

RESEARCH ARTICLE

Quality characteristics of apple fruit pulp and tulsi leaves powder incorporated goat milk shrikhand

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Abstract: The present study was conducted to evaluate the effect of apple fruit pulp and tulsi leaves powder on goat milk shrikhand. Preliminary trials were conducted to optimize the apple fruit pulp level in goat milk shrikhand, where 25% pulp was selected as the best treatment. This apple fruit pulp based goat milk shrikhand was further treated with different levels of tulsi leaves powder *i.e.* 0.4% (AT1), 0.6% (AT2) and 0.8% (AT3) and evaluated for various physico-chemical properties and sensory evaluation. The results revealed that pH and brix values decreased whereas ash content increased significantly ($P<0.05$) with increased level of tulsi leaves powder. There was no significant difference in titratable acidity, moisture, protein, fat content and water activity values between control and treatments. Among the textural and colour parameters, firmness, consistency, work of cohesiveness, lightness and yellowness values decreased significantly ($P<0.05$). Sensory scores decreased significantly ($P<0.05$) with incorporation of tulsi leaves powder, however AT1 had significantly ($P<0.05$) higher overall acceptability scores than AT2 and AT3. Therefore, AT1- goat milk shrikhand with 25% apple fruit pulp and 0.4% tulsi leaves powder was selected as the best treatment.

Keywords: Goat milk shrikhand, Apple fruit pulp, Textural and colour parameter, Sensory evaluation

Introduction

Milk production in the country has grown at a compound annual growth rate of about 6.2 % to reach 230.6 million tones (NDDB, 2023) 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 7.61 million tones and it shares a contribution of 3.30% in the total milk production across the country (DAHD, 2023).. 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 (Goswami et al. 2017) 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. Goat milk is considered as —self-homogenized milk. Goat milk contains, water, protein, fat, sugar, minerals, and vitamins, which are essential for the maintenance of good health. Goat milk and its processed products are useful as functional foods, maintaining nourishment and health of young and elders (Singh et al. 2021). 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.

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Traditional dairy foods play a pivotal role in preservation of essential milk nutrients and promotion of its consumption among masses. Shrikhand is one of the widely relished indigenous milk product prepared by the fermentation of milk by using known strain of lactic acid bacteria. It is produced from chakka which in turn is obtained from dahi (curd) after draining off the whey. Shrikhand is a homogenous mass prepared from chakka with sugar, colour and flavor as basic ingredients (Sahu et al. 2021). 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. However, goat milk is also considered to be deficient in dietary fiber like milk from cattle and buffalo. The characteristic flavour is another constraint in acceptability of goat milk and products. The incorporation of fruit pulp in goat milk products like shrikhand will not only enhance the nutritional content especially in terms of dietary fiber but will also substantially mask the characteristic odour of shrikhand prepared by goat milk. Apple (*Malu 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 (Nouret *al.* 2010). It contains 85% water, 13% carbohydrate and 2.2% total dietary fiber. Incorporation of fruits pulp may enhance shrikhand's nutritive value making it more prone for physico-chemical and microbiological spoilage. Tulsi (*Ocimum tenuiflorum*) or holy basil is an aromatic shrub in family *Lamiaceae* that is thought to have originated in north central India and now grows native throughout the eastern world tropics. Tulsi is a sacred herb that has been used in Ayurveda and other traditional medical treatments in India for thousands of years. eugenol, camphor, flavonoids, nerol, and various terpenes. This rich blend of organic compounds *i.e.* eugenol, camphor, flavonoids, nerol present in tulsi delivers a number of health benefits and can help relieve acne, asthma, inflammation, respiratory issues, and lower your chances of heart diseases and atherosclerosis (Hanaa et al. 2016). There, the present study was conducted to evaluate the effect of tulsi leaves powder on physico-chemical properties and sensory evaluation of apple fruit pulp based goat milk shrikhand.

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. Starter culture (NCDC-159) was procured from NDRI, Karnal which contained mixed culture of *Lactococcus lactis*, *Lactococcus 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) 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, apple fruit pulp and different level of tulsi leaves powder. Finally shrikhand was filled in pre sterilized thermo rigid polypropylene cups and stored at under refrigeration at 4±2°C. In present study, following abbreviations were used for present experiment: AT1- goat milk shrikhand prepared with 25% apple fruit pulp with 0.4% tulsi leaves powder, AT2- goat milk shrikhand prepared with 25% apple fruit pulp with 0.6% tulsi leaves powder and AT3- goat milk shrikhand prepared with 25% apple fruit pulp with 0.8% tulsi leaves powder.

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 (A/BE) using 35 mm cylinder probe was used where pre-test speed, test speed and post test speed was set at 1 mm/sec, 1mm/sec and 10mm/sec respectively. The 30 mm distance was set with Auto (F) -10g Trigger type and 0.04903 N force. 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).

Sensory evaluation

Sensory evaluation was conducted by experienced semi trained panellists using 9-point descriptive scale (where 1= extremely disliked and 9= extremely liked) (Keeton, 1983) for colour and appearance, flavour, texture, sweetness, mouth coating and overall acceptability. Samples were served for sensory evaluation at around 7-9°C temperature in sensory evaluation room at late afternoon around 4:00 p.m. Sensory panellists were not allowed to communicate with each other and plain lukewarm water was given for mouth rinsing in between sensing two samples.

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

Several preliminary trials were conducted to standardize the processing technology of apple fruit based goat milk shrikhand on the basis of literature and preliminary trials. The final formulation of goat milk shrikhand was optimized following the method prescribed by Gupta et al. (2018) and 25% apple fruit pulp was finally selected on the basis of sensory evaluation.

Physico-chemical properties

The physico-chemical properties of goat milk shrikhand prepared

with different levels of apple fruit pulp are presented in table 1. The pH and brix values decreased significantly ($P<0.05$) with increased level of tulsi leaves powder in treatments; however there was no significant difference between A3 and AT1 as well as between AT2 and AT3. Sahu et al. (2021) also reported significant ($P<0.05$) increase in brix values of goat milk shrikhand with increased level of starter culture. There was no significant difference in titratable acidity, moisture, protein and fat content as well as water activity values between control and treatments. Pramanick et al. (2017) also reported no significant change in protein and fat content of value added rasogulla prepared by incorporation of tulsi leaf extract. As per Sahu et al. (2022), protein and fat content decreased significantly ($P<0.05$) whereas ash content, water activity and brix values increased significantly ($P<0.05$) with the incorporation of papaya in goat milk shrikhand. Ash content increased significantly ($P<0.05$) with increased level of tulsi leaves powder in treatments, whereas ash content of AT2 was comparable to AT1 and AT3. Singh et al. (2023) reported that chemical composition of yogurt prepared by addition of (0.20 to 2.50) kiwi fruit pulp had 0.20% fat, 0.17% protein, 83.07% moisture, 16.70% total solids, 0.15% ash, 3.26 pH, 1.43% Titrable acidity and 14.67 % carbohydrate. Mehrotra et al. (2014) also observed significant ($P<0.05$) increase in ash content of yogurt incorporated with different levels of *Stevia* leaves powder. Vidhani et al. (2016) reported that ash content in tulsi leaves ranges between 0.90 to 0.96% which contained higher amount of minerals i.e. 61.75 ppm Mn, 32.38ppm Zn, 0.62ppm K, 0.74ppm Na and 1.10 ppm P respectively. Kumar et al. (2023) also reported that goat milk yogurt contained 32.03±0.07 ppm Fe, 360.25±0.07 ppm Zn, 145.68±0.09 Na, 225.86±0.08 Ca and 285.27±0.05 Mg content.

Textural and colour parameters

The values of textural and colour parameters of goat milk shrikhand prepared with different levels of apple fruit pulp are presented in

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

Parameters	A3	AT1	AT2	AT3	Treatment Mean
pH	4.21 ^a ±0.03	4.18 ^a ±0.02	4.15 ^b ±0.03	4.11 ^b ±0.03	4.16±0.03
Titratable acidity	0.54±0.01	0.55±0.02	0.56±0.02	0.56±0.01	0.55±0.02
Moisture (%)	47.24±0.24	47.45±0.36	47.50±0.25	47.63±0.31	47.45±0.35
Protein (%)	5.32±0.11	5.35±0.09	5.27±0.07	5.24±0.07	5.29±0.20
Fat (%)	7.22±0.07	7.25±0.12	7.23±0.11	7.18±0.11	7.23±0.12
Ash (%)	0.82 ^c ±0.01	0.84 ^b ±0.01	0.87 ^{ab} ±0.02	0.90 ^a ±0.02	0.85±0.01
Water activity	0.959±0.01	0.958±0.02	0.958±0.01	0.957±0.04	0.956±0.02
Brix value	33.57 ^a ±0.12	33.30 ^a ±0.08	32.49 ^b ±0.05	32.26 ^b ±0.10	32.90±0.14

- Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly ($P<0.05$)
- n=6
- A3- goat milk shrikhand with 25% apple fruit pulp and 0% tulsi leaves powder
- AT1- goat milk shrikhand with 25% apple fruit pulp and 0.4% tulsi leaves powder
- AT2- goat milk shrikhand with 25% apple fruit pulp and 0.6% tulsi leaves powder
- AT3- goat milk shrikhand with 25% apple fruit pulp and 0.8% tulsi leaves powder

table 2 & 3. Firmness, consistency and work of cohesiveness values of A3 and AT1 had significantly ($P<0.05$) higher than AT2 and AT3; however there was no significant difference between A3 and AT1. The decrease in textural parameters values was due to an increase in compactness on microstructure of shrikhand prepared using Tulsi extract (Rai et al. 2018). There was no significant difference in cohesiveness values between control and

treatments due to very less amount of tulsi leaves powder added in goat milk shrikhand. In contrast to present study, Fodaet al. (2007) reported significant ($P<0.05$) increase in firmness values of turmeric powder incorporated herbal milk. Lightness and yellowness values of A3 and AT1 were significantly ($P<0.05$) higher than AT2 and AT3; however there was no significant difference between A3 and AT1. Lower colour values at higher level

Table 2: Texture and colour parameters (Mean $\pm$ SE) of goat milk shrikhand prepared with different levels of apple fruit pulp

Parameters	A3	AT1	AT2	AT3	Treatment Mean
Firmness	79.18 ^a $\pm$ 0.24	79.09 ^a $\pm$ 0.12	77.03 ^b $\pm$ 0.26	75.29 ^c $\pm$ 0.21	77.64 $\pm$ 0.26
Consistency	60.24 ^a $\pm$ 0.25	60.18 ^a $\pm$ 0.20	58.88 ^b $\pm$ 0.32	57.74 ^c $\pm$ 0.26	59.26 $\pm$ 0.29
Cohesiveness	47.31 $\pm$ 0.25	47.45 $\pm$ 0.31	47.76 $\pm$ 0.34	48.12 $\pm$ 0.26	47.58 $\pm$ 0.28
Work of cohesiveness	41.51 ^a $\pm$ 0.27	41.60 ^a $\pm$ 0.18	39.87 ^b $\pm$ 0.19	37.64 ^c $\pm$ 0.13	40.15 $\pm$ 0.18

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

n=6

A3- goat milk shrikhand with 25% apple fruit pulp and 0% tulsi leaves powder

AT1- goat milk shrikhand with 25% apple fruit pulp and 0.4% tulsi leaves powder

AT2- goat milk shrikhand with 25% apple fruit pulp and 0.6% tulsi leaves powder

AT3- goat milk shrikhand with 25% apple fruit pulp and 0.8% tulsi leaves powder

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

Parameters	A3	AT1	AT2	AT3	Treatment Mean
Lightness (L^*)	71.85 ^a $\pm$ 0.37	71.29 ^a $\pm$ 0.35	69.54 ^b $\pm$ 0.20	67.29 ^c $\pm$ 0.35	69.99 $\pm$ 0.42
Redness (a^*)	10.22 $\pm$ 0.11	10.66 $\pm$ 0.09	10.89 $\pm$ 0.09	11.41 $\pm$ 0.15	10.79 $\pm$ 0.51
Yellowness (b^*)	11.58 ^a $\pm$ 0.11	11.51 ^a $\pm$ 0.09	10.04 ^b $\pm$ 0.04	9.54 ^c $\pm$ 0.04	10.66 $\pm$ 0.19

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

n=6

A3- goat milk shrikhand with 25% apple fruit pulp and 0% tulsi leaves powder

AT1- goat milk shrikhand with 25% apple fruit pulp and 0.4% tulsi leaves powder

AT2- goat milk shrikhand with 25% apple fruit pulp and 0.6% tulsi leaves powder

AT3- goat milk shrikhand with 25% apple fruit pulp and 0.8% tulsi leaves powder

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

Attributes	A3	AT1	AT2	AT3	Treatment Mean
Colour and appearance	7.27 ^a $\pm$ 0.03	7.13 ^a $\pm$ 0.06	6.70 ^b $\pm$ 0.09	6.46 ^c $\pm$ 0.10	6.89 $\pm$ 0.08
Flavour	7.26 ^a $\pm$ 0.05	7.16 ^b $\pm$ 0.06	6.73 ^c $\pm$ 0.08	6.42 ^c $\pm$ 0.11	6.89 $\pm$ 0.08
Texture	7.13 ^a $\pm$ 0.07	7.12 ^b $\pm$ 0.07	6.80 ^c $\pm$ 0.11	6.56 ^c $\pm$ 0.10	6.90 $\pm$ 0.08
Sweetness	7.17 ^a $\pm$ 0.08	7.07 ^{ab} $\pm$ 0.05	6.96 ^b $\pm$ 0.08	6.46 ^c $\pm$ 0.12	6.91 $\pm$ 0.07
Mouth coating	7.24 ^a $\pm$ 0.08	7.12 ^b $\pm$ 0.10	6.82 ^c $\pm$ 0.10	6.51 ^c $\pm$ 0.10	6.92 $\pm$ 0.10
Overall acceptability	7.31 ^a $\pm$ 0.05	7.18 ^b $\pm$ 0.07	6.75 ^c $\pm$ 0.08	6.48 ^c $\pm$ 0.11	6.93 $\pm$ 0.09

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

n=21

A3- goat milk shrikhand with 25% apple fruit pulp and 0% tulsi leaves powder

AT1- goat milk shrikhand with 25% apple fruit pulp and 0.4% tulsi leaves powder

AT2- goat milk shrikhand with 25% apple fruit pulp and 0.6% tulsi leaves powder

AT3- goat milk shrikhand with 25% apple fruit pulp and 0.8% tulsi leaves powder

of tulsi incorporation in goat milk shrikhand might be due to dark green colour of tulsi leaves powder. Gaur et al. (2019) also reported that addition of tulsi leaves juice and turmeric powder imparted dark green colour to herbal flavoured milk. Merai et al. (2002) and Kumar et al. (2018) also observed similar results in tulsi leaves powder incorporated ghee and curry leaves powder incorporated herbal ice cream respectively. There was no significant difference in redness values between control and treatments.

Sensory evaluation

The sensory scores of goat milk shrikhand prepared with different levels of apple fruit pulp are presented in table 4. Sensory scores of all attributes decreased significantly ($P < 0.05$) with increased level of tulsi leaves powder in apple fruit pulp incorporated goat milk shrikhand. Colour and appearance scores of A3 and AT1 were significantly ($P < 0.05$) higher than AT2 and AT3; however there was no significant difference between A3 and AT1. Kumar et al. (2013) observed that colour and appearance scores of ice cream decreased significantly ($P < 0.05$) with increased level of tulsi leaves powder due to dark green colour. However, Johri and Chauhan (2014) reported that color acceptability of herbal Tulsi doi was significantly ($P < 0.05$) higher than control doi samples. The scores of sweetness of A3 were significantly ($P < 0.05$) higher than AT2 and AT3; however scores of AT1 were comparable to A3 and AT2. Flavour, texture, mouth coating and overall acceptability scores of A3 were significantly ($P < 0.05$) higher than AT1, AT2 and AT3. Kumar et al. (2018) also reported lower body and texture scores of herbal ice cream incorporated with 0.25-0.75% curry leaves and lemon grass powder due to perception of 'crumbly' texture and sometimes 'chewy' body in such ice cream. Among the treatments, AT1 had significantly ($P < 0.05$) higher cores than AT2 and AT3; however there was no significant difference between AT2 and AT3. Therefore, AT1- goat milk shrikhand with 25% apple fruit pulp and 0.4% tulsi leaves powder was selected as the best treatment.

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 and tulsi leaves powder did not only mask the goaty flavor but also improved the texture of goat milk shrikhand in terms of consistency, cohesiveness and work of cohesiveness upto 0.4% level. Therefore it was concluded that goat milk shrikhand blended with 25% apple fruit pulp and 0.4% tulsi leaves powder was well acceptable in terms of flavor, consistency and sensory evaluation. Further studies may be carried out to evaluate the shelf life of tulsi leaves powder in terms of lipid oxidation and microbial count.

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