al.* (2009) had also reported an increase in yeast and mould count in paneer samples during storage.

### Coliform count

The coliform count on 0<sup>th</sup> day was  $0.88 \pm 0.18$  log cfu/g and it was absent on

4<sup>th</sup> day of storage in full fat control (C1). For C2 the values were  $0.72 \pm 0.23$  and  $0.22 \pm 0.22$  log cfu/g on 0<sup>th</sup> and 4<sup>th</sup> day of storage respectively. For T1 the value was  $0.22 \pm 0.22$  log cfu/g on 0<sup>th</sup> day and it was absent on 4<sup>th</sup> day of storage. In treatment group two T2 the values were  $0.72 \pm 0.23$  and  $0.33 \pm 0.21$  log cfu/g respectively. Coliforms were absent in all paneer samples on 7<sup>th</sup> day of storage due to the increase in acidity of paneer during storage. Viji (2014) also reported that coliform counts were absent on 5<sup>th</sup> day of refrigerated storage in goat milk paneer samples. In the present study, coliform counts were within the acceptable limit prescribed by FSSAI until seven days of refrigerated storage.

### Sensory evaluation

Table 6 represents the sensory scores of low fat paneer incorporated with inulin.

**Table 6 Sensory scores of inulin added low fat paneer (Mean  $\pm$  S.E)**

Parameters	Full fat control (C1)	Skim milk control (C2)	Skim milk paneer incorporate with 1.5% inulin (T1)	Skim milk paneer incorporated with 2 % inulin (T2)
Color and appearance	$9.42 \pm 0.27^a$	$7.67 \pm 0.67^b$	$8.83 \pm 0.31^{ab}$	$8.75 \pm 0.31^{ab}$
Body and texture	$37.67 \pm 0.95^a$	$29.50 \pm 2.01^b$	$33.67 \pm 1.48^{ab}$	$31.50 \pm 1.26^b$
Flavour	$48.17 \pm 0.87^a$	$42.67 \pm 2.67^a$	$46.00 \pm 1.77^a$	$45.33 \pm 1.54^a$
Overall score	$95.25 \pm 1.61$	$79.83 \pm 3.61$	$88.50 \pm 2.88$	$85.58 \pm 2.48$

Means within a row bearing different letters as superscript differ significantly.

Means within a row bearing same small letters as superscript are homogenous.

In inulin added paneer samples the mean appearance and colour, body and texture, flavor and overall scores of full fat control paneer were  $9.42 \pm 0.27$ ,  $37.67 \pm 0.95$ ,  $48.17 \pm 0.87$  and  $95.25 \pm 1.61$  respectively. The corresponding values for C2 were  $7.67 \pm 0.67$ ,  $29.50 \pm 2.01$ ,  $42.67 \pm 2.67$  and  $79.83 \pm 3.61$  respectively. The values for T1 paneer were  $8.83 \pm 0.31$ ,  $33.67 \pm 1.48$ ,  $46.00 \pm 1.77$  and  $88.50 \pm 2.88$  respectively. For T2 paneer the values were  $8.75 \pm 0.31$ ,  $31.50 \pm 1.26$ ,  $45.33 \pm 1.54$  and  $85.58 \pm 2.48$  respectively. Kantha (2005) reported that paneer developed from milk with 1.8% fat and 4.5% inulin had similar sensory attributes to that prepared from full cream milk.

### CONCLUSION

From the above results, it can be concluded that good quality low fat paneer could be prepared from skim milk by the addition of WPC or inulin. The yield and moisture content of paneer increased with the addition of WPC or inulin. The sensory scores of low fat paneer were improved due to the incorporation of WPC and inulin. The paneer prepared by the addition of 1.5 per cent inulin showed better sensory scores than 2 per cent inulin. The microbiological qualities of the developed low fat paneer samples were good until seven days of refrigerated storage. Low fat paneer prepared with the incorporation of 0.5 per cent WPC had maximum yield (15.73 per cent).

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### REFERENCES

- Agnihotri, M.K and Pal U.K. (1996). Quality and shelf life of paneer in refrigerated storage. *Small Rumin. Res.* **20**: 75-81.
- AOAC (2000). The Official Methods of Analysis of AOAC International. (7th Ed). W. Horwitz (Ed.) Washington D.C. Vol.1, Method 960.52, 991.43 and 991.29.
- B.I.S. (1977). Part-II, Determination of Fat by Gerber Method: Milk Products. Indian Standard Institution. Manak Bhavan, New Delhi. 8-9p.
- B.I.S. (1983). Specification for Paneer, Bureau of Indian Standards, New Delhi.
- B.I.S. (2003). Methods for sensory evaluation of paneer/chhana. Bureau of Indian Standards, New Delhi.
- B.I.S. (1981). Methods of sampling and microbiological examination. Handbook of food analysis, SP: 18 PART XI dairy products. Manak Bhavan, New Delhi: Bureau of Indian Standards.
- Bhatt, J.D. (2013). Standardization of method for preparation of reduced fat paneer using whey protein concentrates and selected emulsifier. M.Tech Thesis. Anand Agricultural University, Anand. 229p.

- Gupta, M.P. (2009). Effect of various coagulants on sensory, chemical and microbiological quality of paneer. *Journal of Rural and Agric Res.* **9**:11-14.
- Kantha, K.L. and Kanawjia, S.K. (2007). Response surface analysis of sensory attributes and yield of low fat paneer enriched with soy fiber. *Indian J. Dairy Sci.* **60(4)**:230–238.
- Lo, C.G and Bastion, E.D. (1998). Incorporation of natured and denatured whey protein into cheese curd for manufacture of reduced fat cheese. *J. Dairy Sci.* **81**:16-24.
- Megha, K.R and Radha, K. 2016. Development and quality evaluation of prebiotic yoghurt from goat milk. *Ind. J. Vet. Anim. Sci. Res.*, **45(3)** 655-661.
- Narayanarao, S.V. (2005). Preparation of low fat paneer enriched with whey protein concentrates. M.VSc Thesis. College of Veterinary And Animal Sciences, Parbhani. 55p.
- Snedecor, G.W. and Cochran, W.G. 1994. Statistical methods.(8th Ed.). Oxford and IBH Publishing company, New Delhi.
- Teresa Grzelak, Joanna Grupinska, Marta Pelczynska, Marcelina Sperling and Krystyna Czyzewska (2016).The merits of fat replacers in low-calorie food. *Acta.Sci.Pol.HortorumCultus.* **16(2)**: 87–94.
- Thapa, T.B and Gupta, V.K (1996). Chemical and Sensory qualities of processed cheese foods prepared with added whey protein concentrate. *Indian J. Dairy Sci.* **42(2)**: 129-137.
- Viji, K.S and Radha, K. (2015). Microbiological quality studies of goat milk paneer. *Ind. J. Vet. Anim. Sci. Res.*, **44(3)**: 181-188.
- World Health Organization and Candau, Marcolino Gomes(1965). The work of WHO, 1965: Annual report of the director general. 244p.
- Yadav, Y.N. Singh, C. Dwivedi, B.R. and Gupta, M.P. 2009. Effect of various coagulants on sensory, chemical and microbiological quality of paneer. *J. Rural and Agric Res.* **9**: 11-14.