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Development and comparison of goat milk shrikhand with apple fruit pulp shrikhand prepared with goat milk

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Abstract

The present study was conducted for development of goat milk shrikhand incorporated with apple fruit pulp level (%) *i.e.* 15 (A1), 20(A2) and 25 (A3) % for preparation of goat milk shrikhand. pH values decreased whereas titratable acidity increased significantly (P<0.05) with increased level of apple fruit pulp, however there was no significant difference between GH and A1. Among the proximate parameters, protein and fat content decreased however moisture and ash content increased significantly (P<0.05) with increased level of apple fruit pulp. All textural parameters values *i.e.* firmness, consistency, cohesiveness and work of cohesiveness values increased significantly (P<0.05) with increased level of apple fruit pulp; however there was no significant difference between GH and A1 for any textural parameter. The scores of all sensory attributes increased significantly (P<0.05) with increased level of apple fruit pulp in shrikhand. Overall acceptability scores of A3 were significantly (P<0.05) higher than GH, A1 and A2; however there was no significant difference between GH and A1. Therefore, A3- goat milk shrikhand with 25% apple fruit pulp was selected as the best treatment.

Keywords: Goat milk shrikhand, apple fruit pulp, textural and colour parameter, sensory evaluation

Introduction

Fruit and vegetables have been recognized as important sources for a wide array of nondigestible components and phytochemicals that individually, or in combination, may act synergistically to contribute to the nutritional and health benefits of dairy products (Isabel and Deisy, 2011) ^[13]. Apple (*Malus domestica*) is one of leading fruits of Rosaceae family which is grown in temperate regions of various countries including India. The therapeutic value of apple is well known for different illnesses and is good for the treatment of anemia, dysentery, heart disease, kidney stones (Nour *et al.*, 2010) ^[22]. It contains 85% water, 13% carbohydrate and 2.2% total dietary fiber.

Highest milk producer in world is India with 187.7 million tonnes of milk (NDDB, 2019)^[21] due to advancement of technology, proper nutrition and appropriate managemental 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) ^[8]. 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 therapeautic values in medicine and human nutrition (Park and Chukwu, 1989; Park, 1994)^[24, 23] 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)^[25]. It is also rich source of amino acid, being 20-40 folds higher than cow milk (Mehaia and Al-Kanhal, 1992)^[19] which is involved in bile salt formation, osmoregulation, antioxidation, calcium transport and in the central nervous system (Redmond et al., 1998)^[26]. 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)^[6]. 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.

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 NDRI, Karnal which contained mixed culture of *Lactococcus lactis, Lactococccus diacetylactis* and *Lactococcus cremoris*. The culture was activated to 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) ^[11] with slight modifications. Fresh goat milk was filtered through muslin cloth and then fat content was standardized using Pearson square method. 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 hanged 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.

Fresh goat Milk ↓ Filtration through muslin cloth ↓ Fat standardization ↓ Heating of milk @ 85° C for 30 min Cooled to 37±2°C Inoculation with starter culture NCDC-159 @ 2.5 % by v/v of milk Dahi Drainage of whey by hanging for16-18 hrs Chakka Addition of ground sugar (@ 30% of total weight) Mixing with apple fruit pulp Shrikhand T Filling of polypropylene cups Storage at refrigerator temperature $(4\pm 2^{\circ}C)$ Flow diagram 1: Preparation of shrikhand

Analytical methods

Physic-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)^[30]. 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)^[1].

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)^[4]. 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	:	0.04903 N		
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)^[16] 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) ^[29]. 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.

Result and discussion

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) ^[11] with slight modifications.

Physico-chemical properties

pH values decreased whereas titratable acidity increased significantly (P < 0.05) with increased level of apple fruit pulp, however there was no significant difference between GH and A1. Lower pH and higher titratable acidity in treatments might be due to acidic pH of apple fruit pulp which ranges between 3.5-3.8. Highly acidic pH of apple fruit is due to presence of mallic acid and citric acid (Khan et al., 2013)^[17]. Avhad et al. (2017)^[2] also reported significantly (P < 0.05) higher titratable acidity of custard apple incorporated soya milk shake than control. Among the proximate parameters, protein and fat content decreased however moisture and ash content increased significantly (P<0.05) with increased level of apple fruit pulp. Kumar et al. (2011) [18] also observed significant (P < 0.05) decrease in protein and fat content of apple pulp and Celosia argentea incorporated shrikhand. Similarly, Singh and Kumar (2017) ^[28] also observed

significantly (P<0.05) lower protein and fat content as well as higher moisture and ash content of shrikhand prepared with 10 and 15% of wood apple pulp. Water activity and brix values increased significantly (P<0.05) at higher level of apple fruit pulp incorporation in shrikhand. Higher water activity values of treatments might be correlated with increased moisture content with increased level of apple fruit pulp. The possible reason of higher brix values in treatments might be the water binding ability of pectin present in apple fruit pulp providing the viscosity to the product (Celus *et al.*, 2018)^[5].

Textural and colour parameters

All textural parameters values *i.e.* firmness, consistency, cohesiveness and work of cohesiveness values increased significantly (P < 0.05) with increased level of apple fruit pulp; however there was no significant difference between GH and A1 for any textural parameter. Higher textural values at 20 and 25% of apple fruit pulp incorporated shrikhand might be due to pectin water binding capacity causing swelling and increased consistency of product (Kamruzzaman et al., 2002) ^[15]. Similar findings were also reported by Ayar and Gurlin (2014) ^[3] in fruits pulp and herbs incorporated flavoured spreadable yogurt. Lightness values decreased whereas redness and yellowness values increased significantly (P < 0.05) with increased level of apple fruit pulp due to slight golden yellow colour of apple pulp. As per Espley et al. (2000) ^[9], golden yellow colour of apple pulp is due to cyanidin 3-O-galactoside compound.

Sensory evaluation

The scores of all sensory attributes increased significantly (P < 0.05) with increased level of apple fruit pulp in shrikhand. Colour and appearance as well as sweetness scores of A3 were significantly (P < 0.05) higher than GH, A1 and A2; however there was no significant difference between A1 and A2. Texture and mouth coating scores of A2 and A3 were significantly (P < 0.05) higher than GH and A1, whereas there was no significant difference between GH and A1 as well as between A2 and A3. Higher sensory scores in treatments than control might be due to pleasant fruity flavour, desirable smooth texture and appropriate acidity of product. Overall acceptability scores of A3 were significantly (P < 0.05) higher than GH, A1 and A2; however there was no significant difference between GH and A1. Goat milk shrikhand blended with 25% apple fruit pulp was very much liked by sensory panelists among all the treatments. Therefore, A3- goat milk shrikhand with 25% apple fruit pulp was selected as the best treatment.

Table 1: Physio-chemical properties (Mean±SE) of goat milk shrikhand prepared with different levels of apple fruit pulp

Parameters	GH	A1	A2	A3	Treatment Mean
pH	4.57 ^a ±0.15	4.48 ^a ±0.05	4.38 ^b ±0.08	4.14°±0.11	4.39±0.11
Titratable acidity	0.46°±0.01	0.47°±0.02	0.53 ^b ±0.01	$0.56^{a}\pm0.01$	0.50±0.01
Moisture (%)	45.56 ^b ±0.03	45.60 ^b ±0.04	47.11 ^a ±0.08	47.43 ^a ±0.05	46.42±0.03
Protein (%)	6.55 ^a ±0.06	6.17 ^b ±0.06	5.79°±0.08	5.67°±0.07	6.04±0.07
Fat (%)	10.25 ^a ±0.11	8.39 ^b ±0.15	7.69°±0.20	7.13°±0.11	8.36±0.30
Ash (%)	0.64°±0.02	0.68°±0.01	$0.74^{b}\pm0.01$	0.83 ^a ±0.01	0.72±0.01
Water activity	0.932 ^d ±0.02	0.936°±0.01	0.946 ^b ±0.01	0.952 ^a ±0.01	0.941±0.01
Brix value	30.56°±0.06	30.45°±0.07	32.46 ^b ±0.06	33.50 ^a ±0.04	31.74±0.04

• Overall means bearing different superscripts in a row (a, b, c, d......) differ significantly (P<0.05)

• n=6

• GH- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture and 30% sugar

• A1- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture, 30% sugar and 15% apple fruit pulp

- A2- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture, 30% sugar and 20% apple fruit pulp
- A3- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture, 30% sugar and 25% apple fruit pulp

 Table 2: Texture profile analysis (Mean±SE) of goat milk shrikhand prepared with different levels of apple fruit pulp

Parameters	GH	A1	A2	A3	Treatment Mean
Firmness	71.18°±0.44	73.28°±0.42	76.57 ^b ±0.23	79.28 ^a ±0.28	75.07±0.37
Consistency	48.24°±0.25	51.83°±0.13	57.37 ^b ±0.36	60.52 ^a ±0.26	54.49±0.22
Cohesiveness	36.31 ^b ±0.05	38.47 ^b ±0.16	43.31 ^a ±0.09	47.47 ^a ±0.21	45.39±0.11
Work of cohesiveness	31 91 ^b +0 27	$3/131^{b}+0.09$	$38.27^{a}+0.10$	$11.00^{a}+0.35$	1130+0.40

• Overall means bearing different superscripts in a row (a, b, c, d......) differ significantly (P < 0.05)

• n=6

• GH- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture and 30% sugar

- A1- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture, 30% sugar and 15 % apple fruit pulp
- A2- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture, 30% sugar and 20% apple fruit pulp
- A3- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture, 30% sugar and 25 % apple fruit pulp

Table 3: Colour estimation (Mean±SE) of goat milk shrikhand prepared with different levels of apple fruit pulp

Parameters	GH	A1	A2	A3	Treatment Mean
Lightness (L*)	77.45 ^a ±0.21	74.80 ^b ±0.30	73.34 ^b ±0.76	71.38°±0.23	74.24±0.50
Redness (a*)	4.70 ^b ±0.08	$8.88^{a}\pm0.30$	9.67 ^a ±0.06	$10.16^{a}\pm0.04$	8.35±0.25
Yellowness (b*)	7.78°±0.07	9.71 ^b ±0.24	10.54 ^{ab} ±0.19	11.25 ^a ±0.29	9.82 ± 0.28

• Overall means bearing different superscripts in a row (a, b, c, d......) differ significantly (P<0.05)

- n=6
- GH- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture and 30% sugar

• A1- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture, 30% sugar and 15% apple fruit pulp

- A2- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture, 30% sugar and 20% apple fruit pulp
- A3- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture, 30% sugar and 25% apple fruit pulp

Table 4: Sensory evaluation (Mean±SE) of goat milk shrikhand prepared with different levels of apple fruit pulp

Attributes	GH	A1	A2	A3	Treatment Mean
Colour and appearance	5.95°±0.06	6.58 ^b ±0.05	6.71 ^b ±0.08	7.27 ^a ±0.03	6.63±0.06
Flavour	5.98 ^d ±0.06	6.37°±0.05	6.67 ^b ±0.11	7.31 ^a ±0.05	6.58±0.07
Texture	6.60 ^b ±0.04	6.76 ^b ±0.06	6.97 ^a ±0.09	7.05 ^a ±0.07	6.84 ± 0.06
Sweetness	6.22°±0.06	6.33 ^b ±0.09	6.75 ^b ±0.07	7.17 ^a ±0.08	6.69±0.05
Mouth coating	$6.78^{b}\pm0.08$	6.81 ^b ±0.11	7.04 ^a ±0.06	7.24 ^a ±0.08	6.96±0.08
Overall acceptability	6.34°±0.06	6.52°±0.08	6.81 ^b ±0.04	7.33 ^a ±0.05	6.74±0.05

• Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly (P < 0.05)

• n=6

• GH- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture and 30% sugar

• A1- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture, 30% sugar and 15% apple fruit pulp

• A2- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture, 30% sugar and 20% apple fruit pulp

• A3- goat milk shrikhand prepared with 5.0% fat, 2.0% starter culture, 30% sugar and 25 % apple fruit pulp

Conclusion

Fruits are essential parts of human life enriched with many macro and micronutrients also they add fiber to our food. Addition of apple fruit pulp did it work by not only masking the goaty flavor but it also improves the texture of goat milk shrikhand in terms of consistency, cohesiveness and work of cohesiveness. Therefore it was concluded that goat milk shrikhand blended with 25% apple fruit pulp was well acceptable.

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