Quality characteristics of no added sugar ready to drink milk supplemented with mango pulp

Usha Bajwa · Shikha Mittal

Revised: 25 September 2013 / Accepted: 30 September 2013 / Published online: 26 October 2013
© Association of Food Scientists & Technologists (India) 2013

Abstract Removal of sugar as a sweetener and its replacement by a high potency sweetener introduces a number of sensory and technical challenges particularly diminution in mouthfeel. Thick consistency of pulpy fruits could be exploited to compensate for the loss of viscosity and mouthfeel in sugar substituted beverages. The investigation was undertaken to study the effect of mango pulp supplementation on the quality of flavoured low calorie milk drinks using sucralose as sugar substitute. The effect of 0.0 to 100 % sugar replacement on total solids (TS), total soluble solids (TSS), specific gravity, viscosity and sensory scores was studied. Sugar replacement considerably decreased TS, TSS, viscosity and sensory scores. The mango flavoured milk drinks (MFDs) prepared by replacing sugar with sucralose and adding 10 % mango pulp in milk of 0.5 % fat and 8.5 % milk solid-not-fat. MFD were pasteurized and stored at refrigeration temperature for shelf life studies. A significant ($p < 0.01$) loss in the viscosity, ascorbic acid and reducing sugar content of pasteurized MFD was noticed during the storage period of 10 days at 5.0 ± 0.1 °C. However, the titratable acidity increased to undesirable levels in MFD after 8 days which rendered it unacceptable. Standard plate count and yeast and mold count of MFDs increased during storage. The shelf life of the pasteurized MFD was found to be 8 days at 5.0 ± 0.1 °C.

Keywords Low calorie · Milk · Sugar replacement · Sucralose · Mango · Viscosity · Sensory quality · Microbial quality

Introduction

Today's consumers expect more and more pleasure from food. They want it to be lower in fat, sugar and calories and to be able to maintain or improve their health conditions. (Arora et al. 2001). Further, the customers are willing to pay extra for foods that can give some health benefits due to an increasing consumer awareness of relationship between diet and health. The above factors collectively are responsible for creation of new market for health and functional food segments with enormous opportunities (Navaneetha et al. 2008).

The food industry has been successful in formulating products that are nutritionally modified versions and deliver altered nutrition than their standard equivalents. For instance fat may successfully be removed from many dairy products leading to a variety of reduced, low and fat free formulations. Similarly sugar is often removed from products to form diet and sugar free versions of beverages, desserts, confectionery and table top preparations. Also food industry is now frequently seeking to add nutrition to many foods and beverages to create specialty products through addition of ingredients such as soluble and insoluble fiber, vitamins, minerals, essential fatty acids and pre-and probiotics. Consumer demand for such products is also increasing.

In response to consumers concerns about the calorie content of sugar sweetened beverages, food companies are able to prepare products with zero calorie high potency sweeteners and hence providing the sweetness of sugar with a non calorie alternative ingredient. However, removal of sugar as a sweetener and its replacement by a high potency sweetener generally introduces a number of difficult sensory and technical challenges including reductions in mouthfeel and alterations in temporal delivery of sweetness (Kemp2009).

The viscosity of milk is a vital characteristic with regards to overall satisfaction. Whole milk has a creamy and heavy

U. Bajwa (✉) · S. Mittal
Department of Food Science and Technology, Punjab Agricultural University, Ludhiana 141004, Punjab, India
e-mail: ushabajwa@rediffmail.com

mouthfeel while low fat milks usually have a lighter and watery consistency (Kemp 2009). These differences in texture are caused by the milk fat (Phillips et al. 1995). Food texture becomes especially important as customers look for food products containing reduced fat and calories but are not willing to accept lower eating quality. Calorific value of the milk drinks could substantially be lowered by reducing fat and replacing sugar with low calorie sugar substitutes/high potency sweetener. Reduction of fat and replacement of sugar adversely affected the consistency/viscosity and sensory attributes especially body and mouthfeel of drinks necessitating the addition of texture modifier. Addition of inulin in sugar substituted low fat milk drinks improved viscosity and developed desirable mouthfeel which otherwise sensed watery (Mittal and Bajwa 2011).

Fruits have numerous functional and nutritional benefits. They impart colours to food products and are natural sources of fiber, minerals and vitamins. They bring value added benefits to finished products by supplementing functional properties. It is commonly known fact that fruits possess many components, such as ascorbic acid, carotenoids, α -tocopherol and a wide range of polyphenols and flavonoids with antioxidant potential (Serafini et al. 2002). Therefore, beverages based on fruits and milk products are currently receiving considerable attention and their market potential is growing. The concept of hybrid dairy products offering health, flavour and convenience are gaining wide popularity for achieving general wellness (Krupa et al. 2011). Besides being delicious, these beverages are highly nutritious. They may be particularly valuable to prevent nutritional deficiency diseases (Zulueta et al. 2007). Gutknecht (1992) developed a skim milk beverage containing 85 % skim milk and 15 % orange juice along with small amount of monocrySTALLINE cellulose as stabilizer. Ibrahim et al. (1993) manufactured guava milk beverage by adding 11 % guava pulp and 3 to 5 % sugar to buffalo skim milk. Hassan and Ahmed (1998) prepared a ready-to-serve (RTS) beverage by blending 15 % milk with 30 to 45 % mango pulp, maintaining the total soluble solids content at 18 °B by the addition of sugar. Shukla et al. (2004) prepared nutritious fruit beverages by blending juice/pulp from apples, guavas, bananas, litchis and mangoes at 10 to 40 % levels with whey and buttermilk. Charanjiv et al. (2006) used skim milk in combination with 10 to 30 % levels of carrot juice to prepare flavoured milk. A variety of fruit flavoured whey beverages have been successfully developed and marketed all over the world (Maheswarlu et al. 2010; Yadav et al. 2010; Sakhale et al. 2012). Hattem et al. (2011) reported that incorporation of strawberry and mango homogenate in milk permeate greatly increased the mineral content of sports drinks. In addition, some dietetic fibers from fruit have been recommended as ingredient to probiotic dairy foods (Espírito Santo et al. 2012). A number of other dairy based composite products with the inclusion of different types of fruit products

are being developed (Kamble et al. 2010, Sonawane et al. 2013). Likewise fruit beverages are commercially supplemented with milk to provide bioactive components such as vitamin C, carotenoids and phenolic compounds from the fruit and to improve nutritional value derived from proteins and minerals such as Ca and P from the milk (Cilla et al. 2011).

Some fruits like mango, banana, peach etc. are pulpy and have high viscosity/consistency. This property could be exploited to compensate for the loss of consistency and attaining desired mouthfeel in sugar replaced and watery beverages along with drawing the benefits of certain health promoting ingredients like vitamins, antioxidants and fiber present in them. Taking this into consideration present study was conducted to develop low calorie functional milk drinks incorporating sucralose a source of sweetener and mango pulp as a source of dietary fiber and natural colour and flavour. The literature on the use of artificial sweetener in combination with fruit pulp/natural fiber in milk drinks/beverages is scanty. The main objectives of the study therefore, were to optimize the level of mango pulp in sugar substituted low fat milk drink and to study the physico-chemical characteristics, sensory quality and shelf life of the prepared product.

Materials and methods

Milk was procured from Dairy Processing Plant of the university. It was separated in a cream separator (Elecrem, France) to obtain skim milk. The milk solids-not-fat (MSNF) was standardized to 8.5 % using skim milk powder (Verka brand, Ludhiana, India). Mango (var. *Dusehri*), sugar and sucralose (*Splenda low calorie sweetener-minis*) in the form of mini tablets (containing 76.9 % lactose, 11 % sucralose, 10 % alanine and 0.7 % sodium) were purchased from local market. For replacement of sugar with sucralose, sweetness level was maintained equivalent to that of 6 % sugar. A level of 660 mg/L *Splenda* equivalent to 72.6 ppm sucralose was found to impart sweetness that of 6 % sugar. The sucralose tablets were powdered for use in experimental samples.

Preparation of mango flavoured milk drinks (MFDs) Mango pulp of fine consistency was prepared and pasteurized at 90 °C for 2 min. It was hot-filled in glass bottles, sealed and refrigerated for further use. From the preliminary trials conducted to determine the most appropriate level of mango pulp in mango flavoured milk drinks (MFD), it was found that the incorporation of 10.0 % (w/v) mango pulp provided the best sensory characteristics. Hence, 10.0 % level was used for further studies on MFD. Fat content was standardized to 0.5 % for both control and low calorie drinks. Thereafter, 6 % sugar in control and 72.6 ppm of sucralose powder was added in low calorie drink, respectively. An optimized level of mango pulp was incorporated to both the drinks and mixed properly. The

drinks were heated to 65 °C with constant stirring, filtered through a muslin cloth, homogenized at 2000 psi, filled in sterilized glass bottles (200 ml) and sealed. The filled bottles were pasteurized (80 °C for 5 s), cooled and stored at 5.0±0.1 °C. Drink containing sucralose powder was termed a low calorie drink because sucralose, a high intensity sweetener, was used in minute quantity to sweeten the milk drink and such additions do not add to calorific value.

Physico-chemical analyses For each parameter, the samples were analysed in three replications. Milk, sucralose tablets and prepared milk drinks were analysed for moisture content, total nitrogen and ash using AOAC (2000) methods. A conversion factor of 6.38 was used for milk and milk drinks. For estimation of fat content, Gerber's method (Bureau of Indian Standards 1981) was used for milk drinks. Hand refractometer (Erma, Japan) was used to determine total soluble solids (TSS°B) of milk drink samples at 20 °C. Lane and Eynon method as given by Bureau of Indian Standards (1981) was used to determine lactose content of milk drinks. Calorific value of the drinks was calculated by taking the sum of calories provided by the individual components. The pH of all the samples was determined using pocket pH meter (Model IQ 125, IQ Scientific, USA). The titratable acidity of milk drinks was determined by titrating 10 ml of sample against 0.1 N NaOH and expressed as % lactic acid. Specific gravity of the drinks was measured at 20 °C using pycnometer (50 ml). Lane and Eynon method of Ranganna (1994) was used for determining reducing sugars and with slight modification for the determination of total sugars. Dynamic viscosity in centipoise (cP) of all the milk drinks was measured using the Hoppler Viscosimeter (design type BH2, Surrey, England) at 20 °C. The time of fall of a ball in a cylindrical tube (internal diameter=15.94 mm) inclined by 10° with respect to the vertical plane and filled with the liquid to be examined, was measured. Ball no. 1 was used to measure the dynamic viscosities of the drinks. The time taken by the ball to fall from first annular mark to the last annular mark (distance of fall=100 mm) was recorded using a stopwatch. The dynamic viscosity was calculated as per Mittal and Bajwa (2011).

Sensory evaluation All the milk drink samples were evaluated for appearance/colour, flavour, consistency and mouthfeel and overall acceptability by 8 semi-trained panelists from the department using a 9-point hedonic scale (Meilgaard et al. 1999) with scores ranging from liked extremely (9) to disliked extremely (1).

Statistical analysis The data collected from the studies was subjected to analysis of variance (Snedecor and Cochran, 1968) using CPCS1 software developed by the Department of Mathematics, Statistics and Physics of the university.

Results and discussion

Effect of mango pulp on the sensory scores of milk drink There was a significant ($p<0.01$) difference in the appearance, flavour, body and mouthfeel and overall acceptability scores of the milk drinks containing different levels of mango pulp (data not presented). Mango pulp addition improved the appearance/colour scores significantly ($p<0.01$). The increasing pulp level imparted yellow colouration, characteristic to mango, which was liked by the panelists. The flavour scores were also improved significantly ($p<0.01$) by the addition of mango pulp being highest for 10 % level of mango pulp. Thereafter, the scores declined for 30 % mango pulp because of dominance of mango flavour over the innate flavour of milk. Similar trend was observed in body and mouthfeel attribute. The scores decreased beyond 10 % level of mango pulp, due to very thick consistency of the drink that was not liked by the panelists. The overall acceptability scores were highest at 10 % mango pulp. Therefore, this level was selected for the further experimentation on mango flavoured milk drinks. This level is lower than that reported by Shukla et al. (2003) who found up to 200 g/L mango pulp could be used successfully in separated and reconstituted skim milk whereas Ibrahim et al. (1993) manufactured guava milk beverage by adding 11 % guava pulp and 3 to 5 % sugar to buffalo skim milk.

Table 1 Effect of level of mango pulp and sugar replacement on total solids and viscosity of flavoured milk drink

Mango pulp,%	Sugar replacement,%				
	0	25	50	75	100
Total solids,%					
0.0	15.3	13.8	12.4	10.9	9.4
10.0	16.6	15.1	13.6	12.1	10.6
20.0	17.8	16.3	14.8	13.4	11.9
30.0	19.0	17.6	16.1	14.6	13.1
Viscosity,cP					
0.0	2.84	2.77	2.57	2.37	2.32
10.0	80.1	79.8	79.4	78.6	78.1
20.0	136.0	135.6	134.9	134.2	133.5
30.0	193.0	192.7	192.1	191.2	190.8
ANOVA					
Source	df	MSS			
Replacement (R)	4	Total solids		Viscosity	
		66.00**		6.93	
Mango pulp (M)	3	37.76**		97880.9**	
R X M	12	-0.0001		0.404	
Error	40	0.081		6.466	

**significant at $p<0.01$, ($n=3$)

Table 2 Effect of levels of mango pulp and sugar replacement on the sensory scores of the flavoured milk drink

Mango pulp, %	Sugar replacement, %				
	0	25	50	75	100
Appearance/Colour					
0.0	7.5	7.5	7.4	7.2	7.2
10.0	8.0	8.5	8.5	8.5	8.5
20.0	8.3	8.3	8.4	8.5	8.5
30.0	8.3	8.4	8.5	8.5	8.5
Flavour					
0.0	6.8	6.7	6.5	6.4	6.4
10.0	8.2	8.1	8.1	8.0	8.0
20.0	8.2	8.1	8.0	7.8	7.7
30.0	8.1	8.0	7.8	7.7	7.5
Body and mouthfeel					
0.0	6.6	6.5	6.4	6.3	6.2
10.0	8.5	8.5	8.4	8.2	8.2
20.0	8.2	8.1	8.1	8.0	8.0
30.0	8.2	8.0	7.7	7.5	7.3
Overall Acceptability					
0.0	7.0	6.9	6.8	6.7	6.6
10.0	8.2	8.4	8.3	8.2	8.2
20.0	8.2	8.2	8.2	8.1	8.1
30.0	8.2	8.1	8.0	7.9	7.8
ANOVA					
Source	df	MSS			
Replacement (R)	4	Appearance	Flavour	Body and mouthfeel	Overall acceptability
		0.14	0.98**	1.15**	0.45
Mango pulp (M)	3	11.34**	19.64**	1.14**	19.28**
R X M	12	0.14	0.05	0.11	0.54
Error	140	0.12	0.05	0.11	0.19

**significant at $p < 0.01$, ($n = 8$)

Effect of level of mango pulp and sugar replacement on total solids, viscosity and sensory scores of MFDs The total solid (TS) content of mango pulp was 21.64 %, addition of which caused a significant ($p < 0.01$) increase in the total solids of the MFD (Table 1). It up swung from 15.35 to 19.04 with the inclusion of 10 to 30 % of mango pulp. This was due to the added solids in the form of mango pulp. Similar trend was observed for all replacement levels. However, with increase in

sugar replacement, total solids decreased significantly ($p < 0.01$) because of reduction in sugar quantity and its replacement with very small amount of sucralose, to maintain the sweetness level. Thus, minimum total solids content (9.42) was observed in the sample without mango pulp along with full sugar replacement. Viscosity of the MFD increased with augmented level of mango pulp whereas it decreased significantly ($p < 0.01$) with increased sugar replacement. The

Table 3 Effect of sugar replacement on the physico-chemical characteristics of mango flavoured milk drink (10 % mango pulp)

Characteristics	Sugar replacement, %					CD (5 %)
	0 (Control)	25	50	75	100	
TSS, °B	13.9	12.3	10.9	9.5	7.9	0.074
Specific gravity	1.060	1.057	1.051	1.046	1.040	NS
Titrateable acidity, % lactic acid	0.166	0.167	0.169	0.171	0.171	NS

NS non-significant at $p < 0.05$. ($n = 3$)

highest viscosity was observed for 30 % pulp (without replacement) and lowest for control drink without mango pulp (100 % sugar replacement).

A noticeable effect of levels of mango pulp and sugar replacement was produced on the sensory scores of the MFD. Incorporation of mango pulp improved the sensory quality of the product. Augmenting mango pulp improved the appearance/colour scores significantly ($p < 0.01$) while raising level of sugar replacement caused slight decline in scores. The decline in the appearance/colour scores caused by replacement of sugar was overcome by the addition of mango pulp (Table 2). Flavour scores improved significantly ($p < 0.01$) with the inclusion of 10 % mango pulp. Amounts greater than 10 % suppressed the characteristic milk flavour in the drink and elevated the sweetness level because of its intrinsic sugars. Body and mouthfeel scores varied significantly ($p < 0.01$) with variation in mango pulp and sugar replacement. The drink without mango and sucralose (control) scored least because of weak body and thin mouthfeel. However, 20 and 30 % pulp resulted in very thick product that was not liked by some of the panelists. The scores were highest at 10 % level of addition at all levels of sugar replacement. The overall acceptability scores showed significant ($p < 0.01$) differences and the sample devoid of mango and sugar (control) had least score of 6.57. The scores at all the replacement levels for 10 % mango pulp were high and comparable, indicating that mango pulp could be incorporated at 10 % level in low fat milk drinks with 100 % sugar replacement that too without inclusion of rheology modifier or bulking agents.

Effect of sugar replacement on some physico-chemical properties of MFDs (10 % mango pulp) It is evident from Table 3 that with increase in sugar replacement total soluble solids values were affected significantly ($p < 0.05$). It decreased from 13.86 (control) to 7.92 °B (100 % replacement). The titratable acidity (as % lactic acid) and specific gravity of the drinks did not differ significantly.

Proximate composition and nutritive value of the milk drinks The proximate composition and the nutritive value of the flavoured milk drink formulations are presented in Table 4. The total solids content was found higher in control drink than MFD. However, the lactose content was found to be higher in low calorie drinks formulations. The calorific value of the control drink was higher than MFD. A significant reduction in calorific value was achieved by replacing sucrose with high potency sweetener, sucralose.

Changes in physico-chemical characteristics of the pasteurized MFDs during storage There was a significant ($p < 0.01$) reduction in TS content with storage and drink type. The TS of control as well as low calorie MFD decreased as the storage time progressed (Table 5). The observed reduction was due to

growth of micro-organisms thriving on reducing sugars without causing apparent spoilage. Mango pulp, though pasteurized, contributed to the microflora of the drinks. Moreover, in control drink sucrose was additional source of microbes. TSS increased significantly ($p < 0.01$) in both the drinks during refrigerated storage. It may be due to the breakdown of insoluble components such as starch and pectic substances to soluble ones.

A significant ($p < 0.01$) increase was noticed in titratable acidity of MFD with storage. The rate of increment was higher in control due to higher TS and microbial count. Mango pulp addition contributed to enhanced titratable acidity and reducing sugars. The increase in rate of acid production was more in control as compared to low calorie drink. After 10 days of storage, the titratable acidity of control and low calorie drink was 0.22 and 0.20 %, respectively, indicating spoilage of both the drinks. Fermentation of sugars to acids especially lactose to lactic acid resulted in destabilization or curdling of proteins and thus the consistency of the drinks increased. Both drinks became unacceptable after 8 days. There was a significant decline ($p < 0.01$) in pH with storage. The corresponding increase in titratable acidity caused reduction in pH values of both the drinks. This reduction was greater in control than low calorie drink due to higher acidity. Al-Haq and Mohyuddin (1992) reported a shelf-life of 49 days under refrigeration of HTST pasteurized beverages containing 3 % each of SMP and mango pulp.

Reducing sugars declined significantly ($p < 0.01$) in both the drinks during 10 day storage (Table 5). This decrease is attributed to their breakdown due to growth and multiplication of psychrophilic bacteria during low temperature storage. Ascorbic acid content of control and low calorie drink was reduced significantly ($p < 0.01$) as storage progressed to 10 days. According to DeMan (1990), ascorbic acid or vitamin C is the least stable of all vitamins and is easily destroyed

Table 4 Proximate composition and nutritional information of the MFDs

Components	Milk	Mango flavour	
		Control	Low calorie
Moisture, %	91.0	83.42	89.35
Total solids, %	9.0	16.58	10.65
Fat, %	0.50	0.50	0.50
Protein, %	3.26	2.97	3.00
Ash, %	0.70	0.69	0.68
Carbohydrates	4.54		
Sucrose, %	–	6.00	Nil
Lactose, %	4.3	4.00	4.02
Sucralose, ppm	–	Nil	72.60
Calorific value, kcal/100 ml		63.6	39.8

($n = 3$), Control – 6 % sugar; Low calorie – 72.6 ppm sucralose

Table 5 Changes in physico-chemical characteristics of mango flavoured pasteurized milk drinks during storage

Type of drink	Storage, days								
	0	2	4	6	8	10			
Total solids,%									
Control	16.3	16.2	16.1	16.1	15.9	15.8			
Low Calorie	10.3	10.2	10.2	10.1	10.0	10.0			
Total soluble solids (TSS),°B									
Control	14.8	14.8	15.0	15.1	15.2	15.3			
Low Calorie	8.9	9.0	9.0	9.2	9.3	9.4			
Titratable acidity,% Lactic Acid									
Control	0.14	0.16	0.16	0.17	0.19	0.22			
Low Calorie	0.14	0.15	0.15	0.16	0.18	0.20			
pH									
Control	6.5	6.5	6.4	6.3	6.1	5.9			
Low Calorie	6.5	6.5	6.5	6.4	6.3	6.1			
Reducing sugars,%									
Control	4.4	4.3	4.3	4.2	4.1	3.9			
Low Calorie	4.4	4.4	4.4	4.3	4.2	4.0			
Ascorbic acid,mg/100 g									
Control	1.30	1.19	1.14	0.99	0.79	0.56			
Low Calorie	1.26	1.18	1.12	0.97	0.78	0.55			
Viscosity,cP									
Control	80.1	79.8	79.0	78.6	77.9	77.1			
Low Calorie	78.1	77.7	77.4	77.1	76.9	76.4			
ANOVA									
Source	Df	MSS	Total Solids	TSS	Titratable acidity	pH	Reducing Sugars	Ascorbic acid	Viscosity
Storage(S)	5	0.126**	0.472**	0.003**	0.235**	0.170**	0.447**	4.42**	16.44**
Drink (D)	1	318.27**	303.75**	0.0008**	0.092**	0.042**	0.003	0.595**	0.042
S X D	5	0.005	0.126*	0.00005	0.012**	0.0007	0.0001		
Error	24	0.007	0.036	0.00005	0.003	0.0047	0.002		

* significant at $p < 0.05$, ** significant at $p < 0.01$, ($n = 3$), Control – 6 % sugar, Low calorie – 72.6 ppm sucralose

Table 6 Changes in sensory scores of mango flavoured pasteurized milk drinks during storage

Type of drink	Storage, days					
	0	2	4	6	8	10
Appearance/colour						
Control	8.5	8.5	8.0	7.8	7.46	7.32
Low calorie	8.4	8.3	7.9	7.5	7.31	7.13
Flavour						
Control	8.5	8.2	7.9	7.7	7.19	6.24
Low calorie	8.5	8.1	7.8	7.6	7.20	6.04
Body and mouthfeel						
Control	8.5	8.5	8.0	7.8	7.46	7.19
Low calorie	8.4	8.3	7.9	7.5	7.31	7.16
Overall acceptability						
Control	8.5	8.4	8.0	7.8	7.37	6.85
Low calorie	8.4	8.2	7.9	7.5	7.28	6.84
ANOVA						
Source	Df	MSS				
		Appearance	Flavour	Body and mouthfeel	Overall acceptability	
Storage (S)	5	3.96**	11.25**	4.32**	5.81**	
Drink (D)	1	0.82**	0.03	0.59**	0.37**	
S X D	5	0.018	0.067	0.044	0.028	
Error	84	0.038	0.030	0.034	0.021	

** Significant at $p < 0.01$, ($n=3$), Control – 6 % sugar; Low calorie – 72.6 ppm sucralose

during processing and storage. Exposure to oxygen and light are harmful to ascorbic acid content of foods. In bottles, all the residual oxygen is available for ascorbic acid oxidation and the effect of light results in rapid destruction of ascorbic acid in milk.

The viscosity of pasteurized mango-milk drinks significantly declined ($p < 0.01$) during storage. The reduction was greater in control than low calorie drink. This might be due to the action of spoilage micro-organisms on sugar and pectin, producing hydrolysis products. The reduction in viscosity of cardamom flavoured milk drinks during storage was earlier observed by Mittal and Bajwa (2011).

Changes in sensory scores of the pasteurized MFDs during storage Appearance scores significantly ($p < 0.01$) reduced for both control and low calorie drink as storage increased to 10 days (Table 6). This decrease might be due to the separation of mango pulp from milk on the surface. A significant ($p < 0.01$) reduction in flavour scores of both the drinks was also recorded during storage. However, the drinks were rejected after 8 days because of increase in titratable acidity in the drink. A significant decrease in sensory scores of carrot juice incorporated milk was observed by Charanjiv et al. (2006) during storage of 4 days at 4 ± 1 °C. Body and mouthfeel scores were considerably reduced for both drinks during storage. This was due to slight reduction in consistency or thinning observed by

some panelists. The overall acceptability scores were significantly ($p < 0.01$) influenced by storage. The scores were least when the product showed signs of spoilage i.e. increased acidity. The decline in scores of all the sensory characteristics led to the reduction in overall acceptability of the drinks. It indicated that the drinks could be stored well up to 8 days at refrigeration temperature. Simon and Hansen (2001) stated that pasteurized milk (72 to 74 °C/16 s) possesses a shelf life between 15 and 10 days at a storage temperature between 4 to 8 °C.

Table 7 Effect of storage period on the microbial counts of mango flavoured pasteurized milk drinks

Type of drink	Storage, days					
	0	2	4	6	8	10
Standard plate count, log ₁₀ cfu/ml						
Control	3.92	3.95	3.98	4.09	4.31	4.58
Low calorie	3.83	3.84	3.89	3.93	3.96	4.33
Yeast and mould count, log ₁₀ cfu/ml						
Control	ND	1.30	1.70	1.79	1.86	1.93
Low calorie	ND	ND	ND	1.48	1.68	1.78

ND: Not detected, ($n=3$), Control – 6 % sugar; Low calorie – 72.6 ppm sucralose

Changes in microbial counts of the pasteurized milk drinks during storage Higher Standard Plate Count (SPC) was recorded in control drink, due to presence of sucrose, than in low calorie drink on zero day. The growth was more evident in control due to high initial count. However, SPC was within safe limits up to 8 days of storage. SPC of pasteurized milk in its final container should not exceed 30,000 cfu/ml (Bureau of Indian Standards 1981). Thereafter, increase in SPC caused spoilage of drinks making them unacceptable. This was due to the growth of psychrotropic bacteria converting sugars into acids. The yeast and mold count was detected on the second day of storage in control and on sixth day in low calorie drink. The counts increased during storage. This was due to the psychrotrophic spores which germinated during storage (Table 7). According to Cromie (1991) stability of pasteurized milk is influenced by various factors that include the quality of raw material, pasteurization time, resistant microorganism to pasteurization temperatures particularly psychrotrophics, post pasteurization contaminants and storage temperature. A shelf life of 43, 36, 8, 5, and 3 days for pasteurized milk packaged in HDPE bottles and stored at 2, 4, 9, 14 and 16 °C, respectively and for those packaged in LDPE pouch it was estimated to be 37, 35, 7, 3, and 2 days, respectively (Petrus et al. 2010).

Conclusion

Low calorie mango flavoured drink (MFD) was prepared by incorporating 10 % mango pulp and 72.6 ppm sucralose in milk containing 0.5 % milk fat and 8.5 % SNF. Replacement of sugar lowered consistency and mouthfeel of control drink which was supplemented by the mango pulp. The addition of thickener or any other texture modifier was not required to attain a desired consistency/viscosity and mouthfeel. The shelf life of the pasteurized MFD was found to be 8 days at 5.0±0.1 °C. A remarkable reduction in calorific value from 63.58 kcal/100 ml to 39.78 kcal/100 ml was accomplished with the replacement of sugar by sucralose.

References

- Al-Haq MI, Mohyuddin G (1992) Commercial manufacturing of pasteurized mango fruit flavoured milk-based beverages. *Pak J Scientific Industrial Res* 35:420–424
- AOAC (2000) Official methods of analyses. Association of Official Analytical Chemists, Washington
- Arora S, Nayak SK, Sindhu JS, Seth R (2001) Artificial sweeteners in formulation of dairy products. *Indian Food Ind* 20:62–66
- Bureau of Indian Standards 1981. ISI Handbook of food analysis. IS: SP: 18 Part XI Dairy products. Manak Bhawan, New Delhi
- Charanjiv S, Grewal KS, Sharma HK (2006) Effect of incorporation of carrot juice in the preparation of flavoured milk. *J Food Sci Technol* 43:80–82
- Cilla A, Lagarda MJ, Alegria A, de Ancos B, Cano MP, Sánchez-Moreno C et al (2011) Effect of processing and food matrix on calcium and phosphorous bioavailability from milk-based fruit beverages in Caco-2 cells. *Food Res Int* 44:3030–3038
- Cromie SJ (1991) Microbiological aspects of extended shelf life products. *Aust J dairy Technol* 46:101–104
- DeMan JM (ed) 1990. Principles of food chemistry. AVI Publishers, Van Nostrand Reinhold, New York pp 231–232, 338–339, 350–352, 358–359
- Espírito Santo AP, Perego P, Converti A, Oliveira MN (2012) Influence of milk type and addition of passion fruit peel powder on fermentation kinetics, texture profile and bacterial viability in probiotic yoghurts. *LWT Food Sci Technol* 47:393–399
- Gutknecht KW (1992) Healthier soft drinks. *Utah Sci* 52:163
- Hassan M, Ahmed J (1998) Sensory and microbiological characteristics of mango-milk beverage. *Egyp J Dairy Sci* 26:289–293
- Hattem HE, Elham H, Abouel-Einin, Mehanna NM (2011) Utilization of milk permeate in the manufacture of sports drinks. *J Brew Distill* 2: 23–27
- Ibrahim MKE, El-Abd MM, Mehriz AM, Ramadan FAM (1993) Preparation and properties of guava milk beverage. *Egyp J Dairy Sci* 21: 59–68
- Kamble K, Kahate PA, Chavan SD, Thakare VM (2010) Effect of Pineapple pulp on sensory and chemical properties of *Burfi*. *Vet World* 3:329–331
- Kemp SE (2009) Developments in sweeteners for functional and speciality beverages. In: Paquin P (ed) Functional and speciality beverage technology. Woodhouse Publishing Ltd, New Delhi, pp 39–41
- Krupa H, Jana A, Patel HG (2011) Synergy of dairy with non-dairy Ingredients or product: A review. *African J Food Sci* 5: 817–832
- Maheswarlu M, Anitha L, Sucharitha KV, Leelavathi M (2010) Qualitative changes in whey based pomegranate (*Punica granatum*) beverage during storage period. *Asian J Res Chem* 3:669
- Meilgaard M, Civille GV, Carr BT (eds) (1999) Sensory evaluation techniques. CRC Press, Boca Raton, pp 385–387
- Mittal S, Bajwa U (2011) Effect of fat and sugar substitution on the quality characteristics of low calorie milk drinks. *J Food Sci Technol*. doi:10.1007/s13197-010-0216-9
- Navaneetha R, Roopa KS, Natarajan AM (2008) Quality of *khoa-burfi* prepared using different low calorie artificial sweeteners. *Indian Food Ind* 27:41–52
- Petrus RR, Loiola CG, Oliveira CAF (2010) Microbiological shelf life of pasteurized milk in bottle and pouch. *J Food Sci* 75:M36–M40. doi: 1111/j.1750-3841.2009.01443.x
- Phillips LG, McGiff ML, Barbano DM, Lawless HT (1995) The influence of fat on the sensory properties, viscosity and colour of low fat milks. *J Dairy Sci* 78:1258–1266
- Ranganna S (ed) (1994) Handbook of analysis and quality control for fruits and vegetables products. Tata McGraw Hill Publishing Company Limited, New Delhi, pp 9–12, 99–101, 281–307
- Sakhale BK, Pawar VN, Ranveer RC (2012) Studies on the development and storage of whey based RTS beverage from Mango cv. *Kesar*. *J Food Process Technol* 3:148–151
- Serafini M, Bellocchio R, Wolk A, Ekström AM (2002) Total antioxidant potential of fruit and vegetables and risk of gastric cancer. *Gastroenterology* 123:985–991

- Shukla FC, Sharma A, Singh B (2003) Studies on the development of beverages using fruit juices/pulp, separated milk and reconstituted skim milk. *Int J Dairy Technol* 56:243–246
- Shukla FC, Sharma A, Singh B (2004) Studies on the preparation of fruit beverages using whey and buttermilk. *J Food Sci Technol* 41:102–105
- Simon M, Hansen AP (2001) Effect of various dairy packaging materials on the shelf life and flavour of ultrapasteurized milk. *J Dairy Sci* 84: 767–773
- Snedecor GW, Cochran WG (1968) *Statistical Methods*. Oxford and IBH Publishing Company, New Delhi, 339
- Sonawane SK, Arya SS, Gaikwad S (2013) Use of Jambhul powder in the development of bioactive components enriched milk kulfi. *J Microbio Biotech Food Sci* 2:2440–2443
- Yadav RB, Yadav BS, Kalia N (2010) Development and storage studies on whey based banana herbal (*Mentha arvensis*) beverage. *Am J Food Technol* 5:121–129
- Zulueta A, María J, Esteve IF, Frígola A (2007) Vitamin C, vitamin A, phenolic compounds and total antioxidant capacity of new fruit juice and skim milk mixture beverages marketed in Spain. *Food Chem* 103:1365–1374