Optimization of fat content to develop goat milk *shrikhand*

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Abstract: The present study was conducted to optimize the fat content of goat milk *shrikhand* using goat milk with three different fat % viz. 4.0 (F1), 5.0 (F2) and 6.0 (F3) %. The pH values decreased while titratable acidity increased significantly ($P<0.05$) with increased fat content. Fat content and brix values increased significantly ($P<0.05$) with increased fat content in goat milk. All textural parameters *i.e.* firmness, consistency, cohesiveness and work of cohesiveness increased significantly ($P<0.05$) with increased fat content. Among the sensory attributes, there was no significant difference in color and appearance, texture and mouth coating scores among the treatments; however flavor, sweetness and overall acceptability scores increased significantly ($P<0.05$) with increased fat content. There was no significant difference between F2 and F3 for any sensory attribute including overall acceptability. Present day health conscious consumer demand product with lower fat content without compromising with taste and flavour. Therefore, F2- goat milk *shrikhand* prepared with 5.0% fat was found optimum and selected as the best treatment.

Keywords: Goat milk *shrikhand*, Fat content, Optimization, Textural and colour parameter, Sensory evaluation.

Introduction

India is leading milk producer in the world with 187.7 million tonnes of milk (NDDB, 2019) due to advancement of technology, proper nutrition and appropriate managerial practices. Livestock contributes about 9.2% in gross value added (GVA) and 26.2 % in agriculture sector in India. The livestock population in India includes 302.3 million bovines, 74.3 million sheep, 148.9 million goats, about 9.1 million pigs and 851.8 million poultry. The rural and urban population of goat is 129.081 million and 6.092 million respectively in India. Total goat milk production in India is 6.09 million tones, out of which Rajasthan and Uttar Pradesh produce 2.31 million tonnes and 1.34 million tonnes respectively (DAHD, 2019). Goat milk production is a dynamic and growing industry that is fundamental to the wellbeing of millions people worldwide and is an important part of the economy in India. Goat milk is having better digestibility, alkalinity, buffering capacity and certain therapeutic values in medicine and human nutrition (Park and Chukwu, 1989; Park, 1994) in comparison to cow's or human milk. The goat milk microbiota is also considered a good source of novel bacteriogenic *Lactic acid* bacteria (LAB) strains that can be exploited as an alternative for use as bio preservative in food (Perin and Nero, 2014). It is also rich source of amino acid, being 20-40 folds higher than cow milk (Mehaia and Al-Kanhal, 1992) which is involved in bile salt formation, osmoregulation, antioxidation, calcium transport and in the central nervous system (Redmond et al. 1998). Minerals content such as calcium, potassium, magnesium and chloride as well as vitamin A, B, C, D, thiamin and niacin content of goat milk is higher than that of cow milk (Chandan et al. 1992). Goat milk also contains higher content of three characteristics fatty acids *i.e.* caproic acid, caprylic and capric acid which are having medicinal values for patients suffering from malabsorption, childhood epilepsy, cystic fibrosis and gallstones (Haenlin, 1992); however these are responsible for intense "goaty flavour" which limits the acceptability of goat milk products among the consumers (Ozer et al. 2017).

Traditional dairy foods have always played a pivotal role in preservation of precious milk nutrients and promotion of its consumption among masses. *Shrikhand* is one of the widely

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relished indigenous milk product prepared by the fermentation of milk by using known strain of lactic acid bacteria. It is very much popular in western part of India due to its high nutritive, characteristics flavour, taste, palatable nature and possible therapeutic value. Shrikhand contains appreciable amount of milk protein and phospholipids and is obtained by lactic acid fermentation through the action of starter culture consisting *Lactobacillus bulgaricus*, *Streptococcus lactis*, *Streptococcus diacetylactis*, *Lactobacillus citrovorum* and *Streptococcus thermophilus*. It is produced from chakka which in turn is obtained from dahi (curd) after draining off the whey. The basic ingredients sugar, colour and flavour are thoroughly mixed into chakka and to form a sort homogenous mass called Shrikhand (Desai and Gupta, 1986). The popularity of fermented dairy products from goats' milk has shown a gradual increase all over the world due to its better functional properties and health benefits. As per FSSAI (2016), shrikhand should contain 58% total solids (min.), 8.5 % fat (min.) 9.0% protein (min.), 1.4% titratable acidity (max.) and 0.9% ash (maximum). Fat is a very important ingredient contributing to the texture, flavor and overall perception of dairy products. Milk fat has a complex and rich chemical composition and provides unique sensorial properties (flavor and mouthfeel) to milk and milk products.

Consumers are becoming increasingly conscious nowadays about their nutrition, hygiene and wellbeing. Consumption of more fat and calories has been related to the coronary heart diseases, and obesity (Law et al. 1991). There is evidence the high fat intake is associated with increased risk of obesity, cancer, high blood cholesterol and coronary heart diseases (Garcia et al. 2002). The number of patients with cardiovascular diseases is growing rapidly in India, so there is a dire need to develop functional products with low fat content (Anand et al. 2015). Present day health conscious consumer demand a healthy product with less fat content, again dairy products from goat milk have less acceptability in terms of flavour and aroma due to presence of medium chain fatty acids. Therefore, development of shrikhand with low fat goat milk may be a technological challenge with higher organoleptic and nutritional quality. Keeping these views in mind, present study was carried out to optimize the fat content of goat milk shrikhand with well acceptability in terms of nutrient content and sensory evaluation.

Materials and Methods

The experiments were carried out in the Department of Livestock Products Technology, College of Veterinary Sciences and Animal Husbandry, U.P. Pt. Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan, Mathura 281001 (UP), India. Fresh clean wholesome milk of goat was procured from Department of Veterinary Physiology, DUVASU Mathura. Starter culture (NCDC-159) was procured from NRI Karnal which contained mixed culture of *Lactococcus lactis*, *Lactococcus diacetylactis* and *Lactococcus cremoris*. The

culture was activated as per the standard method and the activated parent culture was maintained by sub culturing and stored under refrigeration. Clean crystalline sugar was procured from local market of Mathura. All the chemicals used in the study were of analytical grade and procured from Hi Media laboratories (P) Ltd, Mumbai.

Preparation of Shrikhand

The shrikhand was prepared as per method described by Gupta et al. (2018) with slight modifications. Fresh goat milk was filtered through muslin cloth and then fat content was standardized using Pearson square method, where skimmed milk powder or cream was added to adjust fat content in milk. Then milk was subjected to heat treatment at 85 °C for 30 minutes followed by cooling at 37±2°C. Milk was inoculated with NCDC-159 @ 2.5 % by v/v of milk and incubated at 35-37 °C for 12-15 hours for proper curd setting. The curd thus obtained was transferred to clean muslin cloth and hung for 16-18 hours in order to drain the whey to obtain chakka. The chakka was kneaded to have uniform consistency and then mixed with 30% ground sugar. Finally shrikhand was filled in pre sterilized thermorigid polypropylene cups and stored at under refrigeration at 4±2°C. In present study, following abbreviations were used for present experiment: F1- goat milk shrikhand prepared with 4.0% fat, F2- goat milk

shrikhand prepared with 5.0% fat and F3- goat milk shrikhand prepared with 6.0% fat.

Analytical methods

Physico-chemical properties

The pH of shrikhand was determined by using digital pH meter (WTW, Germany, model pH 330i) as per method given by Trout et al. (1992). Water activity of each sample was measured three times in duplicate using a water activity meter (AquaLab 3 TE, Inc. Pullman, WA) at Department of Goat Products Technology, CIRG, Makdhoom. Proximate parameters viz. moisture, protein, fat and ash content were estimated as per AOAC (1995).

Textural and colour parameters

The texture profile analysis of shrikhand was done with the help of instrumental texture profile analyser (TA HD Plus Texture analyser) for firmness, consistency, cohesiveness and work of cohesiveness (Bourne, 1978). Texture analyzer equipped with 5 kg load cell and back extrusion test using 35 mm cylinder probe was used for texture profile analysis of the samples. Other conditions (test descriptions) set for analyses were as follows:

Mode:	Measure force in compression
option:	Return to start
Pre-test speed:	1 mm/sec
Test speed :	1mm/sec
Post-test speed :	10mm/sec
Distance :	30mm
Trigger type:	Auto (F) -10g
Trigger force:	0.04903N
Tare mode:	Auto
Data acquisition rate :	400pps
Probe:	Back extrusion cell (A/BE)

The colour parameters *i.e.* lightness (L^*), redness (a^*) and yellowness (b^*) of the shrikhand were measured using Hunter colourimeter of ColourTech PCM+ (Colour Tec Associates Inc. Clinton NJ, USA) at Department of Goat Products Technology, CIRG, Makdhoom.

Sensory evaluation

Sensory evaluation was conducted by experienced semi trained panellists using 8-point descriptive scale (where 1= extremely disliked and 8= extremely liked) (Keeton, 1983) for colour and appearance, flavour, texture, sweetness, mouth coating and overall acceptability.

Statistical analysis

The data obtained in the study on various parameters were statistically analyzed on 'SPSS-16.0' software package as per standard methods

of Snedecor and Cochran (1995). Duplicate samples were drawn for each parameter and the experiment was replicated thrice ($n=6$). Sensory evaluation was performed by a panel of seven member judges three times, so total observations being 21 ($n=21$). Data were subjected to one way analysis of variance, homogeneity test and Duncan's Multiple Range Test (DMRT) for comparing the means to find the effects between samples.

Results and Discussion

Composition of goat milk

Total 30 goat milk samples were evaluated for proximate composition and reported to have following composition on an average as per table 1.

Ibrahim et al. (2020) also reported the average composition of fresh goat milk as 3.54% protein, 3.25% lactose, 6.68% fat and 6.82% SNF respectively. These differences in fat content might be due to animal type, oldness, competition, season, location, and feedstuffs (Contreras et al. 2015). Santis et al. (2019) developed goat milk yogurt with probiotic culture containing *Streptococcus thermophilus*, *Lactobacillus delbrueckii* spp. *bulgaricus*, with cultures of *Leuconostoc lactis* and fresh raw milk was standardized at 3.74 % fat, 3.47%rotein, 3.92%lactose and pH 6.91. Based on available literature, several preliminary trials were conducted to standardize the processing technology of goat milk shrikhand. The final formulation of goat milk shrikhand was optimized following the method prescribed by Gupta et al. (2018) with slight modifications as milk was standardized at lower fat content, again due to poor rheological properties and soft curd formation from goat milk, temperature time combination was changed as per the standard method. The curd was also hanged up for comparatively more time (16-18 hours) as compared to standard method.

Physico-chemical properties

The physico-chemical properties of goat milk shrikhand prepared with different fat content are presented in table 2. The pH values decreased while titratable acidity increased significantly ($P<0.05$) with increased fat content, however there was no significant difference in titratable acidity of F1 and F2. The pH of product in present study (4.24 to 4.57) is in agreement with the range of 4.15 to 4.50 given in the literature (Kavas et al. 2003; Matos et al. 2013). There was no significant difference in proximate parameters *i.e.* moisture, protein and ash content except fat content which

Table 1 Proximate composition of goat milk ($n=30$)

S.No.	Component	%
1	Fat	5.32
2	SNF	7.79
3	Lactose	4.3%
4	Protein	2.84

increased significantly ($P<0.05$) with increased fat content in goat milk. There was no significant difference in water activity among the treatments; however brix value increased significantly ($P<0.05$) with increased fat content. Higher brix values with increased fat content in shrikhand might be due to higher viscosity and compactness of product with increased fat content. Falke (2015) also observed significant ($P<0.05$) increase in brix values of yogurt with increased fat content and addition of inulin due to higher solid content.

Textural and colour parameters

The values of textural and colour parameters of goat milk shrikhand prepared with different fat content are presented in table 3. All textural parameters *i.e.* firmness, consistency, cohesiveness and work of cohesiveness increased significantly ($P<0.05$) with increased fat content; where no significant difference was observed between F2 and F3 in cohesiveness values. Higher textural parameters values with increased fat content might be due to more firm and smooth curd/chakka produced by milk containing higher fat percentage. Somayeh et al. (2017) also reported higher hardness and consistency values of yogurt with increased fat content. Amatayakul et al. (2006) and Soukoulis et al. (2007) also reported that the change in fat content of milk

might significantly ($P<0.05$) effect the firmness and other textural parameters of fermented milk products. There was no significant difference in lightness, redness and yellowness values among the treatments due to no effect of fat content variation in colour of milk and milk products. Chudy et al. (2020) reported that natural colour of milk is due to the reflection of light by dispersed fat globules, calcium caseinate and calcium phosphate.

Sensory evaluation

The sensory scores of goat milk shrikhand prepared with different fat content are presented in table 4. Fat has an important role in the development of flavor, texture and appearance of milk products (Sipahioglu et al. 1999). There was no significant difference in color and appearance, texture and mouth coating scores among the treatments; however flavor, sweetness and overall acceptability scores increased significantly ($P<0.05$) with increased fat content. F2 had significantly ($P<0.05$) higher flavor scores than F1; however scores of F3 were comparable to F1 and F2. F3 had slightly lower flavour scores than F2 inspite of higher fat content due to pronounced goaty flavour at higher fat content in milk. As per Park et al. (2007), caprylic, capric, and caproic acid present in goat milk might lower the acceptability of goat milk products due to goaty aroma and flavour. Singh et al. (2015)

Table 2 Physio-chemical properties (Mean $\pm$ SE) of goat milk shrikhand prepared with different fat content

Parameters	F1	F2	F3	Treatment Mean
pH	4.57 $\pm$ 0.03	4.40 $\pm$ 0.01	4.24 $\pm$ 0.02	4.40 $\pm$ 0.03
Titrateable acidity	0.41 $\pm$ 0.05	0.42 $\pm$ 0.01	0.46 $\pm$ 0.01	0.43 $\pm$ 0.01
Moisture (%)	47.43 $\pm$ 0.51	47.18 $\pm$ 0.39	46.96 $\pm$ 0.39	47.19 $\pm$ 0.24
Protein (%)	6.55 $\pm$ 0.06	6.52 $\pm$ 0.05	6.51 $\pm$ 0.09	6.52 $\pm$ 0.03
Fat (%)	10.25 $\pm$ 0.11	13.96 $\pm$ 0.20	15.43 $\pm$ 0.26	13.21 $\pm$ 0.54
Ash (%)	0.64 $\pm$ 0.02	0.65 $\pm$ 0.01	0.66 $\pm$ 0.01	0.65 $\pm$ 0.01
Water activity	0.948 $\pm$ 0.07	0.941 $\pm$ 0.26	0.938 $\pm$ 0.13	0.942 $\pm$ 0.10
Brix value	27.82 $\pm$ 0.02	31.29 $\pm$ 0.02	33.46 $\pm$ 0.04	30.85 $\pm$ 0.02

F1- goat milk shrikhand prepared with 4.0% fat

F2- goat milk shrikhand prepared with 5.0% fat

F3- goat milk shrikhand prepared with 6.0% fat

n=6

Table 3 Textural and colour parameters (Mean $\pm$ SE) of goat milk shrikhand prepared with different fat content

Parameters	F1	F2	F3	Treatment Mean
Firmness	66.74 $\pm$ 0.32	67.91 $\pm$ 0.16	69.00 $\pm$ 0.19	67.55 $\pm$ 0.35
Consistency	43.36 $\pm$ 0.13	44.30 $\pm$ 0.11	45.97 $\pm$ 0.17	44.54 $\pm$ 0.27
Cohesiveness	32.24 $\pm$ 0.31	33.70 $\pm$ 0.12	33.98 $\pm$ 0.12	33.31 $\pm$ 0.19
Work of cohesiveness	25.37 $\pm$ 0.18	26.54 $\pm$ 0.14	27.36 $\pm$ 0.11	26.42 $\pm$ 0.21
Lightness (L^*)	76.23 $\pm$ 0.02	77.92 $\pm$ 0.01	77.89 $\pm$ 0.02	77.34 $\pm$ 0.01
Redness (a^*)	4.42 $\pm$ 0.11	4.52 $\pm$ 0.08	4.48 $\pm$ 0.09	4.47 $\pm$ 0.05
Yellowness (b^*)	7.25 $\pm$ 0.10	7.21 $\pm$ 0.09	7.11 $\pm$ 0.11	7.19 $\pm$ 0.05

F1- goat milk shrikhand prepared with 4.0% fat

F2- goat milk shrikhand prepared with 5.0% fat

F3- goat milk shrikhand prepared with 6.0% fat

n=6

Table 4 Sensory evaluation (Mean±SE) of goat milk shrikhand prepared with different fat content

Attributes	F1	F2	F3	Treatment Mean
Colour and appearance	6.81±0.04	6.90±0.14	6.92±0.04	6.88±0.05
Flavour	6.55 ^b ±0.09	6.87 ^a ±0.07	6.75 ^{ab} ±0.08	6.72±0.04
Texture	6.69±0.13	6.77±0.08	6.68±0.08	6.71±0.05
Sweetness	6.67 ^b ±0.09	6.98 ^a ±0.07	7.01 ^a ±0.09	6.88±0.05
Mouth coating	6.53±0.07	6.87±0.07	6.89±0.08	6.76±0.04
Overall acceptability	6.79 ^b ±0.07	6.99 ^a ±0.05	7.01 ^a ±0.04	6.93±0.03

F1- goat milk shrikhand prepared with 4.0% fat

F2- goat milk shrikhand prepared with 5.0% fat

F3- goat milk shrikhand prepared with 6.0% fat

n=21

developed shrikhand with different levels of fat and sugar and observed that shrikhand prepared with 6% fat and 40% sugar had highest overall acceptability among the treatments. Shelke et al. (2014) also reported that well acceptable low fat low sugar mango flavoured shrikhand was prepared with 70% skimmed milk based chakka and 40% sugar. Sweetness and overall acceptability scores of F2 and F3 were significantly ($P<0.05$) higher than F1 in present study; however there was no significant difference between F2 and F3. Present day health conscious consumer demands for low fat products without compromising the organoleptic qualities. Therefore, keeping the view of health concern, F2- goat milk shrikhand prepared with 5.0% fat was found optimum in terms of nutrient content and sensory properties.

Conclusions

People all over the world are more health conscious and choosing healthy diet options to maintain a healthy lifestyle. Increasing awareness about health benefits related to low-fat dairy products among the global population is expected to propel its demand across the globe. The present study was conducted to optimize the fat content of goat milk shrikhand which was a challenge due to lower fat content and total solid content in goat milk along with poor textural properties and soft curd formation. However, increasing fat content in goat milk had significant effect on textural and colour parameters. Fat content also improved sensory qualities of product in terms of flavour, sweetness and overall acceptability scores. Goat milk shrikhand prepared with 5.0% fat was selected as the best treatment. Goat milk products have lower acceptability among people inspite of their medicinal properties and easy digestibility due to presence of medium chain fatty acids like capric, caprylic acids, therefore further research may be recommended for incorporation of fruit pulp and other natural flavoring compounds in goat milk shrikhand to improve its acceptability.

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