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Substitution of Sucrose in *Lassi* by Tagatose as a Sweetener

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Abstract

In the era of reduction in sugar consumption, availability of suitable alternative sweeteners is highly desirable. But to find an ideal substitute of sucrose remained destined dream. Tagatose is now is emerging as very promising substitute of sucrose for use as a sweetener. Therefore, in present study suitability of tagatose evaluated as a sweetener in *Lassi*. The findings of the study suggested that *Lassi* prepared by substituting sucrose by tagatose or its blend with sucrose or fructose was very well acceptable in sensory evaluation. Tagatose was able to substitute sucrose in *Lassi* without any changing the process parameter. Proximate composition, physicochemical properties and microbial counts of the sucrose substituted *Lassi* were more or less similar to corresponding products prepared by using sucrose as a sweetener. Shelf-life of the sucrose substituted *Lassi* was also similar to corresponding *Lassi* prepared by using sucrose as a sweetener.

Keywords: Tagatose, *Lassi*, Substitution, Sucrose

Sweeteners got entry in to food industry and became staple in foodstuffs. Due to progress in production of refined sugar from raw sources, it became possible to add sweetness to food. Among the sweeteners, humans are most accustomed to disaccharide sucrose. Sugar elicit a sweet taste but energy dense diets high in sugars contribute to excess calorie intake, which in turn leads to obesity with concomitant health problems. Therefore, reduction in consumption of sugar has become an important goal.

Substitution of sucrose and other nutritive sweeteners with alternative non-calorie/low-calorie and high-intensity sweeteners is practical approach to achieve this goal. However, sucrose is considered as gold standard for sweetness (WHO, 2017). None of the alternative sweetener up to now seems to be perfect in view of the requirements for an ideal sugar substitute, because sucrose possesses unique combinations of physical, chemical and microbiological properties for its key role in sweetened products. Therefore, it poses unique challenges in its substitution in different types products (Davis, 1995). Consequently, producing a high-quality food product using alternatives to sugar is not straightforward. Hence, total sucrose replacement may remain pipe dream forever (Hutchings *et al*. 2019).

In selection of suitable alternative sweeteners for substitution of sucrose, the sweetener is judged on various facets: naturalness, glycemic index, calorie count and any positive effect on nutrition they may bring (Martí *et al*. 2008; Streak, 2015).

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Tagatose is reported as a natural sweetener with functional attributes. In recent years it has received increasing attention from food industry and scientific community. D-tagatose (or tagatose) is a mirror image of D-fructose at the fourth carbon atom (Vastenavond *et al.* 2012). Although tagatose is naturally occurring in some fruits and dairy products (Skytte 2006), it is commercially produced from lactose through chemical and/or enzymatic processes (Vastenavond *et al.* 2012). The resulting tagatose has sweetness characteristics highly resembling to those of sucrose (Fujimaru *et al.* 2012). Moreover, many physical and chemical characteristics of tagatose are also very similar to those of the sucrose (Levin *et al.* 1995; Levin 2002; Kim, 2004; Lu *et al.* 2008). Tagatose has been generally recognized as safe (GRAS) for use in foods and beverages by FDA (FDA 2011).

Fortunately, now tagatose is emerging as a potential alternative low calorie full bulk sweetener due to its (a) relative sweetness almost equivalent to sucrose, (b) sweetness characteristics very closely resembling to sucrose (c) low glycemic index, (d) low calorie content and (e) similarity in application related technological properties such as bulk, browning, etc.. Moreover, it has functional nature, which makes the tagatose different from other low-calorie sweeteners. It is regarded as a tooth-friendly substance. The unabsorbed tagatose acts as prebiotic (Bertelsen *et al.* 2001; Venema *et al.* 2005). The prebiotic activity of tagatose was well preserved in food products even after thermal treatments (Luecke & Bell 2010).

Though tagatose is emerging as promising substitute of sucrose, information on its application and suitability in various categories of dairy products is very limited. In India, among sweetened fermented dairy products, *Lassi* is the most popular and widely consumed traditional Indian dairy product all throughout the country. Therefore, from the category of fermented milk products *Lassi* was selected to try substitution of sucrose by tagatose as a sweetener.

MATERIALS AND METHODS

The tagatose of sweet health brand from Natural, USA brand was procured from local supplier of ingredients. The content (purity) of tagatose was 100 per cent. Sucrose of Madhur brand from "Shree Renuka Sugars Limited" was procured from local market. Content (purity) of sucrose was 99.4 per cent. Fructose of "Lobachemie" brand was purchased from local supplier. Content (purity) of fructose was 99 per cent. Microbial culture: Cultures *Streptococcus thermophilus* (MTCC 5460) and *Lactobacillus helveticus* (MTCC 5463) were obtained from Dairy Microbiology Department of this college.

Preparation of *Lassi*

For preparation of *Lassi*, Amul brand toned milk containing 3 per cent fat and 8.5 per cent SNF was used. The *Lassi* available in Indian market usually contains 12 per cent sucrose (Aneja *et al.* 2002; De, 2001). In industrial production of *Lassi*, addition of sucrose is reported at the rate of 12 per cent (Ranganadham, 2016). Therefore, in this study for preparation of *Lassi* sucrose was added at rate of 12 per cent.

Lassi was prepared using method as reported by Aneja *et al.* (2002). The milk was heated to 90°C for 10 minutes. After cooling milk to 40°C mixed culture (*Streptococcus thermophilus* (MTCC 5460) and *Lactobacillus helveticus* (MTCC 5463), in ratio of 1:1) was inoculated at the rate of 1 per cent and incubated for 12 hours at 42°C. After incubation sweetener and water were added to give sweetness and reduce viscosity. Product was stirred to smooth uniform consistency. Addition of water was kept fixed at 20 per cent by weight of curd. Samples of *Lassi* were prepared using tagatose alone, blend of tagatose + sucrose, blend of tagatose + fructose and sucrose alone as sweeteners. The amount of each sweetener used in preparation of *Lassi* is given in Table 1. The selection of these sweeteners and their rate of addition are based on the work carried out by Patel *et al.* (2021) for optimization of sucrose substitution in *Lassi* using tagatose as an alternative sweetener.

Table 1: Amount of sweeteners used in preparation of *Lassi*

Sweetener	Amount used (g/100 ml *Lassi*)
Tagatose	14.40
Tagatose + Sucrose	10.80 + 3.00
Tagatose + Fructose	12.96 + 1.44
Sucrose	12.00

Analysis of *Lassi* for proximate composition

Total solids (TS) fat, protein and ash were determined by gravimetric method as described by BIS (1981). Total carbohydrates where estimated by difference method in which sum total of percentage of other constituents in product was subtracted from 100.

Analysis of *Lassi* for physico-chemical characteristics

Specific gravity of *Lassi* was determined at 30°C using specific gravity bottle using method as described by BIS (1981). Viscosity of *Lassi* was determined at 30°C using Brookfield DV-II + Pro viscometer. Method provided by manufacture was followed for determining viscosity of *Lassi* (Brookfield Engineering Laboratories). Acidity of *Lassi* was determined by titration method as suggested by reported by BIS (1981).

Analysis of *Lassi* for microbial counts

Lassi was analyzed for coliform count as well as yeast and mold counts (YMC). For the microbial counts methods suggested by BIS (1981) were used.

Sensory evaluation of *Lassi*

Sensory evaluation of flavoured milk, *Lassi* was carried out for their overall acceptability using 9 point hedonic scale according to the method suggested by Wichchukit & O'Mahony (2015). The evaluation was carried out by a panel of experienced judges. The score given by different judges was averaged out. The average values were compiled and used for statistical analysis and reported here.

Shelf life evaluation of *Lassi*

Samples of *Lassi* were filled in PET bottles, stored in refrigerator at 6°±1°C and analyzed for changes in acceptability in sensory evaluation and acidity at an interval of 24 h (i.e. every day).

Statistical analysis of data

The mean values of each of the attributes in the study were subjected to statistical analysis using Completely Randomized Design. The statistical model adopted was given by Steel and Torrie (1980) which is illustrated as given below:

$$Y_{ij} = m + T_i + E_{ij}$$

Where,

Y_{ij} = Response due to j^{th} observation in the i^{th} treatment.

m = general mean

T_i = effect of i^{th} treatment, and

E_{ij} = Error due to j^{th} observation in the i^{th} treatment.

RESULTS AND DISCUSSION

Lassi prepared using different sweetener was proximate composition, relevant physico-chemical properties, microbial counts and acceptance in sensory evaluation.

Proximate Composition of *Lassi*

For proximate composition, *Lassi* prepared using 14.4 g tagatose (T), 12.0 g sucrose (S), blend of 10.8 g tagatose + 3.0 g sucrose (T + S) and blend of 12.96 g tagatose + 1.44 g fructose (T + F) per 100 ml *Lassi* as sweeteners was analyzed for total solids (TS), fat, protein carbohydrates (CHOs) and ash content. Proximate composition of the *Lassi* and its statistical analysis are summarized in the Table 2.

Total solids content of *Lassi*

Total solids content of *Lassi* with different sweeteners varied from 22.06 to 24.10 per cent. The highest total solids content was found in *Lassi* prepared using tagatose alone as a sweetener, very closely followed by the *Lassi* prepared using the blend of tagatose and fructose. The lowest total solids content was found in *Lassi* prepared using sucrose alone as a sweetener, followed by the *Lassi* prepared using sucrose alone

Table 2: Proximate composition of *Lassi* prepared using different sweeteners

Sl. No.	Sweetener used	% Sucrose substitution	Constituent (%)				
			TS	Fat	Protein	CHOs	Ash
1	T	100	24.10[b]	1.95	2.28	19.35	0.51
2	T + S	75	23.61[b]	2.04	2.36	18.69	0.52
3	T + F	100	24.07[b]	1.92	2.34	19.29	0.52
4	S	0	22.06[a]	2.10	2.41	17.02	0.53
			ANOVA				
SEm.			0.21	0.05	0.09	0.21	0.01
CD			0.92	—	—	0.87	—
$Test_{(0.05)}$			*	NS	NS	*	NS
CV%			1.86	4.82	7.45	2.22	2.51

There was statistically significant difference in total solids and total carbohydrates content of Lassi, whereas fat, protein and ash content of Lassi were statistically at par.

as a sweetener, and that prepared using the blend of tagatose and sucrose. The differences in total solids content were attributed to differences in rate of additions of sweeteners between these samples.

The total solids content of all the samples of *Lassi* were very well in accordance the values reported in the literature (Bagal *et al.* 2007; Bhoir *et al.* 2012; Ranganadham *et al.* 2016; Khupse *et al.* 2017; Upadhyay *et al.* 2017; Mule *et al.* 2018).

Fat content of *Lassi*

Fat content of *Lassi* with different sweeteners varied from 1.92 to 2.04 per cent. The differences in fat content of *Lassi* prepared using different sweeteners appeared very narrow and were proportionate to differences in their total solids content.

In literature the fat content in *Lassi* is reported from 1.02 to 4.70 per cent (Bagal *et al.* 2007; Bhoir *et al.* 2012; Ranganadham *et al.* 2016; Khupse *et al.* 2017; Upadhyay *et al.* 2017). Therefore, the fat content of *Lassi* were very well in accordance the values reported in the literature.

Protein content of *Lassi*

Protein content of *Lassi* with different sweeteners varied from 2.28 to 2.41 per cent. The differences in protein content of *Lassi* prepared using different sweeteners appeared very narrow and were proportionate to differences in their total solids content.

In literature the protein content in *Lassi* is reported from 1.71 to 3.59 per cent (Bhoir *et al.* Khupse *et al.* 2017; Pallavi *et al.* 2020; Upadhyay *et al.* 2017; Mule *et al.* 2018). Therefore, the protein content of *Lassi* were very well in accordance the values reported in the literature.

Total carbohydrates content of *Lassi*

Total carbohydrates content of *Lassi* with different sweeteners varied from 17.02 to 19.35 per cent. The highest total carbohydrates content was found in *Lassi* prepared using tagatose alone as a sweetener, very closely followed by the *Lassi* prepared using the blend of tagatose and fructose. The lowest total carbohydrates content was found in *Lassi* prepared using sucrose alone as a sweetener, followed by the *Lassi* prepared using sucrose alone as a sweetener, and that prepared using the blend of tagatose and sucrose. The differences in total carbohydrates content were attributed to differences in rate of additions of sweeteners between these samples.

In literature the carbohydrates content in *Lassi* is reported from 12.60 to 17.40 per cent (Bhoir *et al.* 2012; Khupse *et al.* 2017; Pallavi *et al.* 2020; Upadhyay *et al.* 2017; Mule *et al.* 2018; Shuwu *et al.* 2011). Therefore, the carbohydrates content of *Lassi* was in accordance

the values reported in the literature. Somewhat higher carbohydrates content in tagatose containing samples was attributed its relatively greater amount added to generally use in preparation of *Lassi* reported in various studies.

Ash content of *Lassi*

Ash content of *Lassi* with different sweeteners varied from 0.51 to 0.53 per cent. The differences in ash content of *Lassi* prepared using different sweeteners appeared very narrow. Slightly higher ash content of *Lassi* prepared with sucrose alone as a sweetener might be due to relatively higher ash content of sucrose compared to that of the tagatose.

In literature the ash content in *Lassi* is reported from 0.41 to 0.70 per cent (Bhoir *et al.* Khupse *et al.* 2017; Pallavi *et al.* 2020; Upadhyay *et al.* 2017). Therefore, the ash content of *Lassi* were very well in accordance the values reported in the literature.

Physico-chemical Properties of *Lassi*

For physico-chemical properties, *Lassi* prepared using 14.4 g tagatose (T), 12.0 g sucrose (S), blend of 10.8 g tagatose + 3.0 g sucrose (T + S) and blend of 12.96 g tagatose + 1.44 g fructose (T + F) per 100 ml *Lassi* as sweeteners was analyzed for specific gravity, viscosity, and acidity. Average results of specific gravity, viscosity, and acidity from four replications are presented in Table 3.

Specific gravity of *Lassi*

Specific gravity of *Lassi* with different sweeteners varied from 1.08 to 1.088 at 30°C. The highest specific gravity was found in *Lassi* prepared using the blend of tagatose and fructose as a sweetener, very closely followed by the *Lassi* prepared using tagatose alone. The lowest specific gravity was found in *Lassi* prepared using sucrose alone as a sweetener, followed by the *Lassi* prepared using blend of sucrose and tagatose as a sweetener. The differences in specific gravity were attributed to differences in their total solids contents, because changes in specific gravity was proportionate variation in total solids content of *Lassi*.

According to Deshpande *et al.* (2020) specific gravity of *Lassi* varied from 1.065 to 1.070. Therefore, the specific gravity of *Lassi* prepared using sucrose as sweetener in present study was in close proximity the values reported by these authors. The specific gravity of *Lassi* prepared using tagatose as sweetener was somewhat higher compared to the reported value, due its higher rate of addition than that of the sucrose.

Viscosity of *Lassi*

Viscosity of *Lassi* with different sweeteners varied from 284.4 to 312 mPs at 30°C. The highest viscosity was found in *Lassi* prepared using the blend of tagatose and fructose as a sweetener, very closely followed by the *Lassi* prepared using tagatose alone.

Table 3: Physico-chemical properties of *Lassi* prepared using different sweeteners

Sl. No.	Sweetener used	% Sucrose substitution	Specific gravity	Viscosity (mPa•s)	Acidity (% lactic acid)
1	T	100	1.088^{b}	308.3	0.68
2	T + S	75	1.085^{ab}	303.6	0.69
3	T + F	100	1.089^{b}	312.4	0.68
4	S	0	1.080^{a}	284.4	0.70
			ANOVA		
SEm.			0.002	8.21	0.024
CD			0.007	—	—
$Test_{(0.05)}$			*	NS	NS
CV%			0.32	5.46	6.82

There was statistically significant difference in specific gravity of Lassi, whereas viscosity and acidity of Lassi were statistically at par.

The lowest viscosity was found in *Lassi* prepared using sucrose alone as a sweetener, followed by the *Lassi* prepared using blend of sucrose and tagatose as a sweetener. The differences in viscosity were attributed to differences in their total solids contents, because changes in specific gravity was proportionate variation in total solids content of *Lassi*.

In literature the wide variation in viscosity of *Lassi* is reported. The reported values are ranging from 136 to 363.2 cp (Dixit, 2018; Kaur *et al.* 2019; Mule *et al.* 2018; Ranjan *et al.* 2015). Therefore, the viscosity of *Lassi* were very well in accordance the values reported in the literature.

Acidity of *Lassi*

Acidity of *Lassi* with different sweeteners varied from 0.68 to .70 per cent lactic acid. Therefore it is evident that there very narrow differences in acidity of *Lassi* prepared using different sweeteners. The sweeteners were added after completing the step of fermentation involved in preparation of *Lassi*. Therefore, effect of sweeteners on acidity of *Lassi* is not expected.

In literature the wide variation in acidity of *Lassi* is reported. The reported values are ranging from 0.43 to 1.15 per cent. (Bagal *et al.* 2007; Bhoir *et al.* 2012; Deshpande *et al.* 2020; Kaur *et al.* 2019; Khupse *et al.* 2017; Mule *et al.* 2018; Upadhyay *et al.* 2017). Therefore, the viscosity of *Lassi* were very well in accordance the values reported in the literature.

Microbial Counts of *Lassi*

Microbial analysis of the *Lassi* was carried for coliform count as well as yeast and mold count. In enumeration of microbial counts of *Lassi*, only *Lassi* prepared using tagatose alone and sucrose alone as sweeteners were included, since these were two extreme cases among four types of sweeteners. Total three replications were conducted. Results of the microbial counts of *Lassi* are presented in Table 4.

The results of the microbial counts suggested that SPC, coliform as well yeast and mold count in *Lassi* fulfilled the requirements laid down by FSSAI for fermented milk products under Microbiological Standards for Milk and Milk Products –Process Hygiene Criteria (FSSAI, 2019).

Acceptability of *Lassi* in sensory evaluation

For evaluating acceptability *Lassi* was prepared using

Table 4: Microbial counts of *Lassi* prepared using different sweeteners

Sl. No.	Sweetener used (g/100 ml)	Coliform (cfu/g)	Yeast & mold (cfu/g)
1	Tagatose (14.40)	Absent	1.33±0.88
2	Sucrose (12.00)	Absent	2.33±0.33

Table 5: Overall acceptability score of *Lassi* prepared using different sweeteners

Sl. No.	Rate of sucrose substitution (%)	Sweetener & its amount used (g/100 ml)	Acceptability score (out of 9)
1	100	Tagatose (14.40)	8.41
2	75	Tagatose (10.80) + Sucrose (3.00)	8.47
3	100	Tagatose (12.96) + Fructose (1.44)	8.28
4	0	Sucrose (12.00)	8.37
		ANOVA	
SEm.		0.11	
CD		0.45	
$Test_{(0.05)}$		NS	
CV%		2.53	

14.4 g tagatose, 12.0 g sucrose, blend of 10.8 g tagatose + 3.0 g sucrose and blend of 12.96 g tagatose + 1.44 g fructose per 100 ml *Lassi* as sweeteners. The samples of *Lassi* were evaluated for overall acceptability by a panel of experienced judges. Average results of overall acceptability from four replications are presented in Table 5.

The overall acceptability score of *Lassi* prepared using different sweetener was in the order of tagatose + sucrose > tagatose alone >sucrose alone > tagatose + fructose. However, the overall acceptability score of *Lassi* in all the four sweeteners was highly acceptable (>8).

The statistical analysis of data revealed that use of tagatose alone (@ 14.4 g/100 ml), blend of tagatose + sucrose (@ 10.8 + 3.0 g/100 ml), blend of tagatose + fructose (@ 12.96 + 1.44 g/100 ml) and sucrose alone (@ 12 g/100 ml) as sweetener in preparation of *Lassi* had no significant effect on overall acceptability score of *Lassi*. The overall acceptability score of *Lassi* was statistically at par in all the four cases.

The results suggested that substitution of sucrose in *Lassi* by tagatose alone, blend of tagatose and sucrose or blend of tagatose and fructose had no negative effect of acceptability of *Lassi*. Rather there was some improvement in acceptability of *Lassi* upon use of tagatose alone or its blend with sucrose as sweetener.

Shelf-life of *Lassi*

For shelf-life evaluation only *Lassi* prepared using tagatose alone and sucrose alone as sweeteners were included, since these were two extreme cases among four types of sweeteners. Total three replications were conducted. *Lassi* was prepared using 14.4 g tagatose per 100 ml and that using 12 g sucrose per 100 ml. Samples of *Lassi* were prepared, filled in PET bottles and stored in refrigerator at 6°±1°C. The fresh (on 0 day) samples were analyzed for overall acceptability and acidity. Changes in overall acceptability and acidity of *Lassi* were monitored during storage on every day (*i*.e. at an interval of 24 h), till their overall acceptability reached in vicinity of 6.0 score.

Changes in overall acceptability score of *Lassi* during storage

The overall acceptability score of *Lassi* was determined through sensory evaluation by a panel of experience judges using 9 point hedonic score. Total three replications were conducted. Results of the study along with their statistical analysis are presented in Table 6.

Table 6: Overall acceptability score of *Lassi* during storage on storage

Sl. No.	Storage period (days)	Acceptability score (out of 9)	
		Tagatose	Sucrose
1.	0	8.71	8.71
2.	1	8.60	8.55
3.	2	8.55	8.48
4.	3	8.10	8.14
5.	4	7.79	7.90
6.	5	7.62	7.55
7.	6	7.29	7.29
8.	7	6.98	7.00
ANOVA			
	Type of sweetener	Storage period	Sweetener × Storage
SEm.	0.022	0.044	0.062
CD	—	0.200	—
$Test_{(0.05)}$	NS	*	NS
CV%	1.35		

The overall acceptability score of the fresh sample of *Lassi* prepared using tagatose alone as a sweetener was 8.71 and that prepared using sucrose alone was also 8.71. On seventh day of storage the acceptability score of *Lassi* prepared using tagatose decreased to 6.98 and that prepared using sucrose decreased to 7.00. The results revealed that on seventh day of the storage the *Lassi* prepared using the tagatose as a sweetener and that prepared using sucrose were very well acceptable in sensory evaluation.

Comparison between the two types of sweeteners suggested that the acceptability scores of both the *Lassi* were statistically at par when fresh, as well as, during each interval of the storage and at the

end of the storage statistically remained at par. The results suggested that type of sweetener used had no statistically significant effect on acceptability score both the *Lassi*.

On the other hand comparison between different intervals of storage reviled that the storage period had significant effect on overall acceptability score of both the *Lassi*. The acceptability score of both the *Lassi* started decreasing significantly from initial period. The rate of decline was faster during the initial period up to 3 days, but became relatively slower at the latter stage.

The acceptability score of the *Lassi* decreased at almost at the similar rate during storage, irrespective of the sweetener used. Thus, stability of *Lassi* during the storage was not dependent on type of sweetener. This was also evident from the interaction effect between sweetener and storage period, which was non-significant.

Changes in acidity of *Lassi* during storage

The acidity of *Lassi* was determined by titration method. Total three replications were conducted. Results from the study along with their statistical analysis are presented in Table 7.

Acidity of the fresh sample of *Lassi* prepared using tagatose alone as a sweetener was 0.73 per cent. Similarly, acidity of the fresh sample of *Lassi* prepared using the sucrose alone as a sweetener was also 0.73 per cent. On seventh day of the storage acidity of *Lassi* prepared using tagatose increased to 0.74 per cent and that prepared using sucrose increased to 0.75 per cent. Thus, acidity of *Lassi* was at normal level on seventh day of the storage.

Comparison between the two types of sweeteners, the acidity of both the *Lassi* were statistically at par when fresh, as well as, during each interval of the storage and at the end of the storage. The results suggested that type of sweetener used in preparation had no statistically significant effect on acidity both the *Lassi*.

On the other hand comparison between different intervals of storage reviled that the storage period had significant effect on acidity of the *Lassi*. The acidity of both the *Lassi* increased during the storage. However, increase in acidity of *Lassi* from tagatose was not statistically significant. Whereas, there was statistically significant increase in acidity of *Lassi* from sucrose was noticed during the storage.

Table 7: Acidity of *Lassi* during storage when prepared using different sweeteners

Sl. No.	Storage period (days)	Acidity (% lactic acid)	
		Tagatose + sucrose	Sucrose
1	0	0.73	0.73
2	1	0.73	0.74
3	2	0.73	0.74
4	3	0.73	0.74
5	4	0.73	0.74
6	5	0.74	0.74
7	6	0.74	0.74
8	7	0.74	0.75
9	8	0.74	0.75
		ANOVA	
	Type of sweetener	Storage period	Sweetener × Storage
SEm.	0.005	0.002	0.006
CD	—	0.010	—
$Test_{(0.05)}$	NS	*	NS
CV%	1.49		

In both the sweeteners the acidity of the *Lassi* increased at almost at the similar rate during storage, irrespective of the sweetener used. Thus, rise in acidity of *Lassi* during the storage was not dependent on type of sweetener. This was also evident from the interaction effect between sweetener and storage period, which was non-significant.

No report is available in the literature regarding shelf life of *Lassi* prepared using tagatose as a sweetener. Therefore, effect sucrose substitution in *Lassi* with tagatose could not be compared with the literature.

Lassi can be stored up to 7 days at 5°C without any significant change in its sensory qualities (Ranganadham *et al.* 2016). Pawar *et al.* (2010) found shelf life of 5 days on storage at 5°C. Whereas, Krishna *et al.* (2019) reported that control sample of

Lassi was acceptable up to 12 days, at refrigerated temperature (4±1°C). Therefore, shelf life of *Lassi* obtained in present study was in general agreement with that reported in the literature.

The results of the study on shelf-life of *Lassi* and their statistical analysis, as discussed above, suggested that substitution of sucrose by tagatose as a sweetener had no adverse effect on shelf-life of the *Lassi*.

Therefore, findings of the study entailed to conclude that sucrose can be successfully substituted in *Lassi* by tagatose alone or blend of tagatose with fructose as an adjunct sweeter.

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