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SHRIKHAND - VALUE ADDED TRADITIONAL DAIRY PRODUCT

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ABSTRACT

The investigation was conducted to study the characterization of lactic acid bacterial isolates, physicochemical properties and sensory evaluation of shrikhand, a fermented dairy product prepared using cattle, buffalo and dairy milk by adding curd as well as lactic acid bacterial isolates and probiotics as a starter culture. The isolates obtained from shrikhand were tested for Gram's reaction, colony morphology, and biochemical tests like catalase, fermentation of carbhohydrates, gelatin hydrolysis, spore production, growth on neutral red chalk agar and dextran production and were analysed for pH, residual sugars, total sugars and for titrable acidty. Result revealed that, all the lactic acid bacterial isolates were Gram +ve, rods and cocci, catalase -ve, could not hydrolyse gelatin and they showed acid and gas production and isolates from dairy milk (D_2 and D_3) produced dextran and the shrikhand prepared using probiotics in combination and with lactic acid bacterial isolates showed highest pH, residual sugars, total sugars and for titrable acidty. the highest score was recorded with combinations of probiotics *i.e. Lactobacillus acidophilus* + *Lactobacillus sporogens*, and the lowest score was recorded in *Lactobacillus rhamnosus* in terms of colour, appearance, aroma, texture, taste and overall acceptability of the product and lactic acid bacterial isolates using cattle milk isolates recorded highest score followed by dairy milk and buffalo milk.

Key words: Characterization, chemical composition, Lactic acid bacteria, probiotics, organleptic evaluation.

INTRODUCTION

India's market potential and current growth rate of traditional dairy products is unparalleled and all set to boom further under the technology of mass production. An estimated 50 to 55 % of the milk produced in India is converted into a variety of traditional milk products, using processes such as coagulation, desiccation and fermentation. Indian fermented milk products utilize 7% of total milk produced and mainly includes three product dahi, shrikhand (sweetened concentrated curd) and lassi which may be considered the western equivalent to yogurt, quarg and stirred yogurt, respectively. Fermented milk products constitute a vital component of the human diet in many regions of the world. In the Indian sub-continent such products are also classified as "indigenous milk products" like dahi (curd), lassi, shrikhand etc. which are prominent in people's diet. 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 taste and does not have any preservative effect. Other natural additives like dried fruits are added to the shrikhand to enhance flavour. Shrikhand is traditionally made at home in western India. The name shrikhand is derived from the Sanskrit work "Shikharini". A lactic acid bacterium 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 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. Therefore, the present study was undertaken with the objective to study the development of traditional dairy products with an addition of probiotics and lactic acid bacterial isolates as starter cultures on the quality of shrikhand by their physico-chemical characteristics.

MATERIAL AND METHODS

ISOLATION OF LACTIC ACID BACTERIA FROM SHRIKHAND

Lactic acid bacteria (LAB) were initially isolated

from shrikhand prepared using three different types of milk *i.e.* Cattle milk, buffalo milk and commercially available dairy milk by standard plate count technique using Mann, Rogosa and Sharpe's (MRS) agar medium (11). Lactic acid bacterial colonies i.e. cattle milk (C_1, C_3& C_4), buffalo milk(B_1) and dairy milk (D_1, D_2 & D_4) thus obtained were further purified and were maintained in MRS broth for further preparation of shrikhand instead of using curd as starter culture. Then, the lactic acid bacterial isolates were further characterized for their biochemical changes. In similar fashion, the three different commercially available probiotics *i.e. Lactobacillus acidophilus*, *Lactobacillus sporogenes* and *Lactobacillus rhamnosus* are also used as starter culture alone or in combination of probiotics. (Fig. 1).

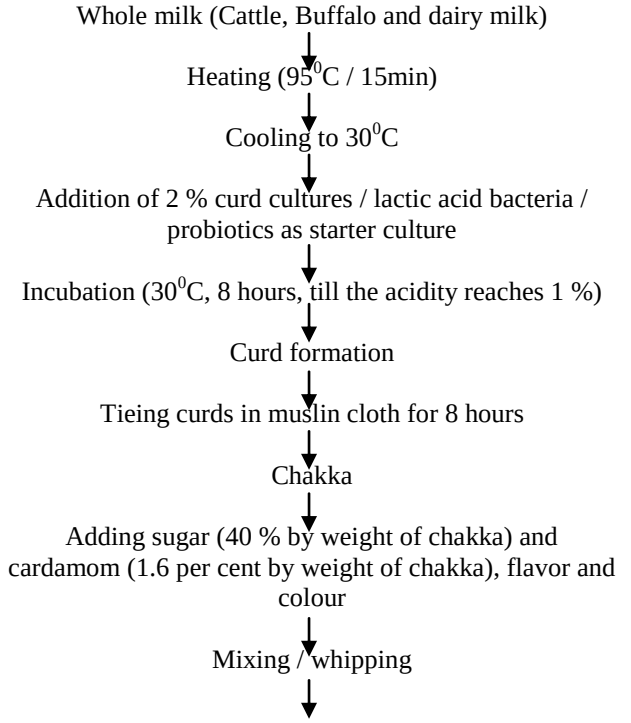

Fig. 1. Flow diagram illustrating the preparation of shrikhand

CHARACTERIZATION OF LAB ISOLATES AND CHEMICAL COMPOSITION OF SHRIKHAND

Lactic acid bacterial isolates were characterized based on the growth in MRS broth using biochemical tests *i.e*. Gram staining technique using 24 hours old culture, catalase production, fermentation of carbohydrates and spore production as suggested by Aneja (2). dextran production according to Garvie (6)., gelatin hydrolysis by Harrigan and Mc Cance (8) and growth on neutral red chalk agar medium as suggested by Chalmers (4). The shrikhand samples were analyzed for pH, titrable acidity, total sugars and reducing sugars. 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 0.1N 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 (19).

$$\% \text{ Total acid} = \frac{\text{Titre value x N of alkali x Volume made up x equivalent wt. of acid x100}}{\text{Volume of the sample taken}} \times 1000$$

REDUCING SUGAR

It was estimated by following the method described by Shaffer-Somogyi micro method by Association of Official Analytical Chemists (1)

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

TOTAL SUGARS

A shrikhand sample of 0.1ml 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^{0}C for 10 -20 min. The absorbance of the solution was recorded at 490 nm according to Dubios (5)

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

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

% Total sugars = % reducing sugar + % Sucrose

SENSORY EVALUATION

Shrikhand prepared using cattle milk, buffalo milk and dairy milk by adding curd, lactic acid bacterial isolates and probiotics as stater culture were evaluated by a selected panel of 10 members, which was based mainly on the appearance, colour, aroma, taste and overall acceptability of the product. Prior to tasting, each sample was coded and placed in a random manner, different shrikhand samples were placed along with water (to rinse the mouth) in the laboratory, and panelists were instructed to evaluate each sample by blind tasting as per the standard score card for organoleptic evaluation.

RESULTS AND DISCUSSION

Lactic acid bacterial isolates formed characteristic white, submerged colonies on Mann, Rogosa and Sharpe's (MRS) agar medium. Result revealed that (Table 1), all the lactic acid bacterial isolates were Gram +ve, rods and cocci. The lactic acid bacterial isolates were catalase -ve, Colonies appeared after 48 hrs on neutral red chalk agar, which were very small, deep red, surrounded by a clear zone formed due to the dissolution of $CaCO_3$ in the

medium, could not hydrolyse gelatin and they showed that isolates C_3, B_1, B_2, D_2, D_3 and D_4 changed the colour from red to yellow due to production of acids but C_1, C_4 and D_1 showed no change in colour. Collection of gas in durham's tube was observed in the tubes inoculated with the isolates C_1, C_4 and D_1 acid and small colonies appeared after 24 hrs on sucrose agar which were creamish to yellowish in colour. Isolates D_2 and D_3 could produce enormous deposition of slimy substances on the colonies, dextran was observed. These findings support the reports of Kebede (2007) reported that isolation, characterization and identification of lactic acid bacteria involved in traditional fermentation of Borde, an Ethiopian cereal beverage. Similar results were also reported by Rao et al. (2000). Lactic acid bacteria can assimilate glucose as carbon source. All the isolates in this study showed assimilation of glucose in MRS broth. Glucose is a flavoured source which is an indication of glycolysis and is a major carbon utilizing pathway. These results are similar to those of Samelis et al.(1994) who also reported that gas ($C0_2$) production by glucose was determined in modified MRS broth contaning inverted Durham tubes, with diammonium citrate replaced by ammonium sulphate.

Table 1: Characterization of isolates from shrikhand

Isolates	Shape	Gram's reaction	Catalase activity	Glucose utilization		Dextran production	Gelatin hydrolysis	Spore production	Growth on neutral red chalk agar
				A	G				
C_1	Short rods	+	-	-	+	-	-	-	-
C_2	Short rods	+	-	-	-	-	-	-	-
C_3	Short rods	+	-	+	-	-	-	-	-
C_4	Long rods	+	-	-	+	-	-	-	-
B_1	Short rods	+	-	+	-	-	-	-	-
B_2	Long rods	+	-	+	-	-	-	-	-
B_3	Short rods	+	-	-	-	-	-	-	-
B_4	Short rods	+	-	-	-	-	-	-	-
D_1	Short rods	+	-	-	+	-	-	-	-
D_2	Cocci	+	-	+	-	+	-	-	+
D_3	Cocci	+	-	+	-	+	-	-	+
D_4	Long rods	+	-	+	-	-	-	-	-

Note: A: Acid production, G: Gas production C: LAB isolated from cattle milk, D: LAB isolated from Dairy milk B: LAB isolated from Buffalo milk

CHEMICAL COMPOSITION OF SHRIKHAND

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 x P_2 (*L. sporogenes* x *L. acidophilus*) along with different lactic acid bacterial isolates *viz*., Cattle milk (C_1, C_3& C_4), buffalo milk(B_1) and dairy milk (D_1, D_2 & D_4) were estimated and are presented in (Table 2, 3, 4 and 5). The treatments P_1x P_3, P_2 x P_3 and P_1 x P_2 x P_3 along with different lactic acid bacterial isolates are not presented in the result as they produced undesirable odour and not showed good quality with respect to appearance, taste, texture, colour and overall acceptability, hence the treatments were discarded.

EFFECT PH ON SHRIKHAND

The shrikhand prepared using lactic acid bacterial isolate C_1had the highest pH in P_1 x 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 x 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 x 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 x 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 x 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_1had the highest pH in P_1 x P_2 (3.70) followed by P_3 (3.67), 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 x 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 Boghra et al. (2000) and Reddy et al. (1984).

Table 2: pH of shrikhand samples prepared using lactic acid bacterial isolates with probiotics

Treatments	pH					Mean
	Lactic acid bacterial isolates					
	C	P_1	P_2	P_3	$P_1 x P_2$	
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	

Note: C : Control, P_1 : *Lactobacillus sporogenes* , P_2 : *L. acidophilus*, P_3 : *L. rhamnosus*, P_1xP_2: *L. sporogenes +L. acidophilus*, B_1: LAB isolated from buffalo milk, D_1, D_2 & D_4 : LAB isolated from dairy milk, C_1, C_3& C_4 : LAB isolated from cattle milk

Table 4: Total sugar (%) of shrikhand prepared using lactic acid bacterial isolates with probiotics

Treatments	Total sugar(%)					Mean
	Lactic acid bacterial isolates					
	C	P_1	P_2	P_3	$P_1 x P_2$	
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	S.Em ±		CD @ 5%			
Probiotics (P)	0.82		1.63			
Treatments (T)	1.25		2..49			
Interaction (PxT)	1.025		4.06			

Note: C : Control, P_1 : Lactobacillus sporogenes , P_2 : L. acidophilus, P_3 : L. rhamnosus, P_1xP_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

Table 3: Residual sugars (%) of shrikhand prepared using lactic acid bacterial isolates with probiotics

Treatments	Residual sugars (%)					Mean
	Lactic acid bacterial isolates					
	PC	P_1	P_2	P_3	$P_1 x P_2$	
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	S.Em±			CD @ 5 %		

Probiotics (P)	0.13	0.26	
Treatments (T)	0.20	0.40	
Interaction(PxT)	0.02	0.10	

Note: C : Control, P_1 :Lactobacillus sporogenes, P_2 : L. acidophilus, P_3 : L. rhamnosus, P_1xP_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

Table 5: Titrable acidity (%) of shrikhand samples prepared using lactic acid bacterial isolates with probiotics

Treatments	Titrable acidity (%)					Mean
	Lactic acid bacterial isolates					
	C	P_1	P_2	P_3	$P_1 x P_2$	
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	1.26	
Source	S.Em±		CD @ 5 %			
Probiotics (P)	0.02		0.03			
Treatments (T)	0.03		0.05			
Interaction (PxT)	4.00		1.68			

Note: C : Control, P_1 : Lactobacillus sporogenes ,P_2 :L. acidophilus, P_3 : L. rhamnosus, P_1xP_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.

Table 6- Organoleptic evaluation of shrikhand prepared using lactic acid bacterial isolates as starter culture

Treatments	Appearance	Aroma	Texture	Taste	Overall acceptability
C_1	3.8	3.8	3.9	3.7	3.8
C_3	3.8	3.8	3.7	3.8	3.8
C_4	3.8	3.9	3.3	3.8	3.9
B_1	3.6	3.4	3.6	3.6	3.2
D_4	3.8	3.5	3.3	3.5	3.5
D_2	3.7	3.5	3.2	3.5	3.7
D_1	3.7	3.7	3.6	3.6	3.6

Note: *Each value is an average of 10 replications (10 persons), *Scale: 5- Liked extremely; 4-Liked; 3-Neither liked nor disliked; 2-Disliked; 1-Disliked extremely, B1: Lactic acid bacteria isolated from buffalo milk. D1, D2 & D4: Lactic acid bacteria isolated from dairy milk, C1, C3& C4: Lactic acid bacteria isolated from cattle milk

EFFECT OF RESIDUAL SUGARS (%) ON SHRIKHAND

The shrikhand prepared using lactic acid bacterial isolate C_1 recorded highest residual sugars in P_1 x 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 x 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 x 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 x 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 x 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 x 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 x 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 influence in sugar utilization by lactic acid bacteria Osman and Razig (2010); Khurana and Kanawjia (2007).

EFFECT OF TOTAL SUGAR (%) ON SHRIKHAND

The shrikhand prepared using lactic acid bacterial isolate C_1 had the highest total sugar in P_1 x 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 x 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 in P_1 x 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 x 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 x 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 x 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 x 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 fermentation Boghra et al. (2000); Navita, 2009.

EFFECT OF TITRABLE ACIDITY ON SHRIKHAND

The shrikhand prepared using lactic acid bacterial isolate C_1 had highest titrable acidity in P_1 x P_2 (1.24 %) followed by P_1(1.24 %), P_3 (1.23 %), P_2 (1.22 %) and the lowest titrable acidity was found in C (1.21 %), C_3 had highest titrable acidity was found in P_1 x 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 x 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 x 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 x P_2 (1.28 %) followed by P_3 (1.26 %), P_1 (1.25 %), P2 (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 x 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 x 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 Ghatak and Dutta (1998).

ORGANOLEPTIC EVALUATION

The Shrikhand samples prepared using lactic acid bacterial isolates were tested for organoleptic characteristics of the product are given in (Table 6). Results revealed that, the highest score was recorded with LAB isolates i.e. C1, C3 & C4 obtained from cattle milk (3.80, 3.80 and 3.90 out of 5.00), followed by lactic acid bacterial isolates obtained by buffalo milk i.e. B1 (3.20 out of 5.00) in terms of colour, appearance, aroma, texture, taste and overall acceptability of the product. Similar observation were recorded by Rameshwar (2006), who also reported that the shrikhand has a typical semi solid consistency showing a characteristic firmness and pliability contributing to its suitability for consumption with puri and bread. Similar results were obtained by Salunke et al. (2006), and Patel and Chakraborty (1985) who reported that varying levels of fat, moisture and sugar had the least effect on colour but had a profound effect on appearance, flavour, body and textural properties of shrikhand.

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