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ORIGIAL ARTICLE

Use of Milk Protein Isolate to Improve the Textural Properties of Curd

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Abstract

The objective of this study was to evaluate the effect of Milk Protein Isolate (MPI) on the textural properties of curd. Four different incorporation levels of MPI as 0.5%, 1%, 1.5% and 2% were compared with control having 2.5% of skim milk powder. Physicochemical properties including pH, titratable acidity, syneresis were measured during the shelf life of 14 days. Hardness, chewiness and adhesiveness were assessed as textural properties. Microbiological safety was analysed during the shelf life of 14 days including *E-coli*, yeast and mould counts. Sensory evaluation was carried out using 30 untrained panellists. All the textural properties were significantly different ($p<0.05$) among the treatments while the highest mean values were recorded in curd incorporated with 2% MPI. There was no significant difference ($p>0.05$) for pH and titratable acidity among the treatments. Curd developed with 2% MPI had the lowest syneresis compared to other treatments. Sensory evaluation results revealed that, appearance, texture and spoon ability were also much better in the 2% MPI treatment. Coliform was not observed during the storage period while yeast and mould growth were below the safe levels in all treatments during the period. In conclusion, 2% MPI could be effectively used to replace the skim milk powder like constituents in commercial curd manufacturing while enhancing both textural and nutritional properties and consumer acceptance.

Keywords: *Commercial curd, Milk protein isolate, Spoon ability, Texture*

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1. Introduction

Curd is one of the oldest fermented dairy products which is highly popular in Sri Lanka. There is a growing demand for curd, due to its unique taste, therapeutic and nutritional value (Meydani and Ha, 2000). It has a higher consumer demand since it is considered as a natural product in its composition. Curd is a native product obtained by coagulation of cow or buffalo milk or a mixture of both, inoculating with starter cultures obtained either from previously made curd or commercially available cultures. Milk proteins get coagulated due to the pH decline caused by production of lactic acid during fermentation by starter culture bacteria. Even though, the production of curd remains as predominantly a traditional industry in Sri Lanka, there has been a spike in popularity of branded curd products of large-scale commercial producers in recent past.

A major concern existing in the curd industry is the production and maintenance of a product with optimum consistency and stability without syneresis. Whey gets separate from the curd and appear as a thin layer of water on top of the product which termed as syneresis and this act as one of the major quality defects of curd (Modler et al. 1983). Therefore, curd manufacturers tend to add gelatine, skim milk powder like constituents to obtain better spoon ability which help to extend the shelf life of curd by maintaining gel viscosity over a longer period. However, addition of gelatin like constituents are banned from Sri Lankan Standard Institute and it could lead to allergic conditions, some serious health issues and mute characteristic flavour, aroma of curd. Fortification of curd with skim milk powder is commonly practiced to obtain better textural and organoleptic properties of curd.

Milk protein isolate (MPI) has been identified as a potential ingredient to provide better textural properties in dairy products mainly in yoghurt (Karam et al. 2013). Unlike gelatine, MPI do not disturb the natural flavour and it helps stabilize yoghurt gels replacing starches or other thickening agents and improve overall texture reducing the cost of production (Sodini et al. 2005). With the increased quality and availability, MPI is commonly used as a replacer for skim milk powder in dairy industry to get better sensory and textural properties. Therefore, the current study was designed to evaluate the effect of MPI on textural and sensory properties of curd and assess the compositional and microbiological attributes during the storage period.

2. Materials and Methods

Preliminary study was undertaken to select the best four incorporation levels of MPI (originated from casein protein of cattle milk) out of ten (10) different levels ranged from 0.25% to 2.5%. Preliminary study results confirmed that MPI incorporation

level starting from 2.25% onwards having unacceptable hardness and 0.25% level had higher water drain out. Therefore, 0.5% and 2% was selected as lower and upper limit respectively for further analysis.

Curd was developed using 4 levels of MPI including 0.5% (T1), 1.0% (T2), 1.5% (T3) and 2.0% (T4) (w/v). Curd incorporated with 2.5% (w/v) skim milk powder was used as the control. In brief, cow milk was standardized and heated to 65-70 ^{0}C using a water bath and homogenized at double stage under 3.5 MPa. Homogenized milk was heat treated to 90 ^{0}C temperature for 3 min in a water bath. After that selected MPI levels were added and mixed properly. Milk is cooled to 30-32 ^{0}C and inoculated with curd culture (Lyofast KD-01). It was mixed well to ensure proper dispersion of culture and incubated at 44 ^{0}C until preferred pH level was achieved. Curd cups were then transferred to refrigerator and stored at 4 ^{0}C.

2.1 Compositional analysis

Total solids content, protein content and ash content were measured according to AOAC standards (2003). Total protein content was determined by micro-Kjeldahl method, while ash content was measured by ignition at 550 °C in an electric Muffle furnace. Titratable acidity of curd was measured as percentage of lactic acid using standard method described in AOAC method (2003) and pH determination was carried out using a pH meter (Model: 775249 Eutech, Singapore).

2.2 Textural property analysis

Texture parameters of curd including adhesiveness, cohesiveness, chewiness and hardness were determined using texture analyzer (CT3 Brookfield USA) with compression mode. Susceptibility of yoghurt to syneresis was measured using a drainage and a centrifugation method as described by Harwalkar and Kalab (1986).

2.3 Microbiological analysis

Microbiological quality assessment was done by determining the yeast and mold count and total coliform count using Potato Dextrose Agar (PDA) and Mac-Conckey Agar respectively during storage period of 14 days at five days interval.

2.4 Sensory evaluation

Sensory analysis was carried out using 30 untrained panelists. The panelists were asked to evaluate the product for colour, appearance, aroma, taste, spoon-ability and overall acceptability according to the five-point hedonic scale.

2.5 Statistical analysis

Data was statistically analysed by Complete Randomized Design (CRD). Parametric data were analyzed by ANOVA procedure in SAS

(Statistical Software Analysis ,9.1 Version) and mean separation was done by Tukey's Studentized Range Test (TSRT). Sensory data were analyzed by Friedman test in MINITAB software package at 95% confidence interval.

3. Results and Discussion

Addition of milk protein isolates (MPI), milk protein concentrates, whey protein isolates and concentrates, micellar casein and caseinates to fortify dairy products has gained higher interest due to their functional and nutritional properties (Sodini et al. 2005, Séverin and Wenshui, 2005). Whey proteins are rich with proteins, minerals and functional properties including emulsification, water holding, foaming, thickening and gelling. Thereby the addition of MPI positively affect curd texture and overall nutritional and sensorial aspects (González-Martınez et al. 2002). As well as the addition of thickening agents reduce cost of solidification (Cannolly, 2013).Texture is considered as one of the most important attributes of curd which could be assessed by sensory or instrumental analysis. Curd incorporated with MPI showed significant ($p<0.05$) effect on textural properties including adhesiveness, cohesiveness, hardness and chewiness. Values of all the textural attributes of curd were significantly ($p<0.05$) higher than the control throughout the storage period.

Table 1: Changes of textural properties with different incorporation levels of MPI in curd

Treatment	Adhesiveness	Cohesiveness	Chewiness	Hardness
T1	0.60 ± 0.28^{b}	0.32 ± 0.06^{c}	7.3 ± 0.99^{c}	0.28 ± 0.034^{c}
T2	2.55 ± 0.49^{a}	0.32 ± 0.04^{c}	6.80 ± 0.28^{c}	$0.27\pm0.036^{b, c}$
T3	2.60 ± 0.42^{a}	$0.46\pm0.01^{a, b}$	13.35 ± 0.35^{b}	$0.30\pm0.028^{a, b}$
T4	2.60 ± 0.42^{a}	0.53 ± 0.01^{a}	19.40 ± 1.69^{a}	0.33 ± 0.004^{a}
Control	$1.20\pm0.28^{a, b}$	$0.35\pm0.01^{b, c}$	6.75 ± 0.35^{c}	$0.21\pm0.007^{b, c}$

(a, b, c, d Mean values with different superscripts in the same column differ significantly, $p<0.05$;>b>c>d)

The adhesiveness of different curd samples showed a significant difference ($p<0.05$) among the different levels of MPI.

T3 and T4 which contains highest levels of MPI had the highest mean value for adhesiveness (Table 1). Adhesiveness has a positive effect on the thickness of the dairy products, and act as an important factor determining the stability of the products resulting good mouth-feel, improved texture and stability of the yoghurt and curd like products during storage (Zhao et al.

2006). Higher adhesiveness improve the binding capacity of curd gel (Krasaekoopt et al. 2004). Curd incorporated with highest level of MPI (T4) had the highest mean values for cohesiveness, chewiness and hardness while control incorporated had the lowest value (Table 1). The increase of total solid content due to the addition of MPI cause to increase all these properties. The higher cohesiveness also increases the binding property of curd which takes place due to the shape and structure of its molecules (Szczesniak 1963). Hardness values also in agreement with the previous research studies, which mainly influenced by protein and total solid content of set type yoghurt and curd (Karam et al. 2013). Control incorporated with skim milk powder showed inferior textural properties compared to MPI incorporated curd.

Separation of the liquid phase in milk gels is termed as syneresis which consumers generally considered as a quality defect of curd and yoghurt. Syneresis values were reduced with the increased levels of MPI while it increased in all treatments with the storage period of 14 days (Fig. 1). Curd treated with highest level of MPI displayed minimal syneresis during the shelf life whereas the control is criticized for whey separation. Susceptibi1ity of yoghurt and curd to syneresis depends on several factors including preheat treatment of milk, total solids content, acidity resulting from the growth of the lactic acid bacteria cultures, incubation condition and homogenization (Abd El-Khair 2009, Younus et al. 2002). Fortification of curd with MPI cause to increase the total solid content resulting a denser matrix with minimum syneresis (Chandan and Kilara, 2013, Sodini et al. 2005). It has been shown in previous studies that yoghurt and *dahi* fortified with casein and whey proteins has shown low whey separation compared to the products fortified with skim milk powder (Karam et al. 2013, Abd El-Khair 2009, Bhuiyan et al. 2010). It has been reported that enrichment of yoghurt with skim milk powder lower the water holding capacity of the product and similarly in the current study the control incorporated with skim milk powder had higher syneresis than MPI incorporated curd.

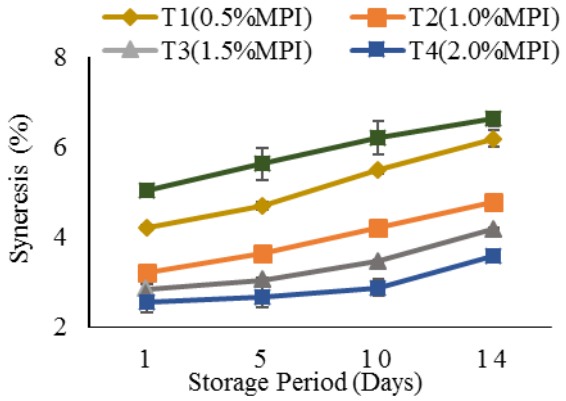

Figure 1: Variation of syneresis in MPI incorporated curd samples during the storage period of 14 days

3.1 Chemical composition

The mean values for chemical composition of curd mixes are shown in Table 2. Significant differences ($p<0.05$) were observed among different treatments as to total solid and protein contents. The

incorporation of MPI in the manufacturing of curd has contributed to the increase of the total solid content in favor of protein. Similar results have reported by Abd El-Kahir (2009) that incorporation of yoghurt with skim milk retentate has increased total solid content and protein content while decreasing the lactose content than incorporation of skim milk powder. According to the previous studies, the best quality *dahi* is prepared with a total solids content of 14.5-15.0% and the total solid values reported in the current study are higher than those values (Varghese and Mishra, 2008). The protein content was highest in curd incorporated with highest MPI content and the lowest value was reported in control. Incorporation of MPI can improve the protein content because of the chemical composition of MPI (Younus et al. 2002, Abd El-Khair 2009, Sodini et al. 2005)

Table 2: Proximate composition of curd incorporated with different levels of MPI

Treatment	Crude protein%	Ash%	Total Solids%
T1	4.52±0.06^{c}	0.84±0.003^{a}	16.00±0.07^{b}
T2	4.87±0.04^{b}	0.84±0.005^{a}	16.13±0.06^{b}
T3	5.47±0.02^{a}	0.85±0.006^{a}	16.94±0.36^{a}
T4	5.64±0.06^{a}	0.86±0.005^{a}	17.12±0.15^{a}
Control	3.46±0.02^{d}	0.83±0.031^{a}	16.83±0.13^{a}

(a, b, c, d Mean values with different superscripts in the same column differ significantly, $P<0.05$; a>b>c>d)

Titratable acidity is considered as one of the important quality parameters of the dairy products since it affect palatability, consumer acceptance and shelf life (Routray and Mishra 2011). Titratable acidity of all treatments and control increased with the storage period (Fig. 2). Sahan et al. (2008) and Kamruzzaman et al. (2002) also showed that pH of *dahi* and yoghurt decreased significantly with storage period. It is directly linked with the lactic acid production by starter bacteria present in curd and increase the acidity during storage period (Vahedi et al. 2008). According to the SLS standards (1989), the minimum titratable acidity for dairy products is 0.8-1.25%. All the curd samples had titratable acidity values within the standard range during the storage period.

Variation of pH depends on the method of preparation including incubation time, temperature and amount of starter culture added during the fermentation. Amount of inoculation starter culture, incubation time and temperature were kept constant for all treatments during the current study. There was no significant difference ($p>0.05$) among the pH of different treatments at a particular period (Fig. 3).

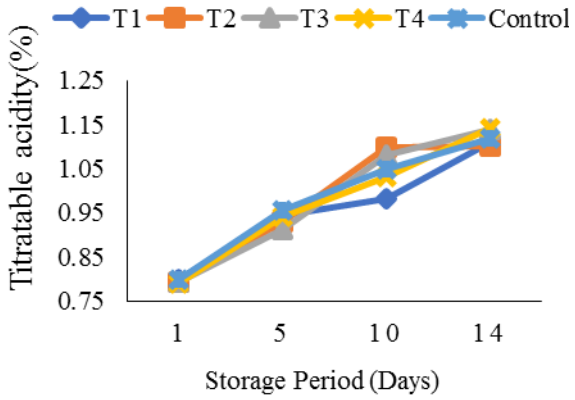

Figure 2: Variation of titratable acidity in MPI incorporated curd samples during the storage period of 14 days

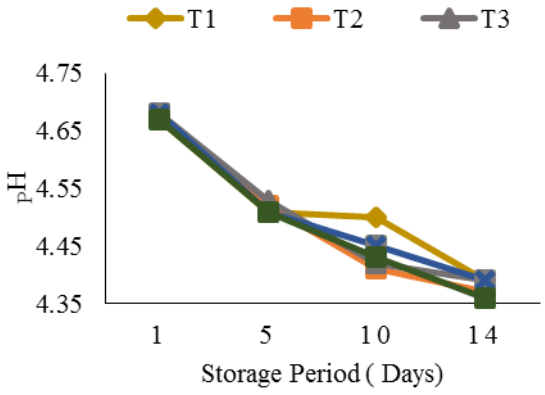

Figure 3*:* Variation of pH in MPI incorporated curd samples during the storage period of 14 days

Total coliform counts were zero for all treatments during the storage period of 14 days. Yeast and mould growth was observed after day 5 and the highest counts was observed in 2% MPI incorporated curd sample. Yeast and mould counts were within the accepted level for curd ($<10^2$ cfu/mL) according to SLSI standards during the storage period of 14 days implying good hygienic conditions of manufacturing. As well as curd incorporated with MPI can be stored for 14 days without any microbial quality deterioration.

3.2 Sensory attributes

According to the sensory evaluation results, curd incorporated with 2% MPI (T4) had the highest score for color, taste, aroma, texture and spoon ability while control had the lowest (Fig. 4). High protein content available in the MPI contribute the improved taste of T4. These results agreed with Younus et al. (2002), who found that variation in taste score of curd usually depends on type of milk, starter culture, manufacturing process and fat, protein, or carbohydrate content of milk. As well as the variation in aroma score of curd usually depends on type of milk, volatile constituents of milk, heat treatment, starter culture and manufacturing process involved (Younus et al. 2002). Highest spoon ability score was also seen in T4 since MPI act as a stabilizer replacer and it had the highest binding ability. As Khurana (2004) described, increased total solids content increase the spoon ability resulting better textural properties. Therefore, the curd

incorporated with 2% MPI had the best overall sensory acceptance since it contains higher protein and TS content (Lee and Lucey, 2010).

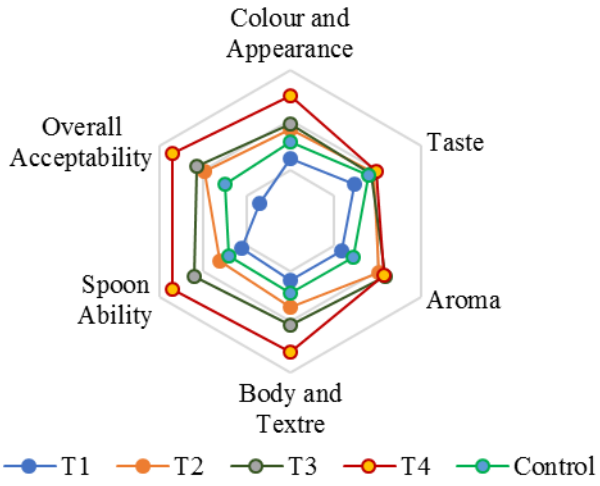

Figure 4: Sensory evaluation of curd incorporated with different levels of MPI

4. Conclusions

According to the current study findings, the 2% incorporation level of MPI could be used successfully for manufacturing of curd with superior sensory and textural characteristics. The Addition of MPI could be used effectively to replace gelatine or skim milk powder like constituents in commercial curd manufacturing while enhancing their nutritional value. Also, MPI incorporated curd samples could be stored around 14 days at 4 ^{0}C without any quality deterioration.

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