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Shelf life study of developed reduced fat Synbiotic cream cheese

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Abstract
Cream cheese is a soft, rich, creamy white, unripened cheese with slightly acidic and diacetyl flavour. The focus of the present study was to study the shelf life of the developed Reduced fat cream cheese (RFCC) prepared by addition of 1% probiotic (Lactobacillus helveticus) culture along with 4% inulin in comparison with the control cream cheese sample both packed in 150 ml of polypropylene cups, sealed with aluminium foil and kept at 7-8° C in refrigerator. The developed synbiotic reduced cream cheese was found to have a higher shelf life (24 days) than the control (20days). Sensory profile, physico-chemical properties and microbial count also varied significantly as the storage progressed. Free fatty acid (FFA) content of both the samples increased throughout the storage period. The viability of probiotic culture was better in RFCC with inulin than in control.

Keywords: Cream cheese, synbiotic, probiotic, reduced fat, free fatty acid, inulin

Introduction
Cheese is a product obtained by coagulation of milk from certain mammals using rennet or similar enzymes in the presence of the lactic acid produced by added or adventitious microorganism, from which part of the moisture has been removed by cutting, warming, and/or pressing, which has been shaped in mould and then by holding for some time at suitable temperature and humidity [1, 2]. Health benefits cheese is well known fact [3, 4].Cream Cheese (Rahmfrischkase) means soft unripened cheese obtained by coagulation of pasteurised milk of cow and / or buffalo or mixtures thereof and pasteurised cream with cultures of harmless lactic acid producing bacteria with or without the addition of suitable coagulating enzymes. It is mostly popular in North America and is mostly used as a substitute for butter, or as a spread and also in making several dishes like cheesecake [5].
Depending upon the fat content, Cream cheese is often categorized into two: double-cream cheese with at least 32-33% fat content and single-cream cheese with at least 16-18% fat content in the final product[6]. Fat, apart from its nutritional significance in cream cheese, plays a major role in the sensory and functional properties of cream cheese[7]. Even though fat rich products were preferred by the consumers, recently there has been a paradigm shift in the preference of consumers to reduced fat products citing health and lifestyle issues [8]. Recent studies have linked the association of fat consumption with the development of increased risk of various diseases like coronary heart disease, elevated blood pressure, obesity, atherosclerosis and tissue injury diseases associated with lipid oxidation. Subsequently, there is a surge in the demand of low calorific, reduced fat products especially among the customers so that they have an option of healthy binge eating on their favourite food products [9].
This sudden shift in consumer demand has left manufactures in great dilemma to manufacture low fat cream cheese with similar organoleptic and functional properties as full fat cream cheese as mostly reduction in fat content resulted in rheological, textural, functional and sensory defects [10, 11, 12, 13]. Specifically, as the fat content of cheese is lowered, moisture content increases and protein plays a greater role in texture development [14]. Fat replacers are found to be a suitable solution for this challenge, which replaces fat without significantly affecting its textural and functional properties and also lowers calorific value [15, 16].
Inulin is a naturally available carbohydrate-based dietary fiber, extracted from chicory root. Inulin is increasingly used in industrially processed dairy and non-dairy products because of its properties as a bulking agent for use in fat replacement, textural modification and organoleptic improvement. Addition of inulin to different kinds of cheese can be beneficial in the manufacture of a reduced or low-fat, texturized, symbiotic products [17].
Synbiotics are defined as "combinations of probiotics and prebiotics that beneficially affect the host by improving the survival and implantation of live microbial dietary supplements in the

gastrointestinal tract." *Lactobacillus helveticus*, one of the probiotic bacteria, is gaining importance as health-promoting culture in probiotic and neutraceutical food products due to its potential to produce bioactive peptides or bacteriocins, and exert synbiotic effect when associated with prebiotics in fermented dairy products. *Lactobacillus helveticus* can therefore be considered as a multifunctional LAB with increasing importance in the food industry [18].

In the present study, we successfully prepared a reduced fat synbiotic cream cheese and the physico-chemical, sensorial and microbial behavior of the developed product such as acidity, viscosity, bacterial count, flavor, FFA etc. was examined during storage.

Materials and Methods

Materials

Skim milk and Cream (40% fat) were procured from experimental dairy plant SRS of ICAR-NDRI, Bengaluru. Freeze dried lactic mesophilic DVS starter culture (*Lactococcus lactis, Lactococcus cremoris, Lactococcus diacetylactis*) from M/s. DSM was used. Probiotic culture (*Lactobacillus helveticus* (NCDC 288)) was obtained from NCDC – NDRI, Karnal. Inulin was procured from M/s DKSH India Pvt. Ltd. Bengaluru. Analytical grade (AR) chemicals obtained from various reputed companies were used for chemical analysis. Glassware of Borosil brand was used for the analysis of cream cheese.

Preparation of Cream cheese

Cream cheese was prepared by [19] fermentation of cream and skim milk separately with 0.03% lactic mesophilic DVS culture (0.03%) and 1% probiotic (Lactobacillus helveticus) at 35^{0}C for 10-12 hours followed by straining with muslin cloth and hanging them for 12-13hours at 7-8^{0}C. Curd mass and fermented cream was then mixed at 6:1 ratio. Heated and cooled 4% inulin was incorporated. Common salt of 0.5% was added and the mixture was mixed thoroughly.

Control cream cheese was obtained by mixing the curd mass and fermented cream at a ratio of 3:1 without the addition of inulin. Samples were packed in 150 g polypropylene cups and sealed with aluminium foil and stored at refrigeration temperature (5-8°C) for the storage study.

Analyses

Sensory Evaluation

Cheese samples were evaluated for sensory attributes *viz*. flavour and taste, body and texture, colour and appearance and overall acceptability by sensory panellists (minimum of 6 members) on a 9- point hedonic scale(9 = like extremely; 1 = dislike extremely) [20]. Duo-trio tests were used to determine a candidate's ability to detect differences among similar products with different ingredients.The judged parameters were flavour; consistency; colour and appearance and overall acceptability. Water was provided for mouth washing between evaluations of samples.

Acidity

Acidity in cream cheese was determined as described in AOAC 920.124 (2005).

pH

The pH of cream cheese was measured as described in this study [21].

Free fatty acid (FFA)

FFA is defined as the milli-equivalent of alkali (KOH) required neutralizing the free fatty acids in 100 g of fat and was determined by using BDI Agent as described in certain studies [22].

Microbial Analysis

Total plate count were enumerated on Milk agar and incubated at 37 ºC for 24 h. Yeast and mold were enumerated on Potato Dextrose Agar and incubated at 30º C for 3-5 days. Viability count of probiotic culture were enumerated on MRS agar and incubated anaerobically at 37^{0}C for 48-72 hours. Rod shaped colonies were counted and expressed in log cfu/g.

Results and Discussion

Changes in sensory properties

Changes in Flavor

The flavour score drastically reduced during storage period (Table 1).The fresh flavour of cream cheese was changed to acidic and sour flavour after 20 days of storage. The control had higher fat and therefore fat lipolysis might have taken place whereas RFCC had low fat content and thus exhibited better flavour. The experimental sample contains 4% inulin which might have masked the acidic taste due to sweetness of inulin.

Changes in body and texture

As the storage progressed the body and texture score decreased in both the samples. Similar results were observed in Karish cheese where 4% inulin was added as a fat replacer and resulted in higher texture and acceptability score [23]. However, during storage no significant change (p> 0.05) was observed in body and texture between the cheese samples

Table 1: Changes in sensory parameters during storage

Days / Flavour	0	4	8	12	16	20	24
Control	7.59±0.24^a	7.72±0.14^a	7.46±0.04^a	7.41±0.11^a	6.81±0.11^a	6.0±0.38^a	5.81±0.08^a
RFCC-inulin	7.8±0.28^a	7.85±0.21^a	7.76±0.09a	7.65±0.17^a	7.05±0.22a	6.81±0.11b	6.06±0.23b
Body and Texture							
Control	7.76±0.32^a	7.72±0.14^a	7.35±0.02^a	7.43±0.08^a	6.97±0.20^a	6.81±0.44^a	5.91±0.11^a
RFCC-inulin	7.96±0.04^a	7.85±0.02^a	7.53±0.37^a	7.6±0.14^a	7.41±0.11^a	6.79±0.05^a	6.19±0.38b
Colour and Appearance							
Control	7.91±0.11^a	7.85±0.02^a	7.86±0.05^a	7.89±0.08^a	7.57±0.34^a	7.25±0.27^a	6.65±0.27^a
RFCC-inulin	7.93±0.08^a	7.93±0.08^a	7.73±0.04^a	7.74±0.12^a	7.60±0.38^a	7.18±0.26^a	6.94±0.32^a
Overall acceptability							
Control	7.37±0.14^a	7.70±0.05^a	7.55±0.07^a	7.70±0.05^a	7.10±0.38^a	6.97±0.20^a	6.16±0.23^a
RFCC-inulin	7.75±0.01a	7.76±0.08^a	7.51±0.15^a	7.53±0.13^a	7.33±0.23^a	7.30±0.20^a	6.85±0.02^b

Changes in colour and appearance

During storage no significant (p> 0.05) change was observed in colour and appearance between the cheese samples irrespective of treatments (Table 1). Discolouration happened with the increase of storage period due to microbial growth in the cheese [24]. Mould growth was observed on the surface of inulin incorporated cheese on 24th day of storage.

Changes in overall acceptability

The control cream cheese was not acceptable after 20th day whereas RFCC was not acceptable after 24th days of storage (Table 1) due to mould growth on the surface, increased sourness and rancid flavour in control cream cheese,Shelf life of developed product was observed to be 4 days more than that of control sample.

Changes in physico-chemical properties

Changes in acidity

Table 2 depicts the changes occurred in acidity during storage of cream cheese stored at refrigeration temperature.The increase in the acidity during storage could be due to the microbial spoilage. Higher acidity in the experimental samples may be due presence of inulin which might have stimulated the growth of probiotic bacteria resulting in higher lactic acid production in the cheese.

Changes in pH

The pH of cream cheese decreased with the increased storage time due to activity of microorganism.he rate of decrease in pH of the RFCC was observed to be higher due to presence of inulin as fat replacer which has stimulated the growth of probiotic organisms. Previous studies [25] have showed similar trend.

Table 2: changes in physico-chemical properties during storage

Samples	Physico-chemical properties	Days						
		0	4	8	12	16	20	24
Control	Acidity	0.536	0.63	0.64	0.66	0.7	0.7	0.69
	pH	4.71	4.60	4.585	4.575	4.535	4.505	4.51
	FFA	0.93	1.12	1.15	1.32	1.35	1.73	1.74
	Moisture (%)	72.84	72.93	73.14	72.68	73.58	73.90	73.61
Experimental	Acidity (% LA)	0.66	0.73	0.73	0.73	0.75	0.77	0.77
	pH	4.69	4.57	4.565	4.5	4.5	4.45	4.43
	FFA	0.74	0.76	0.78	1.15	1.11	1.32	1.27
	Moisture (%)	74.15	74.83	74.80	74.24	74.18	74.51	74.11

Changes in Free fatty acid (FFA)

Free fatty acid content of both the samples increased throughout the storage period, as shown in Fig. 1. Initial FFA content of 0.93meq KOH/100g fat in control cream cheese and increased significantly (p< 0.05) to 1.74 at 24th day of storage. FFA content of experimental cheese was 0.74 at 0th day and increased to 1.21 at 24th day of storage.The FFA content of RFCC sample was lower than control due to less fat content leading to less lipolysis during storage. Addition of *Lactobacillus helveticus* as probiotic in both the cheese showed higher lipolytic activity during storage. Similar observation was reported by number of workers [26, 27].

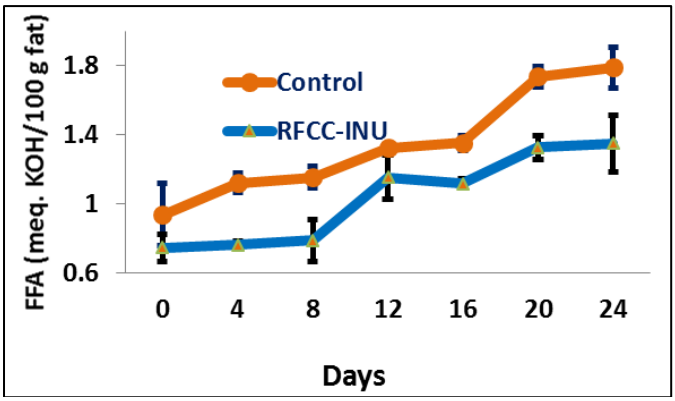

Fig 1: Changes in FFA of cream cheese during storage

Microbiological changes

Changes in total plate count

The initial count in inulin incorporated cheese was more due to presence of growth promoter (inulin) which stimulates the growth of bacteria. TPC increased as storage progressed up to 12th day of storage, thereafter it started decreasing till the end of 24th day of storage (Table 3). Reduction of microbial counts was related to intensive production of lactic acid during refrigerated storage temperature (7-8◦C).

Changes in yeast and mould count

Yeast and mould counts of inulin incorporated cheese increased at much higher rate than compared to control which might be due to carbohydrate (inulin) and less fat content in reduced fat cream cheese. Yeast and mould counts found to be increased during storage. The main spoilage of both cream cheese samples was due to yeast and mould growth, rancid flavour, wheying off and dull appearance of the product.

Table 3: Changes in microbial counts during storage

No of storage days	Control		Experimental (log cfu/g)	
	TPC	Yeast and moulds	TPC	Yeast and moulds
0	9.01	1.47	9.19	1.30
4	9.14	1.47	9.16	1.40
8	9.18	1.94	9.25	1.60
12	9.04	1.92	9.26	1.92
16	8.84	2.11	8.87	2.05
20	8.93	2.21	8.80	2.01
24	8.70	2.25	8.747	2.12

Viability of probiotic culture during storage

Fig. 2 shows the viability of probiotic culture in cheeses during storage. The initial count for both the cheese was almost similar 7.86 log cfu/g for control and 7.88 log cfu/g in experimental sample. The maximum counts in control cream cheese were observed at 6th day of storage whereas maximum count (8.58 log cfu/g) in inulin incorporated cheese was observed at 18th day of storage. Thereafter the growth of *L. helveticus* decreased gradually in both the cheeses. In order to exert the beneficial effects of probiotic foods, a minimum probiotic therapeutic daily dose of 8-9 log cfu/g has been

proposed, which corresponds to the daily intake of 100 g of a food product containing 6-7 log cfu/g [28, 29, 30]. In the present study, the counts of *Lactobacillus helveticus* obtained for both the cheeses were always above the recommended levels of 6-7 log cfu/g, thus satisfying the criteria established for a probiotic food.

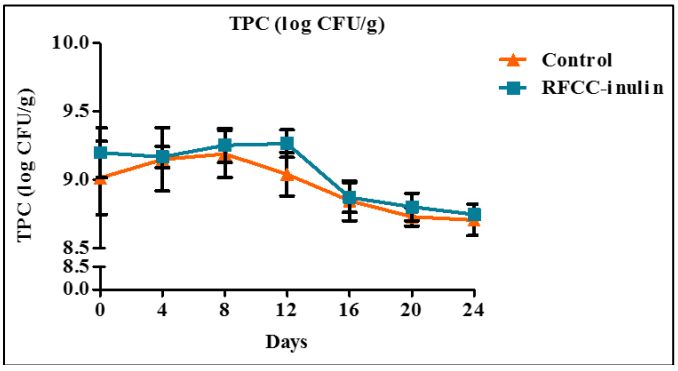

Fig. 2 Changes in TPC of cream cheese during storage

Conclusion

The present study was successful in developing reduced fat synbiotic cream cheese with higher shelf than control cream cheese samples.The pH decreased continuously whereas acidity and FFA increased as storage progressed. Between the two products spoilage was faster in control because of rancid flavour, wheying off and visible mould growth on the surface. TPC increased initially and maximum counts were observed after 12th day of storage in developed cheese. Yeast and mould counts increased in both the samples during storage. Initial viability of probiotic was similar in both control (7.86 log cfu/g) and developed (7.88 log cfu/g) cheese. Viability reached maximum up to 8.58 log cfu/g in developed cheese while it was 8.36 log cfu/g in control cheese on 18th day of storage. Thereafter the growth of *L. helveticus* decreased gradually in both the samples.

This study showed that reduction of fat in cream cheese with addition of suitable fat replacers (inulin) provides health benefits like addition of soluble dietary fibre, stimulation of microorganisms in gastrointestinal tract and possible reduction of risk of coronary heart disease, stroke, hypertension, diabetes, obesity and certain gastrointestinal diseases without any adverse effect on the sensory, textural and physicochemical properties. Addition of *Lactobacillus helveticus* as probiotic also exhibits health benefits such as antihypertensive property. The developed synbiotic reduced fat cream cheese also may be a good substitute for butter.

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Conflict of interest

The authors do not have any conflict of interests with the contents in the paper.

Ethics Statement

This research did not include any human subjects and animal experiments.

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