

DEVELOPMENT OF FIBER FORTIFIED PROBIOTIC SHRIKHAND

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ABSTRACT

The present investigation was conducted to develop a fiber-fortified probiotic shrikhand using the probiotic culture thermophilic lactic acid freeze-dried DVS (Direct Vat Set) culture (ABY-3). Three fiber containing powder were incorporated in *shrikhand* viz., banana powder (@B1:1%, B2:3% and B3:5%), oat powder (@ O1:1%, O2:2%, O3:3%) and inulin powder (@ I1:1%, I2: 2% and I3:3%) on w/w basis of expected yield of shrikhand. It was found that among the three levels studied B₃, O₂ and I3 were found most acceptable with respect to their flavour and overall acceptability scores. *Shrikhands* containing selected level of each fiber containing powder were compared and it was found that I3 i.e. 3% inulin level was preferred the most which was found to contain 59.01 %total solids, 6.37 %milk fat, 5.72 %protein,0.68 % ash and 2.8 %fiber, 0.98 % LA and a consistency of 8.65 Nwith a probiotic count of 8.46-log cfu/g.. The shrikhand could be labelled as a “good source of fiber” providing 12.7% Daily Value (DV) of fiber/ 100 g serving. In conclusion, the study was successful in formulating an acceptable qualityfibre enriched, probiotic shrikhand

INTRODUCTION

Fermented dairy products have long been an important component of nutritional diet. Lactic acid bacteria used as starters in the industrial production of dahi, *Shrikhand*, mishit doi, lassi, buttermilk and yoghurt. The lactic acid bacteria are naturally accepted as GRAS (Generally regarded as safe) for human consumption. The probiotic bacteria used in commercial products today are mainly members of the genera *Lactobacillus* and *Bifidobacterium* (Devshete *et al.*, 2012). Amongst the various fermented milk products, dahi a well-known indigenous fermented milk products prepared by lactic acid fermentation is being converted in to *Shrikhand*because of its better shelf life. *Shrikhand* is an indigenous fermented and sweetened milk product having a typical pleasant sweet-sour taste. It is prepared by blending Chakka, a semi-solid mass obtained after draining whey from dahi, with sugar, cream and other ingredients like fruit pulp, nut, flavour, spices and colour to achieve the finished product of desired composition, consistency and sensory attributes. *Shrikhand* has a typical semi-solid consistency with a characteristic smoothness, firmness and pliability that makes it suitable for direct consumption. Consumption of *Shrikhand* is reported to be effective in treatment of many diseases like diarrhoea, acidity, gastroenteritis (Devshete *et al.*, 2012).

The importance of dietary fibres in the diet has been recognised now a days. Dietary fibres can provide a multitude of functional properties when they are incorporated in food systems. Thus, fibres addition contributes to the modification and improvement of the texture, sensory characteristics and

shelf-life of foods due to their water-binding capacity, gel-forming ability, fat mimetic, anti-sticking, anti-clumping, texturising and thickening effects (Thebaudin *et al.*, 1997; Yangilar,2013; Dello *et al.*,2004). Dietary fiber have beneficial physiological effect like improved laxation, attenuation of blood cholesterol, attenuation of post prandial blood glucose, influence of immune function, fermentability and production of SCFAS (short chain fatty acids), decreasing of intestinal transits time, increasing of stool bulk (EU, 2008).They have technical functionality relating to texture, as well as nutritional functionality relating to health (Ramirez *et al.*, 2010; Ajila and Prasada Rao, 2013).

Since, Shrikhand,an important component of nutritional diet is reported to be effective in treatment of many diseases like diarrhoea, acidity, gastroenteritis incorporation of fiber in such product would help in further improving its nutritional value. Three fibre rich powders banana powder, inulin and oat powder were used in this study. It has been reported that banana stem is a rich source of fibre, potassium and vitamin B6 (Sen *et al.*, 2014).Milk and milk products considered as a vehicle for dietary fiber would not only take care of their own role in human health but could also enhance the heath fullness of the diet as a whole. Therefore, the present study was undertaken to develop a fiber fortified probiotic *Shrikhand* and to study its physico – chemical, rheological, microbiological and sensory properties.

MATERIALS AND METHODS

Pooled raw buffalo skim milk and cream were obtained from

Anubhav Dairy, Anand Agricultural University, Anand. The skim milk was free from any objectionable flavor and had an average composition of 0.1 + 0 % milk fat, 3.5 + 0.1 % protein, 9.3 + 0.1 % total solids and 0.15 + 0.02 % LA. The average composition of cream was 65 to 70 % fat. Good quality granular (crystal) sugar was procured from the local market of Anand. Polystyrene cups of 200 g and 500 g capacity were used as packaging materials. Thermophilic lactic acid freeze dried DVS (Direct Vat Set) culture (ABY-3) procured from the Christian Hansen Ltd. Mumbai containing a mixed culture of *Bifidobacterium* spp., *Streptococcus thermophilus*, *Lactobacillus acidophilus*, *Lactobacillus delbrueckii subsp. bulgaricus* was used for manufacture of dahi. Probiotic *Shrikhand* was fortified with three fiber containing materials viz. banana, oat and inulin powders. Banana powder was procured from Aum fresh- Aum Agri Freeze Foods, Baroda. The composition of banana powder was 5.12% protein, 4.30% moisture, 3.2% fat and 2.46% ash. Bagrrys India Limited, Delhi, supplied oat. The approximate composition of oat powder was 14.2% protein, 14.2% fat, 3.4% ash, and 4.2% moisture. Inulin was supplied by Orafit Ltd. Belgium. The proximate composition of inulin was 92% fiber and 6% fructose and glucose. The total fiber content of banana powder, oat powder and inulin was 2.5%, 12.2% and 92% respectively.

Preparation of dahi and chakka

Buffalo skim milk was heated to 90°C for 10 min., cooled to 39°C and inoculated 0.1g/lit for ABY-3 culture. Thereafter milk was incubated at 39°C until the desired firmness and acidity of 0.65 + 0.05% LA was obtained. The dahi was transferred to a clean dry muslin cloth and kept for draining for 5-6 h in a cool dry area to obtain chakka.

Preparation of shrikhand

Chakka was mixed with a calculated amount of pasteurized cream to get 6% fat content in the *Shrikhand* and fine quality crystalline sugar to get around 41-42% sugar content in the final product. All the ingredients were mixed properly till sugar was dissolved completely and then the mixture was passed through a wire mesh (mesh size 30) to get fine and homogeneous consistency in *Shrikhand*. After mixing, *Shrikhand* was packed in polystyrene cups (previously sanitized in 200 ppm. chlorine solution for 10 min and then drained thoroughly). The cups of *Shrikhand* were stored at refrigerated temperature (*i.e.* 5 ± 2°C).

Analysis

Representative samples of skim milk and cream used for *Shrikhand* making were analysed for fat in the *Shrikhand* was determined as per the Rose – Gottlieb method and total protein prescribed in FSSAI standards (2010), and titra-table acidity

(IS: 1479, Part-I, 1960). The total milk solids were determined by Mojonnier milk tester, Model-D, as per standard procedure. Representative samples of *shrikhand* were drawn immediately after preparation and analysed for fat, ash, total protein, acidity by standard methods suggested by FSSAI, 2015 for *chakka* and *Shrikhand*. Compression testing of *Shrikhand* was done using Food Texture Analyzer (M/s. Lloyd Instruments, LRX Plus, England; Sr. No. 160374) using 50 Newton (N) load cell. Crude fiber was estimated by official method described in Analysis of the Association of Official Analytical Chemist (AOAC, 1990).

Sensory evaluation

Controls as well as experimental samples of *Shrikhand* were subjected to sensory evaluation by an expert trained panel of ten judges. Judges evaluated the products using the scorecard prescribed by Bureau of Indian Standards (IS: 15348, 2003). The organoleptic evaluation of *Shrikhand* (~ 8 + 1°C) was carried out in sensory evaluation laboratory.

Microbiological analysis

Suitable dilutions were selected based on preliminary trials. Phosphate buffer solution used for serial dilution was prepared as described in BIS (IS : 5401 - 1969). Probiotic count was determined by addition of 15-20 of molten MRS agar (prepared as specified in BIS Handbook, BIS Part XI: 1981). The plates were incubated in inverted position at 37 ± 0.5°C for 48 h and the number of colony forming units (cfu) per gram of product was noted. The SPC and coliform count counts were determined using the procedure described in BIS Handbook, BIS Part XI: 1981, IS:5401 (1969) respectively.

Statistical analysis

The mean values of each attribute under studied obtained from duplicate samples of four replications were analyzed using factorial CRD (Steele and Torrie, 1980). The microbial counts were analyzed after square root transformation with additive one.

RESULTS AND DISCUSSION

Three fiber containing powder were incorporated in *Shrikhand* at three rates viz., banana powder @ (B1: 1.0, B2: 3.0, B3: 5.0) %, oat powder @ (O1: 1.0, O2: 2.0, O3: 3.0) %, inulin powder @ (I1: 1.0, I2: 2.0, I3: 3.0) % on w/w basis of expected yield of *Shrikhand*. These levels were selected based on preliminary trials. The fiber content of banana powder, oat powder and inulin powder was 2.5, 12.8 and 92 % respectively. *Shrikhand* was prepared using the method described above. After obtaining *chakka* from skim milk dahi, fiber-containing powders were blended thoroughly with *chakka* followed by

Table 1: Effect of varying levels of banana powder on the composition, physico-chemical property and consistency of *Shrikhand*

Treatments	Chemical composition (%)					
	Total solids	Fat	Protein	Ash	Acidity (%LA)	Consistency(N)
Control – C	58.28 ± 0.03	6.23 ± 0.03	5.82 ± 0.01	0.57 ± 0.02	1.00 ± 0.01	8.15 ± 0.06
B ₁	58.65 ± 0.01	6.20 ± 0.03	5.79 ± 0.01	0.65 ± 0.01	0.99 ± 0.02	8.35 ± 0.06
B ₂	59.35 ± 0.02	5.78 ± 0.05	5.78 ± 0.01	0.68 ± 0.01	0.97 ± 0.03	8.53 ± 0.05
B ₃	60.03 ± 0.05	5.72 ± 0.04	5.75 ± 0.02	0.71 ± 0.02	0.95 ± 0.02	8.73 ± 0.05
CD (0.05)	0.048	0.057	0.02	0.016	NS	0.082

Figure placed after ± indicates standard deviation

Table 2: Effect of varying levels of banana powder on the sensory characteristics of *Shrikhand*

Treatments	Sensory Characteristics			
	Flavor (50)	Body & texture (35)	Color & appearance (10)	Total score* (100)
Control	43.32 ± 0.65	31.48 ± 0.21	9.14 ± 0.21	88.94 ± 0.78
B ₁	45.00 ± 0.37	32.55 ± 0.16	8.00 ± 0.19	90.55 ± 0.24
B ₂	44.52 ± 0.32	32.23 ± 0.19	7.91 ± 0.11	89.66 ± 0.34
B ₃	45.25 ± 0.66	32.71 ± 0.11	7.02 ± 0.16	89.98 ± 0.63
CD (0.05)	0.811	0.268	0.265	0.814

Figure placed after ± indicates standard deviation; *a full mark was given for package i.e. 5 out of 5.

Table 3: Effect of varying levels of oat powder on the composition, physico-chemical property and consistency of *Shrikhand*

Treatments	Chemical composition (%)					
	Total solids	Fat	Protein	Ash	Acidity (%LA)	Consistency(N)
Control – C	58.28 ± 0.05	6.23 ± 0.02	5.80 ± 0.02	0.57 ± 0.04	1.00 ± 0.01	8.48 ± 0.04
O ₁	58.65 ± 0.03	6.31 ± 0.01	5.90 ± 0.02	0.65 ± 0.04	0.99 ± 0.01	8.54 ± 0.01
O ₂	59.01 ± 0.03	6.37 ± 0.01	5.96 ± 0.01	0.68 ± 0.01	0.98 ± 0.01	8.63 ± 0.01
O ₃	59.36 ± 0.02	6.46 ± 0.01	6.03 ± 0.01	0.71 ± 0.01	0.97 ± 0.01	8.65 ± 0.01
CD (0.05)	0.055	0.022	0.022	0.044	0.014	0.032

Figure placed after ± indicates standard deviation

Table 4: Effect of varying levels of fiber containing oat powder on the sensory attributes of *Shrikhand*

Treatments	Sensory characteristics			
	Flavor (50)	Body & texture (35)	Color & appearance (10)	Total score* (100)
Control – C	44.05 ± 0.44	31.64 ± 0.35	9.06 ± 0.31	89.75 ± 0.88
O ₁	43.98 ± 0.06	32.46 ± 0.34	8.64 ± 0.32	90.08 ± 0.45
O ₂	43.85 ± 0.17	32.91 ± 0.44	8.55 ± 0.29	90.31 ± 0.66
O ₃	42.39 ± 0.22	31.94 ± 0.25	7.96 ± 0.17	87.29 ± 0.63
CD (0.05)	0.401	0.541	0.430	1.005

Figure placed after ± indicates standard deviation; *a full mark was given for package i.e. 5 out of 5.

Table 5: Effect of varying levels of inulin powder on the composition, physico-chemical property and consistency of *Shrikhand*

Treatments	Composition (%)					
	Total solids	Fat	Protein	Ash	Acidity (%LA)	Consistency(N)
Control – C	58.28 ± 0.05	6.23 ± 0.02	5.80 ± 0.01	0.57 ± 0.02	1.00 ± 0.02	8.37 ± 0.06
I ₁	58.67 ± 0.03	6.19 ± 0.04	5.73 ± 0.03	0.63 ± 0.03	0.99 ± 0.02	8.51 ± 0.04
I ₂	59.03 ± 0.05	6.10 ± 0.05	5.69 ± 0.04	0.64 ± 0.05	0.98 ± 0.02	8.58 ± 0.07
I ₃	59.40 ± 0.02	6.05 ± 0.04	5.61 ± 0.07	0.64 ± 0.04	0.97 ± 0.03	8.62 ± 0.08
CD (0.05)	0.063	0.059	0.066	NS	NS	0.101

Figure placed after ± indicates standard deviation

Table 6: Effect of varying levels of inulin powder on the sensory attributes of *Shrikhand*

Treatments	Sensory characteristics			
	Flavor (50)	Body & texture (35)	Color & appearance (10)	Total score* (100)
Control – C	45.50 ± 0.09	32.01 ± 0.55	9.35 ± 0.18	91.86 ± 0.73
I 1%	45.53 ± 0.19	33.14 ± 0.45	9.48 ± 0.24	93.15 ± 0.52
I 2%	45.64 ± 0.23	33.48 ± 0.56	9.48 ± 0.20	93.60 ± 0.66
I 3%	45.60 ± 0.24	33.52 ± 0.52	9.48 ± 0.21	93.60 ± 0.57
CD (0.05)	NS	0.807	NS	1.182

Figure placed after ± indicates standard deviation; *a full mark was given for package i.e. 5 out of 5

addition of sugar and cream to prepare *Shrikhand*. The average yield of chakka was 310g/ lit of skim milk and the average yield of *Shrikhand* 472g / lit of skim milk. The sample of *Shrikhand* without addition of fiber containing powder was used as a control. Each sample of product (approximately 50 gm) was evaluated for the composition, physico-chemical and sensory properties.

Effect of varying levels of banana powder on the composition, physico-chemical property and consistency of *Shrikhand*

This part of the study was carried out to optimize the level of

addition of banana powder in *shrikhand*. Four batches of *Shrikhand* viz. C, B₁, B₂ and B₃ were prepared. The average composition of fiber fortified probiotic *Shrikhand* and control as affected by addition of different level of the fiber containing banana powder is presented in Table 1. It can be seen from Table 1 that Control had average TS content of 58.28 % which was significantly (P < 0.05) lower than *Shrikhand*s containing banana powder. These values were found significantly (P < 0.05) different from each other. There was significant (P < 0.05) difference in fat content of control and experimental *Shrikhand* sample of B₁. It can be seen from the tabulated

Table 7: Fiber content in different *Shrikhand* samples

Treatments	(%) Crude fiber
B ₁	0.03%
B ₂	0.08%
B ₃	0.13%
O ₁	0.12%
O ₂	0.24%
O ₃	0.36%
I ₁	0.92%
I ₂	1.84%
I ₃	2.8%

Patel, (2013). Published data on proximate consistency of *Shrikhand* as affected by addition of banana fibre powder are not available for comparison.

Effect of varying levels of banana powder on the sensory characteristics of *Shrikhand*

In product development process, sensory quality plays a vital role in deciding the acceptability of the product. The sensory parameter chosen to assess the quality of *Shrikhand* was flavour, body and texture, colour and appearance and total score. The result are presented in Table 2.

The flavor scores of experimental *Shrikhand* are depicted in

Table 8: Sensory characteristics of fresh fiber fortified probiotic *Shrikhand*

Treatments	Sensory characteristics			
	Flavor (50)	Body & texture (35)	Color & appearance (10)	Total score* (100)
Control - C	44.07 ± 0.64	31.50 ± 0.32	9.17 ± 0.24	89.74 ± 0.98
I ₃	46.11 ± 0.91	33.25 ± 0.80	9.46 ± 0.44	93.82 ± 2.05
O ₂	46.14 ± 0.82	32.64 ± 0.63	9.48 ± 0.44	93.27 ± 1.74
B ₃	44.39 ± 0.27	30.93 ± 0.25	7.17 ± 0.52	87.67 ± 0.13
SE _m	0.353	0.278	0.213	0.717
CD (0.05)	1.08	0.86	0.66	2.21

Figure placed after ± indicates standard deviation *a full mark was given for package i.e. 5 out of 5.

Table 9: Microbiological quality of fiber fortified probiotic *Shrikhand*

Treatments	Microbiological analysis (log cfu/g)		
	Probiotic Count	Standard Plate Count	Coli form Count
C	8.397 ± 0.02	5.233 ± 0.04	Nil
I ₃	8.475 ± 0.03	5.274 ± 0.05	Nil
O ₂	8.460 ± 0.02	5.272 ± 0.06	Nil
B ₃	8.411 ± 0.01	5.243 ± 0.02	Nil
SE _m	0.010	0.022	-
CD (0.05)	0.03	NS	-

Figure placed after ± indicates standard deviation

value that although there was a decrease in fat content with increase in rate of addition of banana powder. There was significant ($P < 0.05$) difference in protein content. In a, control *Shrikhand* had significantly ($P < 0.05$) higher protein content (5.80 %) as compared to all the other samples. It might be due to low protein content in banana powder. The ash content of control (i.e. 0.57 %) was significantly ($P < 0.05$) lower than all the fiber fortified samples viz., B₁, B₂ and B₃. There was no significant ($P > 0.05$) difference in the sugar and carbohydrate content of experimental samples. It can be seen from Table that there was a slight decrease in acidity at the highest level of addition viz., B₃. However, the variation in titratable acidity (% LA) of all experimental samples were found statistically non-significant ($P > 0.05$). Increase in amount of banana powder resulted in progressive improvement in consistency. The variation in consistency of all experimental samples were significant ($P < 0.05$). Addition of banana powder *Shrikhand* was found to exercises significant influence ($P < 0.05$) on consistency at all the levels studied. This could be because of the higher total solids content in samples containing banana powder.

Published data on proximate composition of *Shrikhand* as affected by addition of banana are not available for comparison, however the values observed in the present study are very close to those reported by Aneja *et al.* (2002) and

Table 2. The average flavor score was concerned, control was significantly ($P < 0.05$) lower (43.32) than all three banana powder containing *Shrikhand* samples. Sample B₃ and B₁ did not show any significant ($P < 0.05$) difference in their flavor score. The difference in flavor score of experimental *Shrikhand* samples may be attributed to increasing rate of addition of powder that alter the flavoring score of experimental *Shrikhand*. Control *Shrikhand* sample had body and texture score was significantly ($P < 0.05$) lower than all three banana fiber containing *Shrikhand* samples. The variation in body and texture score of all experimental samples were significant ($P < 0.05$). While, sample B₁ and B₃ were statistically not different ($P > 0.05$) in their body and texture score. It can be seen from the table that the lower scores obtained to banana powder containing *Shrikhand* samples were due to because of presence of dull brownish color in such samples. The dull brownish was with increased in level of addition of banana powder. The variation in color and appearance score of all experimental samples were found significant ($P < 0.05$). *Shrikhand* without fiber content of banana powder (control) had average total score was 88.94. The total score of fiber containing banana powder *Shrikhand* samples B₁, B₂ and B₃ were 90.55, 89.66 and 89.98 respectively. However, B₁ and B₃ *Shrikhand* were found statistically same in their total scores. Published data on proximate sensory attributes of *Shrikhand*

as affected by addition of banana fibre are not available for comparison. However, the results obtained in this study are in agreement with those obtained by Brennan and Tudorica (2008). In their studies it was shown that the sensory quality of yoghurt fortified with β -glucan had improved mouth feel, scoopability, and sensory attributes consistent with full fat yogurt (Brennan and Tudorica, 2008). Similarly, in a such study on manufacture of fibre fortified yoghurt it was reported that apple fibre strained yogurts were not preferred by panellists compared to wheat and bamboo fibers because of their ragged structure, dominant apple taste and strong odor. Panellists found bamboo and wheat fiber strained yogurts acceptable (Kemal *et al.*, 2012).

However, in our study we found that that use of fiber containing banana powder (B_3) *Shrikhand* had superior quality in terms of chemical, physico chemical and sensory attributes compared to control.

Effect of varying levels of oat powder on the composition, physico-chemical property and consistency of *Shrikhand*

The experimentation involved making four batches of *Shrikhand* viz., C, O_1 (1 %), O_2 (2 %) and O_3 (3 %) based on expected yield of *Shrikhand*. The data on average composition of fresh experimental *Shrikhand* sample are presented in Table 3. It can be seen from the Table 3 that *Shrikhand* without fiber content of oat powder (control) had average TS value was significantly lower than *Shrikhand* containing O_1 , O_2 and O_3 oat powder. The difference in total solids content of all experimental samples were significant ($P < 0.05$). It might be due to increasing rate of addition of powder increasing total solids content. It can be seen from the tabulated value that there was slightly but significantly increased in fat content of samples with increased in addition of oat fiber. As shown in table 3 Control *Shrikhand* samples had significantly ($P < 0.05$) lower protein content compared to all the other samples. Whereas sample O_3 had significantly ($P < 0.05$) higher protein content. This might be due to constitution of protein content of oat fiber. There was significant ($P < 0.05$) difference in ash content of all experimental *Shrikhand* samples. However, O_1 and O_2 and O_2 and O_3 had statistically no difference ($P > 0.05$) in their ash content. The increased in ash content might be due to the oat powder containing good amounts of mineral contents. Control *Shrikhand* had significantly ($P < 0.05$) higher acidity value i.e. 1.0 % LA while sample O_3 had lower acidity value 0.97 % LA. However, sample O_1 , O_2 and O_3 did not show any statistical significant ($P > 0.05$) difference in their titratable acidity content. The difference of consistency among all experimental *Shrikhand* samples was found significant ($P < 0.05$). Sample C had significantly ($P < 0.05$) lowest value. It might be due to increasing rate of addition of powder in *Shrikhand*.

Published data on proximate composition of *Shrikhand* as affected by addition of oat powder are not available for comparison, however the values observed in the present study are very close to those reported by (Aneja *et al.*, 2002, Patel, 2013).

Effect of varying levels of fiber containing oat powder on the sensory attributes of *Shrikhand*

It is evident from the tabulated values that flavour score was

significantly ($P < 0.05$) influenced by addition of fiber containing oat powder. It was observed that for control sample, the flavor score was significantly ($P < 0.05$) higher as compared to all experimental samples. While O_1 and O_2 did not have any statistical significant difference in flavor scores. The difference in flavor score of experimental *Shrikhand* samples may be due to increasing rate of addition of oat powder, which may reduce the flavor score of experimental *Shrikhand*. It can be seen from Table 4 that the average body and texture score of control *Shrikhand* sample had body and texture score was significantly ($P < 0.05$) lower from all three *Shrikhand* samples. It might be due to increasing rate of addition of fiber in *Shrikhand*. The experimental sample C was criticized as weak body and O_3 was criticized as grainy texture by judges. Control *Shrikhand* had average color and appearance score is significantly higher than *Shrikhand* containing O_1 , O_2 and O_3 oat powder. The total score of fiber containing oat powder *Shrikhand* samples O_1 (90.08), O_2 (90.31) and O_3 (87.29). However, O_1 , O_2 and control samples had statistically no difference in their total scores. This was because of supplementation of fiber containing oat powder in *Shrikhand*. Published data on proximate sensory attributes of *Shrikhand* as affected by addition of banana fibre are not available for comparison. However, the results obtained in this study are in agreement with those obtained by Fernandez *et al.* (1997) who observed that fibre-fortified yoghurt with maize, soya, sugarbeet and rice had a grainy flavour and gritty texture; however, fortification with oat fibre gave the best results, with flavour and texture scores not being significantly lower than those of control yoghurt.

Published data on proximate sensory attributes of *Shrikhand* as affected by addition of oat powder are not available for comparison. Thus, from the result discussed above, it is observed that use of fiber containing oat powder (O_2) *Shrikhand* had superior quality in term of chemical, physico chemical and sensory attributes. Therefore, addition of 2 % oat powder in *Shrikhand* was selected for further study. As per total score, experimental *Shrikhand* sample is given preference score of $O_2 > O_1 > C > O_3$.

Effect of varying levels of inulin on the composition, physico-chemical property and consistency of *Shrikhand*

The experimentation involved making four batches of *Shrikhand* viz., C, I_1 (1 %), I_2 (2 %) and I_3 (3 %) based on expected yield of *Shrikhand*. It can be seen from the Table 5, that the average total solids content of control *Shrikhand* (C) had significantly ($P < 0.05$) lower total solids content as compared to all other fiber fortified *Shrikhand* samples. Whereas sample I_3 containing 3% inulin powder had a significantly ($P < 0.05$) highest total solid (59.40 %). Increasing rate of addition of inulin resulted in increased total solids content of *Shrikhand*. It can be seen from tabulated value that there was a slight decrease in fat and protein content with increase in rate of addition of fiber containing powder. There was statistically significant ($P < 0.05$) difference in the protein content of all experimental samples. There was no significant ($P > 0.05$) difference in ash content of all experimental *Shrikhand* samples. Control *Shrikhand* had higher acidity value i.e. 1.00 % LA. The variation titratable acidity (% LA) content of all experimental samples were found statistically not significant ($P < 0.05$). It can be seen from tabulated value control sample had

significantly ($P < 0.05$) lowest value. The difference of consistency among all experimental *Shrikhand* samples was found significant ($P < 0.05$). It was might be due to increasing rate of addition of inulin powder in *Shrikhand*.

Effect of varying levels of inulin powder on the sensory attributes of *Shrikhand*

The effect of varying levels of inulin powder on the sensory attributes of *Shrikhand* shown in Table 6. The sensory quality of the experimental *Shrikhand* sample were evaluated using a score-card suggested by Indian standards. The average flavor score for, control sample C was lower than all three fiber containing *Shrikhand* samples. However, the variation in flavor score of all experimental samples were found non-significant ($P > 0.05$). The control *Shrikhand* sample scored was significantly ($P < 0.05$) lower than all three *Shrikhand* samples. Addition of inulin powder in *Shrikhand* resulted in brighter and whiter appearance in inulin-fortified samples compared to control. Among all experimental *Shrikhand* samples I_2 and I_3 had significantly ($P < 0.05$) higher total score compared to I_1 and control. Statistically samples I_1 , I_2 and I_3 were not significantly ($P > 0.05$) different in total score from each other. This may be due to experimental *Shrikhand* supplement with fiber containing inulin powder resulting in smoother product with glossy appearance.

Published data on proximate sensory attributes of *Shrikhand* as affected by addition of inulin powder are not available for comparison. From this part of the study, it is observed that *Shrikhand* sample I_2 and I_3 had superior quality in terms of chemical and physico-chemical attributes. As per total score, experimental *Shrikhand* sample is given preference score of $I_2 = I_3 > I_1 > C$.

Fiber Contents In Different Experimental *Shrikhand*

The crude fiber of different experimental *Shrikhand* were estimated by official method described in Analysis of the Association of Official Analytical Chemist (AOAC, 1990), which are depicted in Table 7.

It can be seen from table 7 that with increasing the rate of addition of fiber, an increasing fiber content in samples *Shrikhand* that was observed. Samples fortified with inulin powder had higher fiber contents because of presence of higher fiber content in inulin powder *i.e.* 92 %.

Based on result obtained above probiotic *Shrikhand* was prepared using banana powder (B_3 at rate of 3 %) oat powder (O_2 at rate of 2 %) and from inulin (I_3 at rate of 3 %) and subjected to sensory evaluation. The data obtained while analyzing the fiber-fortified probiotic *Shrikhand* samples are represented in Table 8. It was observed that for freshly made product, as far as the fresh product samples average flavor score was concerned, control sample C was significantly ($P < 0.05$) lower from all three *Shrikhand* samples, while sample I_2 and O_2 were statistically at par ($P > 0.05$). The difference in flavor score of experimental *Shrikhand* samples may be due to different rate of addition of powder containing fibers, which alter the flavor score of experimental *Shrikhand*.

It can be revealed from Table 8 that the score for body and texture score of I_3 and O_2 samples were significantly ($P < 0.05$) higher than control. Among experimental *Shrikhand* sample scores of body and texture B_3 was significantly ($P < 0.05$) lower

than all other samples. This clearly indicates the supplementation of fiber containing banana powder in the current investigation had positive impact on body and texture of samples I_2 and O_2 were statistically ($P < 0.05$) at par. While B_3 sample was criticized as excessively firm body and sample C was criticized as weak body as compared to other samples by judges.

It can be seen from Table 8 that the color and appearance score of I_3 and O_2 sample had significantly ($P < 0.05$) high score compared to B_3 sample. However, I_2 and O_2 were yielded statistically similar to color and appearance of the *Shrikhand*. It clearly indicates the supplementation of fiber containing powder in the current investigation resulted in improved color and appearance scores. The tabulated value show color and appearance of samples I_3 and O_2 were statistically at par ($P > 0.05$). The total score of experimental *Shrikhand* depicted in Table 8 indicated B_3 sample had significantly lower acceptability score. Among all experimental *Shrikhand*, I_3 had significantly ($P < 0.05$) higher acceptability score indicating superior acceptability among experimental samples. The *Shrikhand* samples I_3 and O_2 were found statistically at par ($P > 0.05$). As per total score, experimental *Shrikhand* sample is given preference score of $I_3 > O_2 > B_3 > C$

Thus, addition of fiber containing Inulin at the rate of 3 % was found most suitable to get good quality of probiotic *Shrikhand*. In similar studies, Hashim *et al.* (2009) found that fortifying yogurt with 3 % date fiber produced acceptable yogurt with beneficial health effects. The developed product was analyzed for its fiber content and it was found to be 2.80 % which .One serving size (100 g) of shrikhand could be a "good source of fiber" having 12.7% Daily Value (DV). In order to make a "good source of micronutrient", the finished product must ideally contain 10 to 19 per cent of DV per serving, since the fiber content were in this range, the product can be labelled as "good source of fiber". Therefore this study, was successful to formulate a shrikhand which can be labelled as "good source of fiber". Based upon the results, conclusively, I_3 shrikhand may be characterized as good source of fiber. The product can be consumed with breakfast or meals and designated as a fiber enriched shrikhand.

Microbiological analysis

The microbiological quality of experimental *Shrikhand* samples are measure as log cfu/g in terms of probiotic count, standard plate count, yeast and mold and coliform count are depicted in Table 9. Tabularized value showed that sample C had significantly ($P < 0.05$) lower counts, while sample I_2 and O_2 had significantly ($P < 0.05$) higher counts, it may be due to supplementation of inulin and oat beta-glucan as prebiotic. A prebiotic is a selectively fermented ingredient that promotes specific changes in the composition and/or activity of the gastrointestinal micro biota, which, in turn, confers benefits on host well-being, and health (Pasquale *et al.*, 2012). Sample I_2 and O_2 were statistically at par and were optimally consistent. The variation in probiotic count was found to be significant ($P < 0.05$). The SPC count of experimental fresh *Shrikhand* samples varied from 1.354 to 1.402, which showed in Table 4.15. The SPC count of all experimental *Shrikhand* samples had showed non-significant ($P > 0.05$) difference.

It was found that during entire course of study, the coliforms in all the four fresh experimental *Shrikhand* samples were absent in 1gm *Shrikhand* sample. Absence of coliform count indicates that the hygienic condition adapted during manufacturing as well as the sanitation of the cups carried out using hypochlorite solution was adequate. According to IS 5402 (2002) / ISO: 4833 (1991) a product can be labeled as probiotic if it meets the minimum standard requirements of probiotic organisms of one million cfu/g. The probiotic count of the developed product is much higher than these requirements i.e. 8.46 log cfu/g. This effect could be attributed to prebiotic effect of inulin. The results were in confirmation with the coliforms count carried out by some workers for *Shrikhand* samples. When *Shrikhand* was prepared using mixed cultures of *Streptococcus lactis* and *Streptococcus lactis* subsp. *diacetylactis*. Upadhyay et al. (1984) found that coliform count was absent in 0.1 g of *Shrikhand* sample, which was within specified limit of FSSA (2011) i.e. max. 50/g. These results are in agreement with those obtained by Pandiyan et al. (2012) who prepared synbiotic ice cream incorporating *Lactobacillus acidophilus* and inulin and viability of *L. acidophilus* was analyzed on storage. Incorporation of inulin in ice cream mix significantly ($P < 0.01$) improved the growth of *Lactobacillus acidophilus*. Freezing of the ice cream mix caused a reduction of 0.61 to 0.77 log counts of *L. acidophilus* count. They concluded that incorporation of inulin increases count of *L. acidophilus* and the organism could survive at therapeutic minimum probiotic level of 106 cells /ml for 15 days of storage at -18 to -23°C in ice cream.

Thus it can be concluded from this study that an acceptable quality cardamom flavoured fiber fortified probiotic *Shrikhand* by addition of inulin powder at the rate of 3% by weight expected yield of *Shrikhand*. This study, was successful to formulate a *shrikhand* which can be labelled as "good source of fiber". The product can be consumed with breakfast or meals and designated as a fiber enriched *shrikhand*. The probiotic count of the developed product was 8.46-log cfu/g, which was much higher than minimum count (6.00 log cfu/g) to state that product is probiotic.

REFERENCES

- Ajila, C. M. and Prasada Rao, U. J. S. 2013.** Mango Peel Dietary Fiber: Composition and Associated Bound Phenolics. *J. Func. Food.* 5: 444-450.
- Aneja, R. P., Mathur, B. N., Chandan, R. C. and Banrje, A. K. 2002.** Cultured/Fermented Products. In: "Technology of Indian Milk Products" P.Gupta (ed.), A Dairy India publication, Delhi, pp. 170-176.
- AOAC. 1990.** Official Methods of Analysis of the Association of Official Analytical Chemists (15th edn.). Publ. By AOAC. Po. Box 540. Benzamin Franklin Station, Washington D.C. 20044, USA.
- Brennan, C. S. and Tudorica, C. M. 2008.** Carbohydrate-based fat replacers in the modification of the rheological, textural and sensory quality of yoghurt: Comparative study of the utilization of barley beta-glucan, guar gum and inulin. *Int. J. Food Sci. Technol.* 43(5): 824-833.
- Dello S. M., Bertola, N., Martino, M. and Bevilacqua, A. 2004.** Influence of Dietary fiber addition on sensory and rheological properties of yogurt. *Int. Dairy J.* 14: pp. 263-268.
- European Union, 2008.** Commission directive 2008/100/EC. *Off J EU.* 2008; L285:9-12. Retrieved from <http://eurx.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:285:0009:0012:EN:PDF>.
- Fernandez-Garcia, E. and McGregor, J. U. 1997.** Fortification of sweetened plain yogurt with insoluble dietary fiber. *Z LebensmUntersForsch A.* 204: 433-437.
- FSSA. 2010.** The Food Safety and Standards Act. Introduction to food and food processing volume – 1. In: Training manual for food safety regulators. pp. 5-6.
- FSSA. 2011.** The Food Safety and Standards Act, chapter 2- Food Product Standards chakka and Shrikhand, Commercial Law Publishers (India) Pvt. Ltd., p.204.
- FSSAI. 2015.** The Food Safety and Standards Act of India. Manual of Methods of Analysis of Foods. pp. 126.
- Hashim, I. B., Khalil, A. H. and Afifi, H. S. 2009.** Quality characteristics and consumer acceptance of yogurt fortified with date fiber. *J Dairy Sci.* 92(11): 5403-5407.
- ISI Handbook of Food Analysis. 1981.** SP: 18 (Part XI - Dairy Products). Bureau of Indian Standards, ManakBhavan, Bahadur Shah Zafar Marg, New Delhi, India. pp. 11-18.
- IS: 1479.1960.** Method of Test for Dairy Industry. Rapid Examination of milk. Indian standards Institution, New Delhi. p.29
- IS: 5401. 1969.** Methods for detection and estimation of coliform bacteria in food stuffs. Indian Standards Institution, New Delhi. pp. 2-9.
- IS: 9532. 1980.** Specifications for chakka and Shrikhand, Indian standards Institution, New Delhi. pp. 5-7.
- IS: 5402. 2002/ ISO:4833. 1991.** Microbiology- General guidance for the enumeration of micro-organisms - Colony count technique at 30°C (first revision) Reaffirmed 2007.
- IS: 15348. 2003.** Method for Sensory Evaluation of Shrikhand. pp. 1-3.
- Kemal, A. S. and Emrah, B. 2012.** Effect of using some dietary fibers on color, texture and sensory properties of strained yogurt. *GIDA.* 37(2): 63-69.
- Pasquale, R., Paloma, L., Vittorio, C., Pilar, F. P., Maria, T. D., Giuseppe, S. and Daniela, F. 2012.** Beta-glucans improve growth, viability and colonization of probiotic microorganisms. *Int. J. Mol. Sci.* 13: 6026-6039.
- Pandiyan, C., Annal, V. R., Kumaresan, G., Murugan, B. and Rajarajan, G. 2012.** Effect of incorporation of inulin on the survivability of *Lactobacillus acidophilus* in synbiotic ice cream. *Int. Food Res. J.* 19(4): 1729-1732.
- Patel, B. J. 2013.** Development of Technology for Manufacture of Probiotic Shrikhand. M.Tech. thesis, AnandAgril. Uni. Anand.
- Ramirez, S. C., Ramos, S. L., Lobato, C. C., Pena, V. C., Vernon, C. E. J. and Alvarez, R. J. 2010.** Enrichment of stirred yogurt with soluble dietary fiber from *Pachyrhizuserosus L. Urban*: Effect on syneresis, microstructure and rheological properties. *J. Food Engg.* 101: 229-235.
- Sen, B., Singh J., Verma T and Patel P.R. 2014.** Performance of Growing Calves Fed on Banana (*Musa Paradisiaca*) Stem. *The Bioscan* 9(1): 121-123
- Steel, R. G. D. and Torrie, J. H. 1980.** A biometrical approach. In: Principals and Procedures of statistics. 2nd Edn. McGraw Hill Kogakusha Ltd., Japan, pp. 137-150.
- Thebaudin, J. and Lefebvre, A. C. 1997.** Dietary fibre: Natural and technological interest. *Trends Food Sci. Technol.* 8: 41-48.
- Upadhyay, S. M., Dave, J. M. and Sannabhadhi, S. S. 1984.** Microbial changes in stored Shrikhand and their application in predicting the sensory quality of the product. *J. Food Sci. Technol.* India. 21(4):208-

211.

Yangilar, F. 2013. The Application of Dietary Fibre in Food Industry: Structural Features, Effects on Health and Definition, Obtaining and

Analysis of Dietary Fibre: A Review. *J. Food and Nutrition Research*. **1(3)**: 13-23.