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RESEARCH ARTICLE

Preparation and characterization of low-fat and low-sugar lemon grass flavoured herbal lassi

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Abstract: Lassi is an amazing thirst-quenching fermented dairy beverage in India. It has numerous health benefits and therapeutic value in humans. In the present investigation, an attempt was undertaken to prepare a low-fat and low-sugar herbal lassi from double toned milk. For the preparation of lassi, double-toned milk containing 1.5% fats and 9% solids not fat was used. Dahi was prepared using 1% mixed dahi culture. Artificial sweetener (sucralose) @ 0.7% was used as a replacement for sucrose in lassi. Optimization of different concentrations of aqueous lemongrass extract (2%, 3% and 4% v/v) was evaluated by sensory analysis. 3% (v/v) lemon grass added lassi scored the highest overall acceptability. Further chemical analysis viz., pH, acidity, total solids, moisture, fat and protein content was evaluated and compared with control lassi samples. No significant difference was observed between the two samples. Shelf- life analysis of the selected herbal lassi was conducted at refrigerated temperature (5 ± 2°C). The lassi was found stable for 9 days at storage condition (5 ± 2°C, in glass bottle) based on the chemical, microbiological and sensory analysis.

Keywords: Low fat, Low sugar, Lemon grass, Herbal lassi, Shelf life

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Introduction

Good health is the need and desire of every individual. A healthy life has become very rare in the current polluted world. The growing concern for health and nutrition among consumers has increased the market potential of different emerging food products day by day. In India around 9% of the total milk produced is converted into fermented milk products (Singh et al. 2006). Fermented milk products are well-known for their nutritional and physiological benefits, which include gastrointestinal infection prevention, serum cholesterol lowering and antimutagenic action and also excellent for lactose-intolerant people (Shiby and Mishra, 2013). Lassi is one of the most popular fermented dairy beverages in India that is prepared by the churning of curd with 1% of mix dahi culture or commercial yogurt culture containing *Streptococcus thermophilus* and *Lactobacillus bulgaricus*.

In today's health-conscious society, people are increasingly mindful of their well-being and actively seek beverages that promote disease-free living. Lassi incorporated with nourishing herbs emerges as the ultimate combination, offering a delightful and tantalizing drink that not only satisfies the taste buds but also supports a healthy lifestyle. Herbs and spices have long been used as food additives, not just to improve food's organoleptic characteristics, but also to extend shelf life by lowering or eradicating foodborne microorganisms. (Maji et al. 2018, Maji et al. 2023, Miran et al. 2021, Gokhale et al. 2021). Herbs and spices are frequently used as preservatives and have antioxidant, anti-inflammatory, antitumorgenic, anticarcinogenic qualities (Pateiro et al. 2021, Pinto et al. 2021, Bhattacharya et al. 2021). Lemongrass is one of the most refreshing and advantageous herbs that helps to cure different types of diseases. It is a tropical plant and as such will grow best in warm, sunny and humid conditions of the tropic and subtropic. It also helps to prevent the growth of some bacteria and yeast. Lemongrass also contains substances that help to relieve pain and swelling, reduce fever, and improve the level of sugar and cholesterol in the blood. Lemongrass has a high number of antioxidants that help in preventing oxidative stress like cancer, aging, hypertension, memory loss, depression, stroke, asthma etc. Today, the industry is particularly interested in using these herbal bio-actives in several ways that the medical advantages of herbs can be

delivered as carriers through specific meals. Milk and milk products are one of the most significant sources and can be used as carriers for such foods (Sawale et al. 2013). The inclusion of herbal bio-actives in milk products not only allows the industry to meet the growing demands of customers for such foods but also helps to compete with increasingly functional food markets around the world (Paswan et al. 2021). Along with this, the rising prevalence of diabetes has led to an increase in the consumption of low-calorie sweeteners. Sucralose, a low-calorie sweetener has been shown to play a useful role in aiding people lose and maintain weight. Consumers are becoming more health concerned as they become more aware of the negative effects of excess calories, fat and sugar. Hence, considering the medicinal properties of lemongrass and the use of sucralose and double-toned milk in restricting caloric intake, the present research was designed.

Materials and methods

Collection of raw materials:

Collection of milk, sugar and herbs:

Double-toned cow milk (1.5% and SNF was 9.0%) and sugar-free Natura (sucralose) were purchased from the local market of Parlakhemundi, Odisha.

Tender lemongrass leaves were collected from the herbal garden of the University campus.

Collection of starter culture:

Mix dahi culture was collected from the Mini Dairy unit of Centurion University of Technology and Management in Paralakhemundi, Odisha.

Preparation of sugar syrup:

Sugar-free Natura (Artificial Sweetener) was dissolved in distilled water at a ratio of 0.7%. Afterward, the syrup was used for the preparation of lassi.

Preparation of herbal extract:

Fresh tender lemon grasses were washed in tap water and cut into small

pieces using a knife. Afterward, the chopped lemongrass was immersed in boiling water for a brief 30-second period to facilitate hot water washing and was subsequently filtered using a strainer. It was then ground in a mixer grinder. The juice was carefully extracted and filtered using a muslin cloth, ensuring proper pressure was applied. Then the herbal extract was measured in weighing balance as per requirement in herbal lassi preparation.

Preparation of herbal lassi:

Lassi was prepared according to the method used by Maji et al. 2018. Double-toned milk was first heated to 95°C and cooled at 35°C. After that 1% of mix dahi culture (Streptococcus sp., Lactobacillus sp., Lactococcus sp.) was added into the milk and incubated at 35 to 40°C for 6 to 7 hours. The prepared dahi was gently crumbled and combined with the artificial sweetener. Previously prepared lemon grass juice was then added at 3% (v/v) and mixed. The prepared lassi was stored in refrigerated condition (5± 2°C) (Fig 1).

Analytical methods

Chemical analysis:

The prepared lassi was analyzed for the titratable acidity (AOAC, 1995), total solids (IS:12333 1997), pH (using pH meter coupled with glass electrode), moisture content, fat content by Mojonnier method (IS: 10484, 1983), Ash content (IS:1479 1961) and protein content by Kjeldahl method (IDF 20B: 1993).

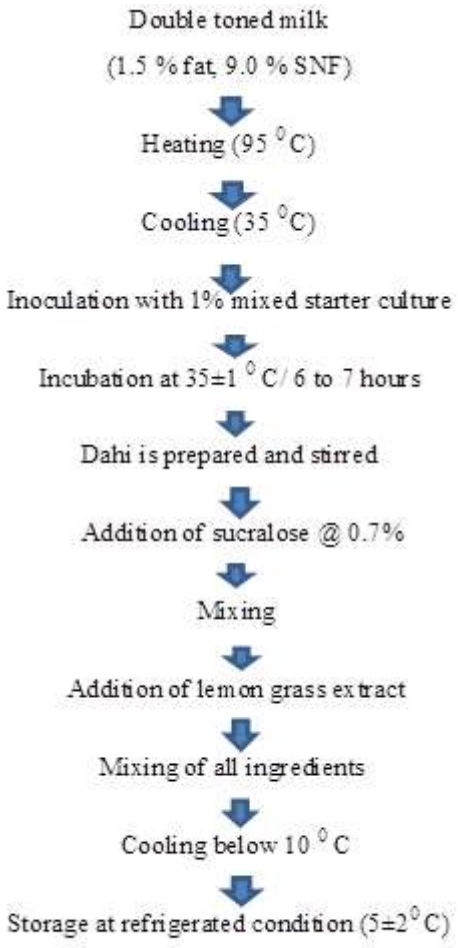

Fig 1: Flow diagram of preparation of lemongrass flavoured lassi

Microbiological analysis:

The Standard Plate Count (SPC), Coliform count, and yeast and mold count in lassi samples were determined following the methods described by FSSAI (2012).

Sensory analysis:

Sensory evaluation of the lemon grass flavoured herbal lassi was done by using a 9-point Hedonic scale as described by the method in Amerine et al. (1965). The samples were judged by a panel of 7 judges in the institution.

Statistical analysis:

Observed data were analyzed for one-way ANOVA using the GraphPad Prism software (version 5.01 for Windows), San Diego, CA, USA. All Data are reported as the mean ± standard error.

Results and Discussions

The optimization of the lemon grass extract for the preparation of flavoured herbal lassi is described below. Different concentrations of lemon grass extract were incorporated into the plain lassi samples. The specific details of each treatment applied are given below.

Treatment Details

T1 - Lassi with no lemon grass extract (Control)

T2 - Addition of lemon grass extract @ 2 percent (v/v) of plain lassi

T3 - Addition of lemon grass extract @ 3 percent (v/v) of plain lassi

T4 - Addition of lemon grass extract @ 4 percent (v/v) of plain lassi

Effect of different levels of lemon grass extract on the sensory quality of lassi:

Different level of lemongrass extract was used to optimize the flavoured lassi. The comparative sensory score of the control lassi and lassi prepared with different levels of lemon grass extract, stored at 5 ± 2°C, are shown in Table 1. The mean score of colour and appearance shows a significant decrease in the case of T2 (2% v/v lemon grass extract added) and T4 (4% v/v lemon grass extract added) compared to T1 (control) and T3 (3% v/v lemon grass extract added). Whereas no significant difference was observed between the T1 and T3 (3% v/v lemon grass extract added) lassi samples. In case of flavour of the herbal lassi, it was observed that the flavour score increased when lemon grass extract was added. A significantly high score was observed in all the treated samples compared to the control i.e. T1. Among all the treated samples, the T3 sample demonstrated the highest

Table 1: Sensory analysis of lemon grass (LG) juice added lassi

Parameters	Level of lemon grass extract (%)			
	T1	T2	T3	T4
Colour and appearance	7.2 ± 0.58^{a}	6.9 ± 0.45^{b}	7.0 ± 0.45^{a}	6.8 ± 0.74^{b}
Flavour	5.1 ± 1.17^{a}	6.3 ± 0.44^{b}	7.8 ± 0.37^{c}	7.06 ± 0.86^{d}
Consistency	5.9 ± 0.64^{a}	6.3 ± 0.62^{b}	6.70 ± 0.70^{c}	6.70 ± 0.70^{c}
Overall acceptability	7.16 ± 0.21^{a}	7.52 ± 0.22^{b}	8.0 ± 0.32^{c}	7.86 ± 0.22^{d}

Values represented as Mean ± SEM, n=7, ^{a,b,c,d}- different superscripts shows significant difference row wise ($p>0.05$)

Table 2: Comparison between chemical composition of control and selected herbal lassi

Parameters (%)	Lassi Samples	
	Control	3% lemon grass added lassi
Acidity	0.72 ± 0.02^{a}	0.74 ± 0.02^{a}
pH	4.79 ± 0.02^{a}	4.77 ± 0.02^{a}
Total Solids	9.05 ± 0.53^{a}	9.12 ± 0.49^{a}
Moisture	90.95 ± 0.54^{a}	90.88 ± 0.48^{a}
Ash	0.69 ± 0.01^{a}	0.71 ± 0.02^{a}
Fat	1.43 ± 0.01^{a}	1.44 ± 0.01^{a}
Sucralose	0.7 ± 0.00^{a}	0.7 ± 0.00^{a}

Values represented as Mean ± SEM, n=7, Same superscript letter in each row represents non significant difference row wise ($p>0.05$)

score in comparison to the others. The consistency profile exhibited a consistent pattern, with higher scores observed in the treated samples as compared to the control sample. The overall acceptability score of control lassi (T1) was found 7.16 ± 0.21. Whereas the scores for the treated lassi samples were 7.52 ± 0.22, 8.0 ± 0.32, and 7.86 ± 0.22 for T2 (2% added), T3 (3% added) and T4 (4% added) respectively. Therefore, it can be concluded that T3 sample (3% v/v lemon grass extract) was the best combination for the preparation of flavoured lassi. The result is comparable with the study of Mule et al. (2018). They used skimmed buffalo milk for the preparation of low-fat lassi. Added with lemon grass extract at a concentration range of 2.5 %, 5%, 7.5% and 10%. Lemon grass distillate at a level of 2% was used for the preparation of dahi and found acceptable for 11 days of refrigerated storage condition (Sutariya and Rao, 2015).

Chemical composition of the selected herbal lassi:

The chemical composition of the control lassi and 3% lemon-grass added lassi was evaluated. The parameters analysed for the lassi were pH, acidity, total solid, moisture, fat and ash content. Table 2 shows the results of the chemical composition of the herbal lassi with a comparison to control lassi.

From table 2, it was observed that the acidity of control lassi and lemon grass added lassi were 0.72 ± 0.02 and 0.74 ± 0.02 percent lactic acid respectively. Whereas the pH of the control and lemon-grass added lassi was 4.79 ± 0.02 and 4.77 ± 0.02 respectively. The results indicated that the addition of lemongrass juice to the lassi did not result in any significant differences in acidity and pH compared to the control lassi in the initial days. These findings are similar to the observations reported by Mule et al. (2018). They found the acidity of control and lemongrass flavoured lassi (2.5% v/v) on the first day was 0.80 and 0.81% of lactic acid. Sutariya and Rao (2015) also found a non-significant difference in pH and acidity of control and flavoured yoghurt samples.

No significant difference was observed in the total solids and moisture content between lemon-grass flavoured lassi and control lassi (Table 2). The total solids content of control and 3% lemon grass added lassi was found 9.05 ± 0.53 and 9.12 ± 0.49 percent, respectively. The moisture content of control and 3% lemon grass juice added lassi was found 90.95 ± 0.54 and 90.88 ± 0.48 percent respectively. The results are in accordance with findings of Mule et al. (2018).

The fat content of control and flavoured lassi showed no significant difference, likely due to the use of double toned milk. The fat content of control and flavoured lassi was found 1.43 ± 0.01 and 1.44 ± 0.01 percent respectively. It was also observed that the addition of lemongrass extract did not affect the fat content in lassi.

The ash content of the control and flavoured lassi was found 0.69 ± 0.01 and 0.71 ± 0.02 percent, respectively. Chaudhari (1959) and Laxminarayan and Shankar (1980), who reported the average ash content of skim milk lassi and plain lassi as 0.70 to 0.75 and 0.7 percent respectively. Mule et al. (2018) observed the ash content of control and lemongrass flavoured lassi was 0.82 and 1.12 % respectively.

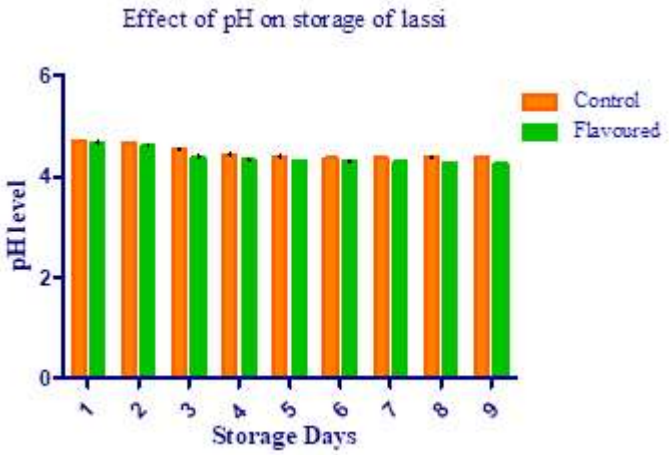

Fig 2: Changes in pH of control and lemon grass flavoured lassi during storage at refrigeration temperature (5±2°C)

Changes in chemical, microbiological and sensory properties of lemon grass flavoured lassi during storage at 5±2°C:

Effect of pH and acidity on the stability of lemongrass flavoured (@ 3% v/v) lassi during storage at refrigeration temperature (5±2°C)

The pH of the control and flavoured lassi was analyzed for a period of 9 days stored in a glass container at refrigerated temperature (5±2°C). It was observed from the results that the pH was decreased with increasing the storage days (Fig 2). In case of the control lassi, the pH on 0th day was observed 4.72 ± 0.01 and on 9th day, it was 4.34 ± 0.01. Whereas, in flavoured lassi, the pH on 0th day was 4.77 ± 0.01 and on 9th day was 4.11± 0.01. The decrease in pH of all lassi samples during storage was due to increasing the microbial load. Therefore, the acidity increases and simultaneously pH decreases. Similar type of result was observed by Kumar et al. (2020). They found a gradual decrease in pH in control (4.53 to 3.91) and flavoured lassi (4.57 to 3.89) in 28 days of storage at 7±1°C.

In case of acidity, it is evident that as the duration of storage increases, there is a corresponding rise in acidity levels. A similar pattern was observed in the case of flavoured lassi samples (Fig 3). It was also observed that the acidity of the flavoured lassi was significantly higher compared to the control lassi. The acidity of control lassi and flavoured lassi on 0th day was found 0.69 ± 0.01 and 0.70 ± 0.01 respectively. Kumar et al. (2020) also did a storage study of herbal honey lassi and observed an increasing trend in the acidity of lassi during a storage period of 28 days at

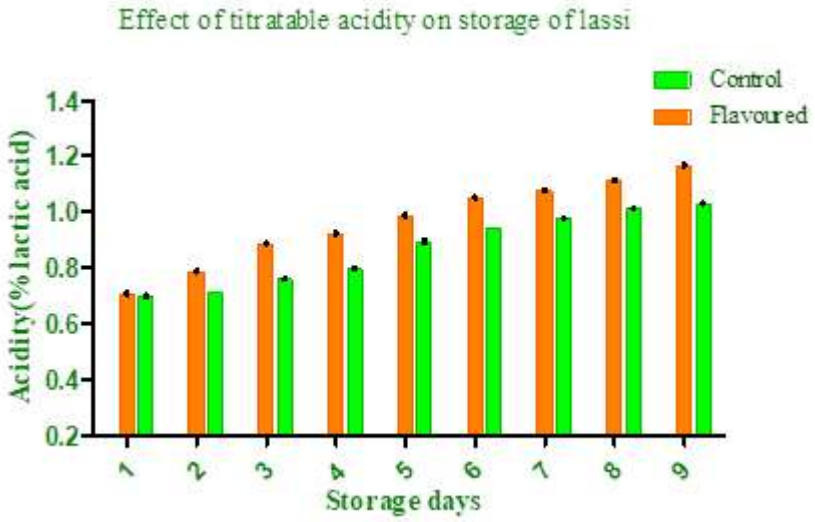

Fig 3: Changes in titratable acidity of control and lemon grass flavoured lassi during storage at refrigeration temperature (5±2°C)

Table 3: Changes in the microbiological quality of control and flavoured lassi during storage at refrigeration temperature (5±2°C)

Parameters	Day 1	Day 3	Day 5	Day 7	Day 9
			Control Lassi		
SPC (cfu/ml)	1.9×10^5	2.4×10^5	2.9×10^5	3.3×10^5	3.9×10^5
Coliform (cfu/ml)	Nil	Nil	Nil	Nil	Nil
Yeast & Mold (cfu/ml)	Nil	Nil	Nil	Nil	Nil
			Lemon grass flavoured Lassi		
SPC (cfu/ml)	0.8×10^5	1.3×10^5	1.8×10^5	2.3×10^5	2.7×10^5
Coliform (cfu/ml)	Nil	Nil	Nil	Nil	Nil
Yeast & Mold (cfu/ml)	Nil	Nil	Nil	Nil	Nil

Values are represented as average of two (n=2) readings. cfu= colony forming unit

7± 1°C. The rate of increase in acidity for control lassi was 0.81 to 1.24% Lactic acid (LA) and herbal honey lassi was 0.77 to 1.38% LA. A similar observation was also observed by Patidar and Prajapati (1998) and Bagal et al. (2007).

Effect of microbial count on the stability of lemongrass flavoured (@ 3% v/v) lassi during storage at refrigeration temperature (5±2°C)

Microbiological analysis of flavoured lassi was done to assess the shelf life of the lassi at refrigeration temperature. The standard plate count, coliform count and yeast and mold count of control and flavoured lassi are given in Table 3. The SPC count of lassi samples was increased with increasing the storage days whereas coliform and yeast and mold count has observed nil throughout the storage period. The results are in accordance with the result of Maji et al. (2018). Where they reported, that in turmeric-flavoured lassi, SPC count increased and coliform and yeast and mold count was nil during storage (7±2°C).

Effect of sensory properties on the stability of lemongrass flavoured (@ 3% v/v) lassi during storage at refrigeration temperature (5±2°C):

Sensory analysis is the best method for figuring out whether a product will be well-liked

by customers or not. The treated lassi samples along with the control lassi were assessed by the four judges from the organization using a "Nine-point Hedonic scale" scorecard. The data obtained for changes in sensory attributes (during storage at 5±2°C) for control lassi and flavoured lassi is presented in Table 4. It was observed that in both the lassi samples, after 7th days onwards the sensory scores were highly affected with increasing the storage days. Comparing the sensory score of both type of lassi, it was observed that the flavour score was significantly higher in case of lemongrass flavoured lassi compared to control one from the day first to the increasing storage days. This is due to the added flavour of fresh lemongrass

Table 4: Sensory analysis of control and flavoured lassi during storage at refrigeration temperature (5±2°C)

Characteristics	Type of Lassi	Storage Days									
		1	2	3	4	5	6	7	8	9	10
Colour	Control	$9.0±0.01^{aA}$	$9.0±0.01^{aA}$	$9.0±0.01^{aA}$	$9.0±0.02^{aA}$	$8.5±0.50^{aA}$	$8.5±0.50^{aA}$	$8.0±0.02^{aB}$	$7.0±0.02^{aB}$	$6.0±0.01^{aB}$	$6.0±0.01^{aB}$
	Flavoured	$9.0±0.01^{aA}$	$9.0±0.01^{aA}$	$9.0±0.02^{aA}$	$9.0±0.02^{aA}$	$9.0±0.02^{aA}$	$9.0±0.01^{aA}$	$8.0±0.01^{aB}$	$7.0±0.02^{aB}$	$7.0±0.02^{aB}$	$6.0±0.01^{aB}$
Flavour	Control	$7.5±0.50^{aA}$	$7.5±0.50^{aA}$	$7.0±0.01^{aA}$	$7.0±0.01^{aA}$	$6.5±0.50^{aA}$	$6.5±0.50^{aA}$	$6.5±0.50^{aA}$	$6.0±0.01^{aB}$	$5.0±0.01^{aB}$	$5.0±0.01^{aB}$
	Flavoured	$9.0±0.01^{bA}$	$9.0±0.02^{bA}$	$9.0±0.01^{bA}$	$8.5±0.50^{bA}$	$8.5±0.50^{bA}$	$8.0±0.50^{bB}$	$7.5±0.10^{aB}$	$7.0±0.50^{bB}$	$7.0±0.20^{bB}$	$6.0±0.30^{bB}$
Mouthfeel	Control	$8.5±0.50^{aA}$	$8.5±0.50^{aA}$	$8.5±0.50^{aA}$	$8.0±0.02^{aA}$	$8.0±0.02^{aA}$	$8.0±0.01^{aA}$	$8.0±0.01^{aA}$	$7.0±0.01^{aB}$	$6.0±0.02^{aB}$	$6.0±0.01^{aB}$
	Flavoured	$9.0±0.50^{aA}$	$9.0±0.50^{aA}$	$8.5±0.01^{aA}$	$8.5±0.01^{aA}$	$8.5±0.01^{aA}$	$8.0±0.02^{aB}$	$8.0±0.05^{aB}$	$7.0±0.02^{aB}$	$7.0±0.01^{aB}$	$6.5±0.01^{aB}$
Consistency	Control	$8.0±0.01^{aA}$	$8.0±0.01^{aA}$	$8.0±0.01^{aA}$	$7.5±0.50^{aA}$	$7.5±0.50^{aA}$	$7.0±0.01^{aA}$	$7.0±0.02^{aA}$	$6.5±0.50^{aB}$	$6.0±0.01^{aB}$	$5.0±0.01^{aB}$
	Flavoured	$8.0±0.02^{aA}$	$8.0±0.05^{aA}$	$8.0±0.01^{aA}$	$8.0±0.01^{aA}$	$7.5±0.50^{aA}$	$7.5±0.50^{aA}$	$7.5±0.50^{aA}$	$7.0±0.01^{aA}$	$7.0±0.01^{aB}$	$6.0±0.02^{aB}$
Overall acceptability	Control	$7.5±0.02^{aA}$	$7.5±0.02^{aA}$	$7.0±0.10^{aA}$	$6.5±0.50^{aA}$	$6.5±0.50^{aA}$	$6.5±0.05^{aA}$	$5.5±0.05^{aB}$	$5.0±0.01^{aB}$	$5.0±0.01^{aB}$	$4.0±0.01^{aB}$
	Flavoured	$8.5±0.50^{bA}$	$8.5±0.50^{bA}$	$8.0±0.01^{bA}$	$7.5±0.50^{bA}$	$7.5±0.50^{bA}$	$7.5±0.50^{bA}$	$7.0±0.50^{bA}$	$6.5±0.50^{bB}$	$6.5±0.50^{bB}$	$5.0±0.10^{bB}$

Values are represented as mean ± SEM, n=4; $^{a-b}$ different superscript column wise differ significantly between control and flavoured lassi in each characteristics, A-B different superscript row wise differ significantly within control and flavoured lassi ($p>0.05$)

juice in lassi. The mouth feeling of lemongrass flavoured lassi was also higher compared to control but non significantly. The overall acceptability score of lemongrass flavoured lassi was comparatively higher than the control lassi. From the result, it was observed that the lemon-grass flavoured lassi was acceptable for up to 9 days when stored in a closed glass container at 5 ± 2°C. Similarly, the control lassi was found suitable for up to 6 days of storage at similar conditions.

Conclusions

Lassi, a well-known fermented product with therapeutic properties, can be enhanced nutritionally through the addition of various herbs. In this study, a low-fat version of lassi was prepared using double-toned milk, while the use of sucralose instead of sugar resulted in a reduction in calorie content. To improve the flavour, nutritional and functional property of the lassi, different concentrations (2%, 3% and 4% v/v) of lemongrass juice were used for the preparation of the lassi. Through sensory evaluation, it was determined that the lassi containing 3% (v/v) lemon grass juice received the highest preference and was selected as the best option. The final product was analyzed for pH, acidity, total solids, moisture, ash and fat content. No significant difference was observed in the chemical composition of the flavoured lassi with the control lassi. The final product showed a shelf life of 9 days according to chemical, microbiological and sensory evaluation when stored in a closed glass container at refrigeration temperature (5 ± 2°C). Therefore, it can be concluded that the preparation of low-fat, low-sugar lemon-grass flavoured lassi could be efficaciously utilized as a low-calorie fermented product.

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