Effect of culture levels, ultrafiltered retentate addition, total solid levels and heat treatments on quality improvement of buffalo milk plain set yoghurt

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Abstract Studied the effect of culture (2, 2.5 and 3%), ultrafiltered (UF) retentate addition (0, 11, 18%), total milk solids (13, 13.50, 14%) and heat treatments (80 and 85 °C/30 min) on the change in pH and titratable acidity (TA), sensory scores and rheological parameters of yoghurt. With 3% culture levels, the required TA (0.90% LA) was achieved in minimum 6 h incubation. With an increase in UF retentate addition, there was observed a highly significant decrease in overall acceptability, body and texture and colour and appearance scores, but there was highly significant increase in rheological parameters of yoghurt samples. Yoghurt made from even 13.75% total solids containing nil UF retentate was observed to be sufficiently firm by the sensory panel. Most of the sensory attributes of yoghurt made with 13.50% total solids were significantly better than yoghurt prepared with either 13 or 14% total solids. Standardised milk heated to 85 °C/30 min resulted in significantly better overall acceptability in yoghurt. Overall acceptability of optimised yoghurt was significantly better than a branded market sample. UF retentate addition adversely affected yoghurt quality, whereas optimization of culture levels, totals milk solids and others

process parameters noticeably improved the quality of plain set yoghurt with a shelf life of 15 days at 4 °C.

Keywords Yoghurt · Total milk solids · Ultrafiltered retentate · Heat treatment · Sensory attributes · Rheological parameters

Introduction

Yoghurt has been defined as the coagulated product obtained from the mixture of pasteurised milks (skim, concentrated, boiled) and cream by lactic acid fermentation through the action of *Lactobacillus bulgaricus* and *Streptococcus thermophiles* provided that its titratable acidity (TA) as lactic acid (LA) shall not be less than 0.85% and not more than 1.2%. The health benefits of yoghurt as the fermented product are well documented. Prajapati and Sreeja (2013) reported that yoghurt is generally made from cow milk with adjusted total solids (TS) in the range of 14–16% by inoculating with the mixture of *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus* and incubating at 42 °C to achieve the desired acidity. It contains typical acetaldehyde flavor.

Because of higher fat, lactose, protein (particularly caseins) and minerals (calcium, magnesium and inorganic phosphate), buffalo milk yoghurt possesses superior body and texture than cow milk yoghurt (Ahmad et al. 2008). The rate of acid production, extent of proteolysis and flavour (acetaldehyde) development by lactic cultures in buffalo milk yoghurt was also higher (Khanna and Singh 1979). Different yoghurt variants based on texture (liquid, set and stirred curd), flavour (natural or plain, fruit, cereal, chocolate) and fat contents (normal, reduced and fat-free) are available in the market. However, yoghurt possesses its

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own set of problems related to colour and appearance (lumpiness, free whey, a typical colour, colour leaching, lack or excess of fruits in case of fruit yoghurt); flavour (high acetaldehyde, bitter, cooked, low and high acid, foreign, metallic, oxidized, unclean and rancid); body and texture (free whey, gel like or too firm, weak, shrunk, grainy and ropy body) as indicated by several researchers. Consumers are now becoming even more discerning and demands products with improved sensory attributes, enriched with nutrients and manufactured from natural components with simple and clear labels. This leads to development of different types of *dahi* (Indian yoghurt) and yoghurts such as dietary fiber (soy, oat and inulin) enriched yoghurt (Raju and Pal 2014); low-fat set-type yoghurt (Pakseresht et al. 2017); flaxseed oil and flour incorporated fruit yoghurt (Kumar et al. 2017); low phenylalanine yoghurt (Goldar et al. 2016); Bambara groundnut (*Vigna subterranea*) and soybeans (*Glycine max*) based yoghurt (Falade et al. 2015); yoghurt containing candied chestnut (Sakin-Yilmazer et al. 2014); omega-3 fatty acids fortified Indian yoghurt (Goyal et al. 2016); β -glucan fortified *dahi* (Bhaskar et al. 2017) etc.

Sensory attributes and rheological properties of fermented milk products are mainly governed by their total solids content. Meena et al. (2015) successfully improved the quality of buffalo milk plain *dahi* employing ultrafiltration (UF). This also resulted in quality improvement and increased nutritive value of yoghurt due to concentration of protein, calcium and phosphorus in retentate. Higher casein contents in UF retentate have been related to the reinforcement of the protein matrix density that leads to improved water holding capacity of the yoghurt gel (Sodini et al. 2004). Thus, it is believed that higher protein content results in better overall quality of the curd. Heat treatment of milk is vital for elimination of growth inhibitors and denaturation of serum proteins as it affects texture, microstructure, and rheology of yoghurt. Homogenization of standardised milk is an inevitable step in the yoghurt manufacturer to improve its consistency and whiteness; reduce whey syneresis and prevent fat separation during fermentation and storage. Therefore, to reduce or eliminate the common defects encountered in conventional yoghurt, optimisation of culture levels, milk solid levels maintained by the addition of different ingredients, time–temperature combination of applied heat treatments and UF retentate addition becomes mandatory.

Considering all these points the quality of buffalo milk plain yoghurt was improved through the optimization of heat treatment, milk solids and culture levels; and the changes in its sensory attributes and rheological parameters during refrigerated storage at 4 °C were studied.

Materials and methods

Materials

Milk and skimmed milk powder (SMP)

The fresh buffalo milk of Murrah breed was procured from Livestock Research Center of National Dairy Research Institute, Karnal; separated at 45 ± 2 °C in a cream separator (Make: Chadha Electro Industries, Delhi; Capacity of 110 L/h) to obtain fresh skim milk (< 0.5% fat) and cream of 65–70% fat.

Fresh buffalo skim milk had 9.98 ± 0.08 , 0.26 ± 0.03 , 3.80 ± 0.02 , 0.79 ± 0.01 ; 6.60 ± 0.01 and $0.165 \pm 0.03\%$ TS, fat, protein, ash contents, pH and TA (% LA) values, respectively. The SMP was procured from M/s Modern Dairies Ltd., Karnal. As per the manufacturer, this SMP was produced from mixed milk and was medium heat treated.

Propagation of yoghurt culture and estimation of lactic acid bacteria counts

Good quality yoghurt of reputed brand containing mixed culture of *S. thermophilus* and *L. bulgaricus* was used as yoghurt culture. This culture was propagated in sterilized skimmed milk with 1.5% culture inoculation in a laminar air flow chamber, followed by incubation (45 ± 2 °C/6 h) and refrigerated storage at 4 °C.

Total counts of lactic acid bacteria were estimated in the yoghurt samples by using the yeast extract lactose agar medium adopting the method reported by Sivakumar and Kalaiaarasu (2010).

Packaging materials

Yoghurt samples were packed and stored in 100 mL polystyrene cups sourced from the Experimental Dairy of the institute.

Methods

Ultrafiltration

Buffalo skim milk was indirectly flash heat treated to 80 °C, cooled (~ 50 °C) and concentrated in a pilot scale ultrafiltration plant (Make: Tech-Sep France; Module type: tubular; Membrane material, area and cutoff: ZrO₂, 1.68 m² and 50,000 kDa) equipped with balance tank (200 L) and flow meters to 3.87 concentration factor (CF) also called folds. The CF was calculated by weighing the quantity of permeate removed from the skim milk. During

operation of UF plant, inlet pressure, outlet pressure and transmembrane pressure (TMP) were kept constant to 4.6, 3.6 and 1 kg/cm², respectively during entire UF operation (Meena et al. 2016).

Standardisation, homogenization and heat treatment of buffalo milk and preparation of different yoghurt samples

The selection of culture and TS levels, retentate addition and heat treatments were carried out on the basis of their effect on TA, pH, sensory scores and rheological parameters of yoghurt samples. Buffalo milk was first standardized to 3.25% fat and 13.70–13.80% TS contents with the addition of SMP and cream; homogenized at 2500/500 psi pressures in 1st and 2nd stage at 65–70 °C; heat treated at 85 °C for 30 min; cooled and inoculated with 2, 2.5 and 3% culture levels for the selection of culture level. Similarly, fat and TS levels were also adjusted in buffalo milk containing 0, 11 and 18% 3.87-folds UF retentate with the addition of SMP, cream and water.

For studying the effect of different total solids levels, buffalo milk was standardised to 3.25% fat and 13–14% TS levels with cream and SMP addition and inoculated with the pre-selected culture level. For the studying the effect of heat treatment, standardised milk containing 3.25% fat and earlier selected TS level was individually heat treated for 30 min at 80 and 85 °C followed by its inoculation with pre-selected culture level.

A standardised method for the preparation of optimised yoghurt was developed using the selected levels of culture, TS and heat treatment as shown in Supplementary Fig. 5a. Sensory quality attributes of optimised yoghurt were also compared with a fresh market sample of a reputed brand. The effect of storage period on quality attributes of optimised yoghurt was studied at 4 ± 1 °C.

Thus, milk samples containing different levels of total solids (maintained with or without the addition of UF retentate), subjected to different heat treatments were homogenized, inoculated with yoghurt culture and filled into pre-sterilized polystyrene cups (100 mL), incubated at 42 °C till required minimum TA (0.90% LA) was achieved. Thereafter, without disturbing, these cups containing plain set yoghurt were instantly transferred to refrigerated storage (4 ± 1 °C). All the trails were conducted in triplicate.

Compositional analysis, whey syneresis and textural analysis

The TS, fat, protein, lactose, ash, pH and TA (% LA) values of buffalo skim milk, UF retentate and yoghurt samples were determined in triplicate using standard

methods as reported by Meena et al. (2015) for plain *dahi*. Moreover, determination of spontaneous whey syneresis and texture analysis of undisturbed plain set yoghurt samples were conducted adopting the procedure reported by Meena et al. (2015).

Sensory evaluation

A panel of six discriminative and trained judges consisting the faculty of Dairy Technology Division of the institute, performed the sensory evaluation. Yoghurt samples were randomly taken out from the refrigerator (4 ± 1 °C), tempered to 20 °C and then served to judges for sensory evaluation. The samples were evaluated on 100 point score card suggested for yoghurt by Ranganadham and Gupta (1987). This score card contains maximum 45, 30, 10, 10, 5 marks for flavour, body and texture, acidity, colour and appearance and container and closure, respectively.

Storage study

Samples of optimised yoghurt were filled in 100 mL polystyrene cups and fitted with the cover and investigated for its storage quality during refrigerated storage at 4 ± 1 °C at a constant interval of 3 days up to 18 days.

Statistical analysis

Results obtained in this investigation were subjected to analysis of variance using a complete randomized design and randomized block design as reported by Snedecor and Cochran (1968). Mean values of two different samples were compared with each other using t test. Mean ± Standard Error (S.E.) were also calculated, wherever required.

Results and discussion

Chemical composition of buffalo skim milk and UF retentate

The percent TS, fat, protein, lactose and ash in 3.87-fold UF retentate were 22.17 ± 0.61, 0.97 ± 0.18, 14.21 ± 0.67, 4.48 ± 0.08, 2.20 ± 0.04, respectively. The constituents of buffalo skim milk were at par with the earlier reported values by Patel and Mistry (1997). UF concentration of skim milk markedly increased the constituents in retentate except lactose. Such decrease in lactose with subsequent increase in other milk constituents in retentate have also been reported by Patel and Mistry (1997) during UF concentration of buffalo skim milk to 1.33, 2.0, 2.85 and 4.34 folds.

Selection of yoghurt culture levels

Yoghurt samples prepared with 2, 2.5 and 3% yoghurt culture levels took 7, 6.5 and 6 h, respectively for achieving the required minimum TA of 0.90% LA. As expected, with increased culture addition, highly significant increase ($p < 0.01$) in the rate of TA development and the decrease in pH of yoghurt were observed. Atta et al. (2009) had also observed a similar increase in TA and decrease in pH with higher culture addition. At 3% yoghurt culture addition, minimum required TA (0.90% LA) was achieved in least time (6 h). Decreased incubation time leads to reduced cost of yoghurt production. Highly significant increase ($p < 0.01$) in body and texture and overall acceptability scores were observed with an increase in culture levels, but no significant difference was observed in flavour, acidity and colour and appearance scores because of the approximately similar acidity of all yoghurt samples. Whey syneresis was absent in these samples. Moreover, rheological parameters of these samples were statistically at par with each other. Therefore, based on minimum incubation period (i.e. 6 h) required to achieve minimum TA (0.90% LA) and better sensory scores of yoghurt, the addition of 3% yoghurt culture was selected for the further study.

Selection of UF retentate addition

The chemical composition of the yoghurt samples prepared with the addition of different amounts of UF retentate in milk, inoculated with 3% yoghurt culture, are presented in Table 1. The fat, TS contents and pH values were almost similar in all yoghurt samples. With higher UF retentate addition, protein and ash contents of yoghurt samples increased, but lactose contents decreased progressively. More UF retentate addition in milk leads to highly significant decrease ($p < 0.01$) in the rate of TA development

and also decreased pH during incubation. The yoghurt samples prepared with 0, 11 and 18% addition of UF retentate took 6, 6.5 and 7 h, respectively for achieving 0.9% LA TA. This was accorded to higher buffering capacity of the added UF retentate as its high protein contents resisted the change in TA or pH than control milk. Mistry and Kosikowski (1986) also observed such increase in protein content and buffering capacity of UF retentates with the progression of UF process. Higher buffering capacity of UF retentate requires longer incubation time to attain the desired pH than normal milk and this phenomenon could easily explain that why higher incubation time was taken by retentate added samples to achieve the same TA level. Christopherson and Zottola (1989) also reported fast rate of drop in pH in skim milk than UF retentate.

Highly significant ($p < 0.01$) decrease in body and texture, colour and appearance and overall acceptability scores of yoghurt prepared with 11 and 18% addition of UF retentate were observed compared to yoghurt made without retentate addition. Slight whey syneresis was observed in yoghurt samples prepared from milk containing 18% UF retentate and the same might be responsible for lower colour and appearance scores. Further, this yoghurt contain higher protein content that resulted in much dry, extra firm and lack of smoothness in its texture that also decreased its body and texture and overall acceptability scores. Abrahamsen and Holmen (1980) also reported that yoghurt manufactured from UF retentate added milk exhibited higher viscosity and firmer (too dry and pudding like) texture, because of its higher protein content. Such changes also underline the lack of proper texture in terms of lower sensory scores of yoghurt prepared from 18% UF retentate added milk in this study. However, acidity and flavour scores of all yoghurt samples were statistically at par with each other.

Table 1 Chemical composition of yoghurt samples prepared from the milk of different total solids and with the addition of different amounts of 3.87-fold UF retentate

Yoghurt constituents	Addition of 3.87 fold UF retentate (%)			Total solids level (%)		
	0.00	11.00	18.00	13.00	13.50	14.00
TS (%)	13.76 ± 0.02	13.72 ± 0.01	13.74 ± 0.08	13.11 ± 0.01	13.57 ± 0.02	14.11 ± 0.03
Fat (%)	3.25 ± 0.00	3.25 ± 0.00	3.30 ± 0.00	3.25 ± 0.1	3.25 ± 0.1	3.25 ± 0.1
Protein (%)	3.95 ± 0.10	4.54 ± 0.14	4.92 ± 0.12	3.98 ± 0.01	4.15 ± 0.01	4.30 ± 0.02
Ash (%)	0.84 ± 0.01	0.93 ± 0.01	0.96 ± 0.01	0.81 ± 0.01	0.83 ± 0.01	0.92 ± 0.01
Lactose (%)	5.72 ± 0.12	5.00 ± 0.16	4.56 ± 0.10	0.91 ± 0.01	5.03 ± 0.0	0.91 ± 0.00
pH	4.32 ± 0.00	4.33 ± 0.00	4.34 ± 0.00	4.32 ± 0.01	4.32 ± 0.0	4.32 ± 0.01

Mean ± S.E. (n = 3)

In comparison to yoghurt made from normal milk, highly significant increase ($p < 0.01$) in rheological parameters of yoghurt samples prepared from different UF retentate added milks were observed as shown in Table 2. A little whey syneresis (0.30 mL) was only observed in yoghurt manufactured from 18% retentate added milk, which may be due to its longer incubation period. Garg and Jain (1980) reported that rheological parameters of curd such as hardness and adhesiveness increased with increase in its protein content. Thus, yoghurt prepared from normal milk (without retentate addition) was considered of better quality by judges based on its sensory attributes. Even a little extra firmness was reported by judges in this yoghurt also, so a need was felt here to optimize TS level in standardized milk in order to produce buffalo milk based plain yoghurt with better sensory attributes and rheological parameters.

Selection of total solid levels

The chemical composition of yoghurt samples produced from normal buffalo milk with different TS levels are shown in Table 1. It was observed that protein content increased progressively in yoghurt samples with the increase in their TS levels.

The rate of TA development and decrease in pH during the incubation period in yoghurt samples prepared with normal buffalo milk with different TS levels were statistically at par with each other. Flavour, body and texture, colour and appearance, and overall acceptability scores of yoghurt prepared with 13.50% TS were highly significantly ($p < 0.01$) better than that of yoghurt prepared with 13 and 14% TS levels. However, body and texture, colour and appearance and overall acceptability scores of yoghurt prepared with 13% TS containing milk were lower because of its weak body and visible whey syneresis in this sample only. On the other side, body and texture and overall acceptability scores of yoghurt prepared from milk containing 14% TS decreased due to its higher firmness as pointed by the sensory panel. These findings are in good agreement with that reported by Mohammed et al. (2004); Sodini et al. (2004) who have underlined that higher TS levels are responsible for increased oral viscosity or perceived thickness, decreased whey syneresis and better texture acceptability of yoghurt samples over lower TS containing samples. Further, with increase in TS levels, significant increase ($p < 0.01$) in firmness, stickiness, work of shear and work of adhesion were observed in yoghurt samples (Table 2). The yoghurt sample prepared from standardized milk containing 13.50% TS fetched maximum scores. Increase in TS levels have been reported to decrease the whey syneresis with higher water holding capacity and gel firmness in yoghurt (Shaker et al. 2000).

Harwalkar and Kalab (1986) reported that 10–20% increase in TS levels increased yoghurt firmness by 2–3 folds. Because of this reasons, rheological parameters of yoghurt prepared with 13.50% TS were observed significantly ($p < 0.01$) better than that prepared with either 13 or 14% TS levels. Thus, based on better sensory scores and rheological parameters, yoghurt prepared with 13.50% TS was observed to be of the optimum quality.

Selection of heat treatments

The rate of TA development and decrease in pH of yoghurt samples prepared employing different heat treatments (80 °C/30 min and 85 °C/30 min) were statistically at par with each other. In studied temperature range, increase in heating temperature significantly improved ($p < 0.01$) the body and texture and overall acceptability scores, but no-statistical difference was observed in other sensory attributes of yoghurt samples. Body and texture and overall acceptability scores of yoghurt made from high heat treated (85 °C/30 min) milk were significantly higher ($p < 0.01$) than the yoghurt produced from low heat treated (80 °C/30 min) milk as maximum hydration of the protein occurs when milk is heated at 85 °C for 30 min. Lee and Lucey (2003) reported that ‘in-mouth’ and ‘in-cup viscosities’ of yoghurt made from milk heated at 85 °C were increased by 4–8 times than yoghurt made from milk heated at 75 °C, because of the presence of more cross-linked and branched protein structure (fine structure) with small pores in the high heat treated milk (> 80 °C) than large protein clusters (coarse structure) present in low heat treated milk. Lucey et al. (1998) also reported that heating of milk (≥ 80 °C/15 min) resulted in significantly increased denaturation of β -lactoglobulin than milk heated at 75 °C/15 min. Firmness, stickiness, work of shear and work of adhesion of yoghurt samples were significantly ($p < 0.01$) increased with increase in heating temperature (Table 2). However, whey syneresis was not observed in yoghurt samples prepared from different heat treatments. Dannenberg and Kessler (1988) reported that the extent of whey protein denaturation in milk during heating had significant impact on viscosity and firmness of acid gel and the same increases with increase in heating temperature (Lee and Lucey 2006). Results obtained in this study are similar to that reported by Abd El-Khair (2009) who emphasized that even at a same protein level, due to difference in the extent of whey protein denaturation, yoghurts made from high heated milk had higher firmness than that produced from low heat treated milk. Thus, based on better sensory scores and rheological parameters of yoghurt, heat treatment of 85 °C/30 min was selected and further used to produce optimized yoghurt sample.

Table 2 Effect of retentate addition, TS levels and heat treatments on rheological attributes of different yoghurt samples

Retentate levels	Effect of retentate addition [#]					Effect of TS levels [#]					Effect of heat treatments [#]				
	Firm. (N)	Stick. (N)	WOS (N s)	WOA (N s)	TS levels	Firm. (N)	Stick. (N)	WOS (N s)	WOA (N s)	Heat treatments	Firm. (N)	Stick. (N)	WOS (N s)	WOA (N s)	
0%	3.319	– 0.636	100.941	– 4.055	13.0%	2.0156	– 0.6050	65.7483	– 3.4210	80 °C/30 min	2.597	– 0.781	93.974	– 5.400	
11%	5.617	– 1.130	160.658	– 5.685	13.5%	3.0690	– 0.8166	97.8040	– 4.5106	85 °C/30 min	3.062	– 1.096	106.887	– 7.656	
18%	6.537	– 1.565	184.305	– 8.238	14.0%	3.5953	– 1.0496	115.6786	– 6.1093	lit	11.93*	4.65*	11.54*	8.15*	
CD ($p < 0.01$)	0.188	0.359	9.162	0.454	CD ($p < 0.01$)	0.099	0.092	2.542	0.283	NA					

Firm. Firmness, Stick. Stickiness, WOS Work of shear, WOA work of adhesion

[#]Mean values (n = 3), *Significant at $p < 0.01$, NA not applicable

Comparison of sensory quality of optimized yoghurt vis à vis market sample

Optimized yoghurt sample was produced adopting the process shown in Fig. 1. The comparison of sensory scores of optimized yoghurt and a reputed market sample revealed that body and texture, acidity and overall acceptability scores of optimized yoghurt were significantly ($p < 0.01$) better than market sample, while other sensory attributes showed no-statistical difference. Optimized yoghurt had 13.57% TS, 3.25% fat, 4.15% protein, 5.03% lactose, 0.83% ash (Table 1) and met FSSAI (2011) standards in terms of its chemical composition. Firmness, stickiness, work of shear and work of adhesion of optimized fresh yoghurt were 3.075 N, – 0.508 N, 85.352 N s and – 3.377 N s, respectively. Optimized set plain yoghurt had the firm body and smooth texture without any whey syneresis compared to 0.6 mL whey syneresis in the market sample. Optimized yoghurt was highly preferred over market sample by the sensory panel.

Storage studies: effect of storage period on the sensory quality and microbial counts of optimized yoghurt

The changes occurred in TA and pH values, sensory attributes and rheological parameters of optimized yoghurt indicated that with advancement of the storage period, significant increase ($p < 0.01$) in TA and significant

Fig. 1 Standardized process for the production of optimized yoghurt

Table 3 Effect of storage period on rheological parameters of optimized yoghurt

Days	Firmness (N)	Stickiness (N)	Work of shear (N s)	Work of adhesion (N s)
0	3.0747	– 0.5080	85.3517	– 3.3770
3	3.2195	– 0.4222	91.4792	– 3.6230
6	3.3797	– 0.4915	98.4270	– 3.6975
9	3.4745	– 0.5475	101.8577	– 3.9285
12	3.5660	– 0.6580	105.8057	– 4.0272
15	3.6390	– 0.7435	107.9532	– 4.4020
18	3.5205	– 0.6902	105.9077	– 4.1695
CD ($p < 0.01$)	0.056	0.144	4.075	0.2
Mean values (n = 3)				

decrease ($p < 0.01$) in pH values of optimized yoghurt were observed. The TA and pH values of yoghurt samples at zero day (fresh) and after 18 days storage were 0.94% LA, 4.33 and 1.20% LA, 1.20% LA, respectively. This might be attributed to TA development by yoghurt culture in yoghurt during storage was continued even at 4 ± 1 °C, but with the lower rate of acid production. These changes in TA and pH values in yoghurt during storage were in good agreement with that previously reported by Atta et al. (2009); Obi et al. (2010). Highly Significant decrease ($p < 0.01$) in all sensory scores of yoghurt particularly between 15th to 18th day of storage were observed, that might be due to increase in TA that resulted in visible whey syneresis in yoghurt samples on the 18th day of storage. Rheological parameters of yoghurt increased highly significantly ($p < 0.01$) during first 15 days of storage followed by a steep deterioration from 15th to 18th day of storage (Table 3) that could be related to change in pH of yoghurt samples. Similar changes were also observed in firmness and stickiness of yoghurt samples during storage by Köse and Ocak (2011). Salvador and Fiszman (2004) reported increased whey syneresis and firmness in whole and skimmed milk yoghurts over storage period.

Lactic acid bacteria (LAB) counts of yoghurt steeply decreased from the initial value of 9.67 to 7.85 cfu/g on the 18th day of storage. Obi et al. (2010) also observed a decrease in the total viable count in yoghurt throughout the storage. On the basis of sensory scores, rheological parameters and TA (1.21% LA), the shelf life of optimised yoghurt was observed to be of 15 days at refrigerated storage.

Conclusion

This study was aimed to improve the quality of plain set yoghurt by optimizing different culture levels, amount of retentate addition, TS levels and heat treatments. The desired acidity in yoghurt was achieved in least 6 h with 3% culture addition. Addition of 11 and 18% 3.87 fold UF

retentate in milk resulted in slower TA development, because of increased protein content and buffering capacity and had detrimental effect on sensory attributes because of increased firmness in yoghurt samples. The overall quality of yoghurt prepared with 13.50% TS was significantly better than that prepared with 13 and 14% TS levels. Body and texture and overall acceptability scores of yoghurt prepared with heat treatment of 85 °C/30 min were significantly better than the yoghurt prepared at 80 °C/30 min because of more whey protein denaturation that leads to firm body and smooth texture in yoghurt via optimal cross linking, interaction and hydration of proteins. Optimized yoghurt met FSSAI (2011) standards and possessed firm body and smooth texture with no whey syneresis compared to 0.60 mL whey syneresis in a branded market sample. The shelf life of optimized yoghurt was observed to be 15 days at 4 ± 1 °C. This investigation has established that common quality defects of conventional yoghurt can be eliminated through the proper selection of total milk solids, process parameters and culture levels and collectively these are capable to improve the quality of plain set yoghurt.

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