Environment & Ecology 29 (3B) : 1486—1492, 2011
 ISSN 0970-0420

Probiotics Status on Keeping Quality of Lactic Acid Bacteria Added Shrikhand and *In-Vitro* Testing of Antimicrobial Activity

G. SWAPNA AND SUVARNA V. CHAVANNAVAR

Department of Agricultural Microbiology, University of Agricultural Sciences, GKVK Bangalore 560065, India
E-mail : sapnamicro@rediffmail.com

Abstract

The investigation was conducted to study the effect of probotics compared to that of lactic acid bacterial isolates. Shrikhand prepared using probiotics singly or in combination and also along with lactic acid bacterial isolates as a stater culture instead of using curd as starter culture. Shrikhand prepared using probiotics and lactic acid bacterial isolates were analyzed for pH, residual sugars, total sugars and for titrable acidty. The antimicrobial activity of shrikhand was tested against *Escherichia coli, Salmonella* sp. and *Staphylococcus aureus.* Results showed that the shrikhand prepared using probiotics in combination and with lactic acid bacterial isolates showed highest pH, residual sugars, total sugars and for titrable acidty compared to single probiotics with lactic acid bacterial isolates. *Salmonella* sp. *Escherichia coli and Staphylococcus aureus* was inhibited by L × C_1 × D_4, S × C_1 and L × C_4, S × L × D_2 and L × C_4, S × L × B_1 respectively.

Key words : Lactic acid bacteria, Starter cultures, Fermented milk product, Probiotics, Pysico-chemical composition.

Shrikhand is the indigenous fermented milk product prepared by the fermentation of milk by using known strain of lactic acid bacteria. Shrikhand is extensively used as a sweet dish after meals. It is also used as a festive sweet in India. Sugar is added as additive to the Shrikhand to enhance teste and does not have any preservative effect. Other natural additives like dried fruits are added to the shrikhand to enhance flavor. Shrikhand is traditionally made at home in western India. The name shrikhand is derived from the Sanskrit work "Shikharini". Lactic acid bacteria refers to a large group of beneficial bacteria that have similar properties and all produce lactic acid as an end product of the fermentation process. They are widespread in nature and are also found in our digestive systems. Although they are best known for their role in the preparation of fermented dairy products. Lactic acid also gives fermented milks their slightly tart taste. Additional characteristic flavors and aromas are often the result of other products of lactic acid. Lactic acid bacteria are therefore excellent ambassadors for an often maligned microbial world. They are not only of major economic significance, but are also of value in maintaining and promoting human health. Probiotic fermented milks, is one major segment amongst fermented milks that has tremendous potential for growth and development. Milk is an excellent medium to carry or generate live and active cultured dairy products. The technology of application of probiotic organisms in fermented dairy products aims to combine the potential health benefits of the bacteria with their ability to grow in milk, resulting in a nutritionally healthy and desirable product for the consumers. Shrikhand consumed as taste ehancer are produced by lactic acid fermentation, where in lactic acid bacteria ferment the milk and yield value added product with enhanced nutrients. Fermentation process not only enhances the nutritional value, but, the product gets enriched with probiotic organisms mainly lactic acid bacteria. Lactic acid bacteria produce several antibacterial compounds which can be used to claim health benefits especially in controlling enteric pathogens.

Methods

Isolation of Lactic Acid Bacteria from Shrikhand

Lactic acid bacteria (LAB) were isolated from shrikhand prepared using cattle milk buffalo milk and

Table 1. Titrable acidity (%) of shrikhand samples prepared using lactic acid bacterial isolates with probiotics. C : Control, P_1 : *Lactobacillus sporogenes,* P_2 : *L. acidophilus,* P_3 : *L. rhamnosus*, $P_1 \times P_2$: *L. sporogenes* + *L. acidophilus*, B_1 : Lactic acid bacteria isolated from buffalo milk, D_1, D_2 & D_4 : Lactic acid bacteria isolated from dairy milk, C_1, C_3 & C_4 : Lactic acid bacteria isolated from cattle milk.

Titrable acidity (%) Lactic acid bacterial isolates						
Treatments	C	P_1	P_2	P_3	$P_1 \times P_2$	Mean
C_1	1.21	1.24	1.22	1.23	1.24	1.23
C_3	1.20	1.23	1.21	1.24	1.25	1.23
C_4	1.17	1.26	1.20	1.22	1.30	1.24
D_2	1.18	1.22	1.26	1.23	1.29	1.26
D_4	1.20	1.25	1.24	1.26	1.28	1.25
D_1	1.18	1.26	1.26	1.25	1.30	1.26
B_1	1.22	1.29	1.27	1.29	1.30	1.28
Mean	1.21	1.25	1.23	1.24	126	
Source		SE ±			CD 5%	
Probiotics (P)		0.02			0.03	
Treatments (T)		0.03			0.05	
Interaction (P×T)		4.00			1.68	

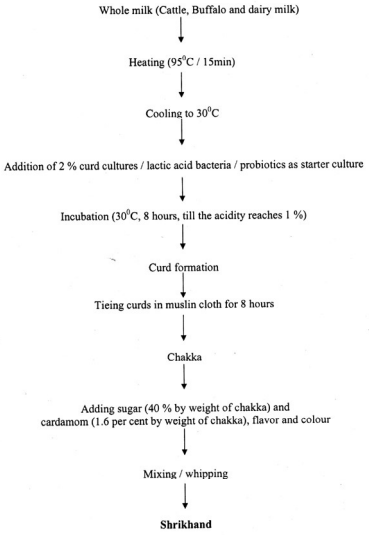

Figure 1. Flow diagram illustrating the preparation of shrikhand.

commercially available dairy milk by standard plate count technique using Mann, Rogosa and Sharpe's (MRS) agar medium (1). Lactic acid bacterial colonies thus obtained were further purified and were maintained in MRS broth. Fresh milk samples were heated and cooled to 30—32 C and then inoculated with curd as starter culture, then the shrikhand samples were subjected to serial dilution to obtain the lactic acid bacterial isolates. Thus, obtained lactic acid bacterial isolates were maintained in the MRS broth as pure culture. Then, the lactic acid bacteria isolates were further characterized for their biochemical changes.

Preparation of Starter Culture from Shrikhand

The lactic acid bacterial isolates obtained from three different types of milk viz., cattle milk (C_1, C_3 and C_4), buffalo milk (B_1) and dairy milk (D_1, D_2 and D_4) were further purified and were maintained in MRS broth were uses as started culture for further preparation of shrikhand instead of using curd as starter culture, it was then used as starter culture for further fermentation process.

Probiotics

Different commercially available probiotics i.e. *Lactobacillus acidophilus, Lactobacillus sporogenes* and *Lactobacillus rhamnosus* are used singly or in combination. Thus, the lactic acid bacterial isolates obtained from three different types of milk also used singly or in combination with probiotics during the preparation of shrikhand.

Method of Preparation of Shrikhand

Fresh cattle milk, buffalo milk and dairy milk were pasteurized at 95 C for 15 minutes, cooled to 37—40 C. It is then inoculated with curd/lactic acid bacteria/ probiotics as starter culture at 1% which is mixed well and incubated at 2830 C for 8—9 hours till coagulation or setting of curd (Fig. 1). When curd has set firmly (acidity 0.7—0.8% lactic), it is placed in a muslin cloth bag and removed the whey content after 8—9 hours. Now the curd get change into solid mass called Chakka. The concentrated mass i.e. Chakka, thus obtained after whey separation was used as the base material for the prepatation of shrikhand and blending with additives like sugar and cardamon at 40 and 1.6%, flavor and color. Thus, the conventional shrikhand making technology is a tedious and time consuming process.

Table 2. Total sugar (%) of shrikhand prepared using lactic acid bacterial isolates with probiotics. C : Control, P_1 : *Lactobacillus sporogenes*, P_2 : *L. acidophilus*, P_3 : *L. rhamnosus*, $P_1 \times P_2$: *L. sporogenes* + *L. acidophilus*, B_1 : Lactic acid bacteria isolated from buffalo milk, D_1, D_2 & D_4 : Lactic acid bacteria isolated from dairy milk, C_1, C_3 & C_4 : Lactic acid bacteria isolated from cattle milk.

	Total sugar (%) Lactic acid bacterial isolates					
Treatments	C	P_1	P_2	P_3	$P_1 \times P_2$	Mean
C_1	50.95	54.07	54.70	53.57	54.86	53.85
C_3	50.92	53.10	53.92	51.02	53.94	52.99
C_4	50.89	53.16	52.93	53.75	54.18	53.67
D_2	52.86	53.97	54.20	53.19	54.45	53.96
D_4	52.05	53.12	54.75	54.80	54.94	54.10
D_1	50.56	53.41	53.85	53.44	54.01	53.41
B_1	52.79	54.69	54.94	54.96	55.07	54.62
Mean	51.57	53.64	54.18	53.53	54.49	
Source	SE ±			CD 5%		
Probiotics (P)	0.82			1.63		
Treatments (T)	1.25			2.49		
Interaction (P × T)	1.025			4.06		

Table 3. Residual sugars (%) of shrikhand prepared using lactic acid bacterial isolates with probiotics. C : Control, P_1 : *Lactobacillus sporogenes*, P_2 : *L. acidophilus*, P_3 : *L. rhamnosus*, $P_1 \times P_2$: *L. sporogenes* + *L. acidophilus*, B_1 : Lactic acid bacteria isolated from buffalo milk, D_1, D_2 & D_4 : Lactic acid bacteria isolated from dairy milk, C_1, C_3 & C_4 : Lactic acid bacteria isolated from cattle milk.

	Residual sugars (%) Lactic acid bacterial isolates					
Treatments	PC	P_1	P_2	P_3	$P_1 \times P_2$	Mean
C_1	22.23	22.36	22.43	22.46	22.53	22.45
C_3	22.16	22.30	22.48	22.44	22.60	22.43
C_4	22.20	22.36	22.40	22.40	22.46	22.40
D_2	22.23	22.33	22.36	22.40	22.44	22.42
D_4	22.10	22.30	22.40	22.36	22.46	22.37
D_1	22.24	22.36	22.36	22.38	22.54	22.44
B_1	22.27	22.40	22.50	22.50	22.66	22.52
Mean	22.20	22.34	22.42	22.42	22.52	
Source	SE ±			CD 5%		
Probiotics (P)	0.13			0.26		
Treatments (T)	0.20			0.40		
Interaction (P × T)	0.02			0.10		

Chemical Composition of Shrikhand

The shrikhand samples were analyzed for pH, titrable acidity, total sugars and reducing sugars.

pH

The shrikhand samples were tested for the pH. The pH of shrikhand samples was measured using digital pH meter of Anolog Model (Corin. Research USA).

Total Titrable Acidity

Samples (10g) were diluted with 30 ml of water and were titrated against 0.1 N NaOH using phenolphthalein as an indicator. The acidity was calculated by using the following formula and expressed in per cent according to Srivastava and Kumar (2).

$$\text{Total acid (\%)} = \frac{\text{Titre value} \times \text{N of alkali} \times \text{vol made up} \times \text{equivalent wt of acid} \times 100}{\text{Volume of the sample taken} \times 1000}$$

Reducing Sugar

It was estimated by following the method described by Shaffer-Somogyi micro method (3).

$$\text{Reducing sugars (\%)} = \frac{\text{Dextrose (mg)} \times \text{vol made up} \times 100}{5 \times \text{wt of sample taken} \times 1000}$$

Total Sugars

A shrikhand sample of 0.1 ml was taken in a series of test tubes, added 1.0 ml of distilled water to each test tube. Pipetted out one ml of distilled water into another test tube to serve as blank. Added 0.5 ml of phenol reagent to each test tube and mixed well. Then five ml of sulphuric acid added to each test tube and allowed to stand for 10 min. The solution was then mixed well and placed in a water bath at 25—30 C for 10—20 min. The absorbance of the solution was recorded at 490 nm according to Dubios (4).

$$\text{Total sugar as invert sugar} = \frac{\text{Dextrose (mg)} \times \text{vol made up} \times 100}{\text{Titer value} \times \text{wt of sample taken} \times 1000}$$

Sucrose (%) = (% Total invert sugar - % reducing sugar) × 0.95

Total sugars (%) = % reducing sugar + % sucrose

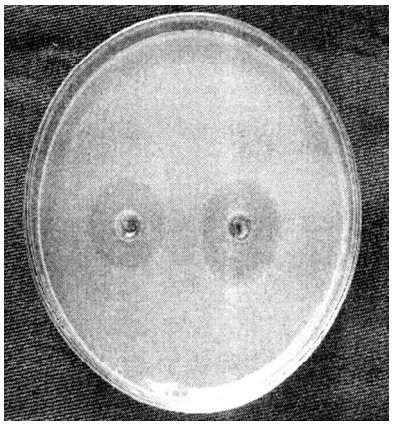

Figure 2. *Escherichia coli* inhibited by shrikhand using *Lactobacillus acidophilus* and isolate C_4.

Table 4. pH of shrikhand samples prepared using lactic acid bacterial isolates with probiotics. C : Control, P_1 : *Lactobacillus sporogenes*, P_2 : *L. acidophilus*, P_3 : *L. rhamnosus*, $P_1 \times P_2$: *L. sporogenes* + *L. acidophilus*, B_1 : Lactic acid bacteria isolated from buffalo milk, D_1, D_2 & D_4 : Lactic acid bacteria isolated from dairy milk, C_1, C_3 & C_4 : Lactic acid bacteria isolated from cattle milk.

	pH					
	Lactic acid bacterial isolates					
Treatments	C	P_1	P_2	P_3	$P_1 \times P_2$	Mean
C_1	3.43	3.54	3.58	3.47	3.59	3.54
C_3	3.49	3.61	3.56	3.60	3.71	3.62
C_4	3.50	3.63	3.53	3.61	3.66	3.60
D_2	3.46	3.50	3.49	3.62	3.68	3.58
D_4	3.55	3.59	3.65	3.64	3.72	3.66
D_1	3.56	3.62	3.60	3.67	3.70	3.65
B_1	3.60	3.67	3.69	3.70	3.73	3.69
Mean	3.51	3.52	3.58	3.54	3.68	

In-Vitro Testing of Anti-Microbial Activity of the Products Against Salmonella sp., *Escherichia coli and Staphylococcus aureus*

The antibacterial activity of products against faecal indicator *Escherichia coli*, food poisoning bacteria *Salmonella* sp. and *Staphylococcus aureus* was studied by agar gel diffusion assay technique according to Prabha (5). Melted and cooled nutrient agar was seeded with 24 hrs old cultures of faecal indicator and food poisoning bacterial isolates and was poured to petri plates, allowed to set for 3 h. Two wells were scooped out in the medium with the help of sterile cork borer and 0.5 ml of product was transferred to these wells, the plates were incubated for 48 h. The diameter of the well was measured. The area of the zone of inhibition was calculated by using the formula.

$$\text{Area of the zone of inhibition} = \pi (R + r) (R - r)$$

Where R = is the radius of the zone of the inhibition,
r = is the radius of the well.

Results and Discussion

Chemical Composition of Shrikhand

The pH, residual sugars, total sugars and titrable acidity of shrikhand prepared using cattle milk, buffalo milk and dairy milk with different probiotics P_1 (*Lactobacillus sporogenes*), P_2 (*L. acidophilus*) and P_3 (*L. rhamnosus*) and in different combinations of $P_1 \times P_2$ (*L. sporogenes* × *L. acidophilus*) along with different lactic acid bacterial isolates viz., cattle milk (C_1, C_3 and C_4), buffalo milk (B_1) and dairy milk (D_1, D_2 and D_4) were estimated and are presented in (Tables 1, 2, 3 and 4). The treatments $P_1 \times P_3$, $P_2 \times P_3$ and $P_1 \times P_2 \times P_3$ along with different lactic acid bacterial isolates are not presented in the result as they produced undesirable odor and not showed good quality with respect to appearance, taste, texture, color and overall acceptability, hence the treatments were discarded.

Effect pH on Shrikhand

The shrikhand prepared using lactic acid bacterial isolate C_1 had the highest pH in $P_1 \times P_2$ (3.59) followed by P_2 (3.58), P_1 (3.54), P_3 (3.47) and the lowest pH was found in C (3.43), C_3 had the highest pH in $P_1 \times P_2$ (3.71) followed by P_1 (3.61), P_3 (3.60), P_2 (3.56) and the lowest pH was found in C (3.49), C_4 had the highest pH in $P_1 \times P_2$ (3.66) followed by P_1 (3.63), P_3 (3.61), P_2 (3.53) and the lowest pH was found in C (3.50), D_2 had the highest pH in $P_1 \times P_2$ (3.68) followed by P_3 (3.62), P_1 (3.50), P_2 (3.49%) and the lowest pH was found in C (3.46), D_4 had highest pH was found in $P_1 \times P_2$ (3.72) followed by P_2 (3.62), P_3 (3.65), P_1 (3.59) and the lowest pH was found in C (3.55), D_1 had the highest pH in $P_1 \times P_2$ (3.70) followed by P_3 (3.67),

Table 5. *In vitro* testing of antimicrobial activity of the product against *Escherichia coli, Salmonella* sp. and *Staphylococcus aureus.* L : *Lactobacillus acidophilus*, S : Sporolac (*Lactobacillus sporogenes*), C : Lactic acid bacterial isolates of cattle milk, D : Lactic acid bacterial isolates of dairy milk, B : Lactic acid bacterial isolates of buffalo milk, Values in the parantheses are square root transformed values.

	Treatments	Area of zone of inhibition zone in sq mm *E. coli*	*Salmonella* sp.	*Staphylococcus aureus*
1.	$L \times C \times D_4$	0.00 (0.71)	91.77 (9.61)	0.00 (0.71)
2.	$S \times L \times C_3$	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
3.	$S \times L \times D_2$	67.77 (8.26)	0.00 (0.71)	0.00 (0.71)
4.	$S \times L \times B_1$	0.00 (0.71)	0.00 (0.71)	71.50 (8.49)
5.	$S \times L \times C_1$	0.00 (0.71)	82.07 (9.08)	0.00 (0.71)
6.	$S \times L \times D_4$	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
7.	$L \times C_4$	48.43 (6.99)	67.07 (8.22)	0.00 (0.71)
	CD 5%	13.61	33.13	18.42

P_1 (3.62), P_2 (3.60) and the lowest pH was found in C (3.56) and B_1 had highest pH was found in $P_1 \times P_2$ (3.73) followed by P_2 (3.58), P_3 (3.54), P_1 (3.52) and the lowest pH was found in C (3.60) This may be due to the conversion of lactose into lactic acid and other organic acids by the starter cultures that reduced the pH of shrikhand and the lactose content of shrikhand is dependent on the extent of lactose degradation, moisture content of shrikhand.

Effect of Residual Sugars (%) on Shrikhand

The shrikhand prepared using lactic acid bacterial isolate C_1 recorded highest residual sugars in $P_1 \times P_2$ (22.53%) followed by P_3 (22.46%), P_2 (22.43%), P_1 (22.36%) and the lowest residual sugars was found in C (22.23%), C_3 had highest residual sugars was found in $P_1 \times P_2$ (22.60%) followed by P_2 (22.48%), P_3 (22.44%), P_1 (22.30%) and the lowest residual sugars was found in C (22.16%), C_4 had the highest residual sugars was found in $P_1 \times P_2$ (22.46%) followed by P_2 (22.40%), P_3 (22.40%), P_1 (22.36%) and the lowest residual sugars was found in C (22.20%), D_2 had highest residual sugars was found in $P_1 \times P_2$ (22.44%) followed by P_3 (22.40%), P_2 (22.36%) P_1 (22.33%) and the lowest residual sugars was found in C (22.23%), D_4 had highest residual sugars was found in $P_1 \times P_2$ (22.46%) followed by P_2 (22.40%), P_3 (22.36%), P_1 (22.30%) and the lowest residual sugars was found in C (22.10%), D_1 recorded the highest residual sugars in $P_1 \times P_2$ (22.54%) followed by P_3 (22.38%), P_2 (22.36%), P_1 (22.36%) and the lowest residual sugars (%) was found in C (22.24%) and B_1 had the highest residual sugars in $P_1 \times P_2$ (22.66%) followed by P_2 (22.50%), P_3 (22.50%), P_1 (22.40%) and the lowest total sugars (%) was found in C (22.27%). This may be due to its influences in sugar utilization by lactic acid bacteria (6—10).

Effect of Total Sugar (%) on Shrikhand

The shrikhand prepared using lactic acid bacterial isolate C_1 had the highest total sugar in $P_1 \times P_2$ (54.86%) followed by P_2 (54.70%), P_1 (54.07%), P_3 (53.57%) and the lowest total sugar was found in C (50.95%), C_3 had highest total sugar was found in $P_1 \times P_2$ (55.07%) followed by P_2 (53.92%), P_1 (54.07), P_3 (51.02%) and the lowest total sugar in C (50.92%), C_4 had highest total sugar was found on $P_1 \times P_2$ (54.18%) followed by P_3 (53.75%), P_1 (53.16%), P_2 (52.93%) and the lowest total sugar was found in C (50.89%), D_2 had highest total sugar in $P_1 \times P_2$ (54.45%) followed by P_2 (54.20%), P_1 (53.97%), P_3 (54.20%) and the lowest total sugar was found in C (52.86%), D_4 had highest total sugar in $P_1 \times P_2$ (54.94%) followed by P_3 (54.80%), P_2 (54.75%), P_1 (53.12%) and the lowest total sugar was found in C (52.05%) D_1 had the highest total sugar was found in $P_1 \times P_2$ (54.01%) followed by P_2 (53.85%), P_3 (53.44%), P_1 (53.41%) and the lowest total sugar was found in C (50.56%) and B_1 recorded the highest total sugar in $P_1 \times P_2$ (55.07%) followed by P_3 (54.96%), P_2 (54.94%), P_1 (54.69%) and the lowest total sugar was found in C (52.79%). That may be due to the blending of sugar with chakka. Sugar slowed down the chemical changes due to fermentastion (4, 8, 11—13).

Effect of Titrable Acidity on Shrikhand

The shrikhand prepared using lactic acid bacte-

rial isolate C_1 had highest titrable acidity in $P_1 \times P_2$ (1.24%) followed by P_1 (1.24%), P_3 (1.22%) and the lowest titrable acidity was found in C (1.21%), C_3 had highest titrable acidity was found in $P_1 \times P_2$ (1.25%) followed by P_3 (1.24%), P_1 (1.23%), P_2 (1.21%) and the lowest titrable acidity (%) was found in C (1.20%), C_4 had highest titrable acidity was found in $P_1 \times P_2$ (1.30%) followed by P_1 (1.26%), P_3 (1.22%), P_2 (1.20%) and the lowest titrable acidity (%) was found in C (1.17%), D_2 had highest titrable acidity was found in $P_1 \times P_2$ (1.29%) followed by P_2 (1.26%), P_3 (1.23%), P_1 (1.22%) and the lowest titrable acidity was found in C (1.18%), D_4 had highest titrable acidity in $P_1 \times P_2$ (1.28%) followed by P_3 (1.26%), P_1 (1.25%), P_2 (1.24%) and the lowest titrable acidity was found in C (1.20%). In the shrikhand prepared using lactic acid bacterial isolate D_1, the highest titrable acidity was found in $P_1 \times P_2$ (1.30%) followed by P_1 (1.26%), P_2 (1.26%), P_3 (1.25%) and the lowest titrable acidity (%) was found in C (1.18%) and B_1 had the highest titrable acidity in $P_1 \times P_2$ (1.30%) followed by P_1 (1.29%), P_3 (1.29%), P_2 (1.27%) and the lowest titrable acidity was found in C (1.22%). This may be due to gradual increase in titrable acidity with the storage period (10, 12, 14—17).

In-Vitro Testing of Antimicrobial Activity of the Product Against Escherichia coil, Salmonella sp. and Staphylococcus aureus

In-vitro testing of antimicrobial activity of shrikhand were presented in (Table 5). *Escherichia coli* was inhibited by two out of seven treatments. Highest inhibition was scored by $S \times L \times D_2$ (67.7 sq mm), followed by $L \times C_4$ (48.43 sq mm). These two treatments differed significantly among themselves. *Salmonella* was inhibited by three out of seven treatments. The highest inhibition was scored by $L \times C \times D_4$ (91.77 sq mm), followed by $L \times C_4$ (67.07 sq mm). These two treatments differed significantly between themselves. *Staphylococcus aureus* was inhibited by the treatment $S \times L \times B_1$ (71.50 sq mm) (5, 18—22).

References

1. Kebede A. 2007. Isolation, characterization and identification of lactic acid bacteria involved in traditional fermentation of borde, an Ethiopian cereal beverage. *Afr. J. Biotech.* 6 : 1469—1478.
2. Srivastava R. P. and S. Kumar. 1993. Important methods for analysis of fruit or vegetable and their products. Pp. 321—339. *In Fruits and vegetable preservation—principles and practices.* 2nd edition. 321—339 pp.
3. AOAC. 1980. Official methods of analysis, 13th edition. Washinghton DC, Assoc. Off. Analyt. Chem.
4. Boghra V. R. and O. N. Mathur. 2000. Physico-chemical status of major milk constituents and minerals at various stages of shrikhand preparation. *J. Food Sci. Tech.* 37 : 111—115.
5. Jin L. Z., Y. W. Ho, N. Abdullah, M. A. Ali and S. Jalaludin. 1996. Antagonistic effects of intestinal *Lactobacillus* isolates on the pathogen of chicken. *Lett. Appl. Microbiol.* 23 : 67—71.
6. Ishibashi N. and S. Yamazaki. 2001. Probiotics and safety. *Am. J. Clin. Nutr.* 73 : 465—470.
7. Karthikeyan S., H. K. Desai and K. G. Upadhyay. 1999. Effect of varying levels of total solids in SCBM on the quality of fresh shrikhand. *Ind. J. Dairy. Sci.* 52 : 95—99.
8. Khurana H. K. and S. K. Kanawjia. 2007. Recent trends in development of fermented milks. *Curr. Nutr. Food Sci.* 3 : 91—108.
9. Luquet F. M. and G. Corrieu. 2005. Lactic acid and probiotic bacteria. *Bacteries-lactiques-et-probiotiques* 34 : 307—308.
10. Osman M. M. D. and K. A. A. Razig. 2010. Quality attributes of soy-yoghurt during storage period. *Pak. J. Nutr.* 9 : 1088—1093.
11. Desai H. K. and S. K. Gupta. 1986. Sensory evaluation of shrikhand. *Dairy Guide* 5 : 33—38.
12. Nalawade J. S., G. R. Patil, A. T. Sontakke and H. Binawaz. 1998. Effect of composition variables on sensory quality and consistency of shrikhand. *J. Food Sci. Tech.* 35 : 310—313.
13. Navita N., S. Rashmi and P. K. Upadhayay. 2009. Incorporation of chakka by papaya pulp in the manufacture of shrikhand. *J. Dair. Foods & HS* 28 : 115—118.
14. Ghatak P. N. and S. Dutta. 1998. Effect of admixing of cow and buffalo milk on the composition and sensory qualities of shrikhand. *Ind. J. Nutr. Dietet.* 35 : 43—46.
15. Jain A., H. K. Desai and K. G. Upadhyay. 1998. Chemical quality of market shrikhand sold in Gujarat. *Ind. J. Dairy. Sci.* 51 : 423—425.
16. Patel R. S. and B. K. Chakraborty. 1987. Storage stability of shrikhand manufactured from different sources of milk solids. *Jap. J. Dairy Food. Sci.* 36 : 209—216.
17. Reddy K. K., M. Pasha Ali, B. V. Rao and T. Jagannadha Rao. 1984. Studies on production and quality of shrikhand from buffalo milk. *Ind. J. Dairy. Sci.* 37 : 293—296.
18. Bennik M. H. J., E. J. Smid and L. G. M. Gorius. 1997. Vegetable associated *Pediococcus parvalus* produces pediocin PA-1. *Appl. Environ. Microbiol.* 63 : 2074—2076.
19. Geis A., J. Singh and M. Teubes. 1983. Potential of

lactic *Streptococci* to produce bacteriocin. *Appl. Environ. Microbiol.* 45 : 205—211.
20. Olasupo N. A., D. K. Olvokoya and S. A. Odunfa. 1995. Studies on bacteriocinogenic *Lactobacillus* from selected Nigerian fermented food. *J. Basic Microbiol.* 35 : 319—324.
21. Schibed F., A. Lalazas, Y. Henis and B. J. Juven. 1993. Purification, partial characterization and plasmid linkage of pediocin SJ-I, a bacteriocin produced by *Pediococcus. J. Appl. Bacteriol.* 74 : 67—77.
22. Spelhaug S. R. and S. K. Harlander. 1989. Inhibition of food borne bacterial pathogens by bacteriocins from *Lactococcus lactis* and *Pediococcus pentosaceus. J. Food Prot.* 52 : 856—862.