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Probing the compositional variations among various synbiotic cheddar cheese prepared from apple pomace and probiotic strains

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Abstract

Cheddar cheese is a hard-ripened type produced by the use of suitable starter culture and hence contain such microflora that strengthen human gut and relieve from different dietary ailments. Present project was designed to prepare synbiotic cheddar cheese using different probiotic strains and prebiotic with aim to explore the effect on various physiochemical parameters. For the purpose, three probiotic strains including *Bifidobacterium lactis* (LAFTI B94), *Lactobacillus casei* (LAFTI L26) and *Bifidobacterium bifidum* (Nu-trish® BB-12) were used to prepare three types of synbiotic cheddar cheese. While apple pomace which is by-product of fruit industry was utilized as prebiotic source in all types of cheddar cheese. Following the preparation of synbiotic cheese, the samples were stored at refrigerated temperature of 4°C for the period of 28 days and were subjected to various physiochemical analysis to explore the effect of storage on the compositional parameters. pH of the synbiotic cheddar cheese (SCC) was decreased from 5.25 ± 0.004 to 5.19 ± 0.005 during storage. While acidity significantly increased from 0.90 ± 0.005 to 0.95 ± 0.004 in SCA. Moisture, fat and protein contents were significantly changed in all cheese samples. Results indicated that treatments and storage had effect on the compositional parameters of cheddar cheese.

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Introduction

Cheese is an extremely versatile food product that has an extensive texture range based on the moisture contents and popular among the end-users. Worldwide, there is substantial increase in production of cheese due to high nutritional awareness amongst the population (Fox *et al*.,2004).The consumers demand for innovative and nutritious products motivates the use of innovative scientific technologies for product development. Cheddar cheese is a hard-ripened type produced by the use of suitable starter culture and hence contain such microflora that strengthen human gut and relieve from different dietary ailments. Quality of the cheese depends on the numerous factors including milk composition and type of the starter culture (Kwak and Jukes, 2001).

Probiotics are live microorganisms that provide the host with health advantages when administered in appropriate quantities' (FAO / WHO, 2002). These include several well-characterized strains of *Lactobacilli* and *Bifidobacteria* that potentially decrease the danger of gastrointestinal (GI) diseases, regulate intestinal microbiota, stimulate & develop the immune system, synthesize & improve nutrient bioavailability, decrease lactose intolerance symptoms etc (Salminen *et al*., 2005).

Prebiotics stimulate probiotic growth and widelyused as food supplement. Their consumption lowers fecal pH, enhance the production of SCFA, improve mineral absorption and regulate metabolism. Moreover, prebiotics affect composition of the gut microflora, especially increase the number of bifidobacteria that improves immune system and protects human body from pathogens. Apple pomace used as a prebiotic source for the production of synbiotic cheddar cheese. This is the leftover of the juice extraction industry and comprises of the seed, peel, core, calyx etc. Apple pomace is rich source of dietary fiber containing cellulose, hemicellulose, lignin, pectin, β-glucans and gums. Fiber rich diets are helpful in attenuating the different diseases including obesity, cardiovascular diseases, colon cancer, diabetes, asthma, and pulmonary diseases. Beside this, apple pomace also the source of polyphenols and considered high value-added compounds. Therefore, apple pomace used as ingredient for functional foods (Boyer and Liu, 2004). A synbiotic food contains a combination of probiotics and prebiotics and adds new advantageous bacteria to the indigenous gut population of the host. The presence of prebiotics,like apple pomace, in synbiotic cheese is expected topromotebeneficial activities of the probiotics. Such foods are very effective to avoid obesity, boost up immunity, bone calcification, improve digestion, and improve cardiovascular diseasesby lowering cholesterol level and blood pressure (Farbod *et al*., 2013). So keeping in view aforementioned health benefits of prebiotic and probiotics, a synbiotic cheddar cheese was prepared in current research andvarious physio-chemical analysis were performed to evaluate the storage behaviour of synbiotic cheese.

Materials and methods

Procurement of raw materials

Raw milk was procured from the local farm of Faisalabad and starter cultures and probiotics were purchased fromDSM food specialist and Nu-trish® .Apple pomace was prepared in the laboratory of Department of Food Science, Government College University Faisalabad.

Product development and storage

Milk was standardized for 3.5% fat contents. Cheddar cheese was prepared with slight modification in the method followed by Scott (1981). Firstly, apple pomace was blended with the standardized and pasteurized milk and then added probiotic mother culture in addition to starter culture at 31°C after cooling with probiotic culture. Three different treatments of the synbiotic cheddar cheese were made in the dairy laboratory of the department (Table 1). The prepared cheese samples were packed in a zip lock polyethene bags and stored at refrigeration temperature for 28 days.

Physio-chemical analysis

Chemical analysis of cheese was conductedfor various parameters including pH, acidity, fat, protein, moisture after one-week interval for 28 days of storage.

pH

The pH of synbiotic cheese samples was measured by the digitalpH meter as per the method described by Ong *et al.* (2007).

Acidity

Acidity in prepared synbiotic cheddar cheese samples was determined by the method given in AOAC (2011).

Fat

Fat contents of the synbiotic cheddar cheese were determined by Gerber test Pearson method (1999).

Protein

Total protein of the different Samples of cheese was determined by Kjeltech method AOAC (2011).

Moisture

Moisture contents of the various cheddar cheese samples were determined by oven drying method AOAC (2011).

Statistical analysis

Analysis of variance will be used for the current research data by SPSS (Statistical Package for The Social Sciences) software with its 19th version. The data was processed through one-way ANOVA (Analysis of variance) using CRD (Completely Randomized Design) (Steel et. al., 1997).

Results and discussion

Gradual decrease in pH was observed in all the treatments during storage period of 28 days. The highest pH value (5.25 ± 0.004) was recorded in fresh samples of SCC while the minimum value (5.17 ± 0.002) was noted in SCA on 28th day of study (Table2). Similar results have been reported for pH decrease in hard cheeses and semi hard cheeses (Guinee *et al.*, 2000) while, Gupta *et al.*, (2009) also observed the decreasing trend in pH of cheddar cheese during storage. Decrease in pH may result from various biochemical reactions inside the cheese matrix e.g. the release of degradation products as a result of proteolysis (Gupta *et al.*, 2009).

When residual lactose is converted to lactic acid by the activity of the starter culture it also leads in pH drop (Fenelon and Guinee, 2000).

Table 1. Treatment plan for Synbiotic cheddar cheese preparation.

Treatments	Description
Control	No addition of prebiotic or probiotic
SC-A	Cheese with probiotic A + 1% Prebiotic
SC-B	Cheese with probiotic B + 1% Prebiotic
SC-C	Cheese with probiotics C + 1% Prebiotic

SCA: Synbiotic cheddar cheese with probiotic A Bifidobacterium lactis (LAFTI B94)

SCB: Synbiotic cheddar cheese with probiotic B Lactobacillus casei (LAFTI L26)

SCC: Synbiotic cheddar cheese with probiotic C Bifidobacterium bifidum (Nu-trish® BB-12)

Prebiotic: Apple pomace.

Acidity has an inverse relationship with pH as acidity increases with decrease in pH (Fenelon and Guinee, 2000). There was a significant increasing trend observed in acidity (%) in all the treatments during storage. The highest value of acidity (0.95 ± 0.004) was recorded in SCA on the 28th day of storage and the minimum value (0.87 ± 0.003) was noted on day 0 in SCC (Table 3). These results findings match with those reported by Marth and Steele, 2001; Aly and Galal, 2002 who reported an increasing trend in acidity during storage of cheese samples. This increase in acidity can be attributed to the coagulation of milk proteins by the starter culture (Amarita *et al.*, 2006).

Table 2. Means for the effect of storage time on pH of symbiotic cheese.

Treatments	Dayo	Day 7	Day 14	Day 21	Day 28
Control	5.23 ± 0.005a	5.21± 0.003a	5.20 ± 0.005a	5.19± 0.004ab	5.18± 0.004a
SC A	5.20± 0.005b	5.19± 0.005b	5.18 ± 0.004b	5.17± 0.005b	5.17± 0.002a
SC B	5.24 ± 0.003a	5.22± 0.004a	5.21 ± 0.003a	5.20± 0.003a	5.19 ± 0.010a
SC C	5.25± 0.004a	5.21 ± 0.010a	5.20± 0.005a	5.19± 0.005ab	5.19± 0.005a

Table 3. Means for the effect of storage time on acidity of symbiotic cheese**.**

Treatments	Day 0	Day 7	Day 14	Day 21	Day 28
Control	0.89 ± 0.004a	0.90 ± 0.004a	0.91 ± 0.005a	0.92 ± 0.004a	0.94 ± 0.005a
SC A	0.90 ± 0.005a	0.90 ± 0.005a	0.91 ± 0.004a	0.93 ± 0.005a	0.95 ± 0.004a
SC B	0.88 ± 0.005ab	0.88 ± 0.004b	0.90 ± 0.003a	0.90 ± 0.004b	0.92 ± 0.003b
SC C	0.87 ± 0.003b	0.89±0.010ab	0.91 ± 0.004a	0.92 ± 0.003a	0.94 ± 0.010a

Moisture analysis is one of the most important quality parameters that can affect the textural properties and shelf life of the end product. Moisture contents is the key to the shelf life of every food product. During storage of cheese there are some continuous processes taking place that utilize water (Farbod *etal.*, 2013).There was a decreasing trend noticed during storage and among all the samples, the highest moisture content (37.50 ± 0.010) was observed in SCA on day 0 whereas, the lowest moisture content (36.07 ± 0.004) was calculated in SCC on 28th Day of storage (Table 4).

Table 5. Means for the effect of storage time on fat of symbiotic cheese.

Treatments	Day 0	Day 7	Day 14	Day 21	Day 28
Control	30.25 ± 0.004a	30.23 ±.005a	30.21 ± 0.005a	30.20 ± 0.010a	30.19 ± 0.005a
SC A	30.29 ± 0.005b	30.28 ±0.004b	30.26 ± 0.004b	30.25 ± 0.004b	30.24 ± 0.004b
SC B	30.28 ± 0.005b	30.27 ± 0.003b	30.25 ± 0.003b	30.23 ± 0.005b	30.20 ± 0.003a
SC C	30.26 ± 0.003a	30.25 ± 0.004a	30.24 ± 0.010b	30.24 ± 0.005b	30.21 ± 0.004a

Table 6. Means for the effect of storage time on protein of symbiotic cheese.

Treatments	Day 0	Day 7	Day 14	Day 21	Day 28
Control	32.02 ± 0.005a	32.00 ± 0.005a	31.99 ± 0.005a	31.89 ± 0.005a	31.76 ± 0.004a
SC A	32.04 ± 0.003ab	32.01 ± 0.004a	32.00 ± 0.005a	31.99 ± 0.004a	31.89 ± 0.005b
SC B	32.05 ± 0.004bc	32.03 ± 0.003b	32.00 ± 0.004a	32.00 ± 0.003a	31.99 ± 0.005c
SC C	32.07 ± 0.005c	32.06 ± 0.005c	32.04 ± 0.010b	32.00 ± 0.005a	31.97 ± 0.002c

The results of the present study resemble with the study of Srivastava (2002) and O'Connor and O'Brien (2000) who reported decreased moisture content in cheddar cheese after extended storage. Likewise, Kucukoner and Haque (2006) reported a 40% moisture in full fat cheddar cheese.

Fat contributes a lot in taste, texture, functionality and appearance of cheese (Tunick *et al.,* 1993). For this parameter, there was significant decreasing trend observed during the storage. The maximum level of fat (30.29 ± 0.005) was observed in the fresh SCA samples while the minimum content (30.19 ± 0.005) was computed in control sample on the 28th day of storage (Table 5). Biochemical reactions are responsible for the reduction in fat content of cheese samples during storage (Dave *et al.*, 2004).

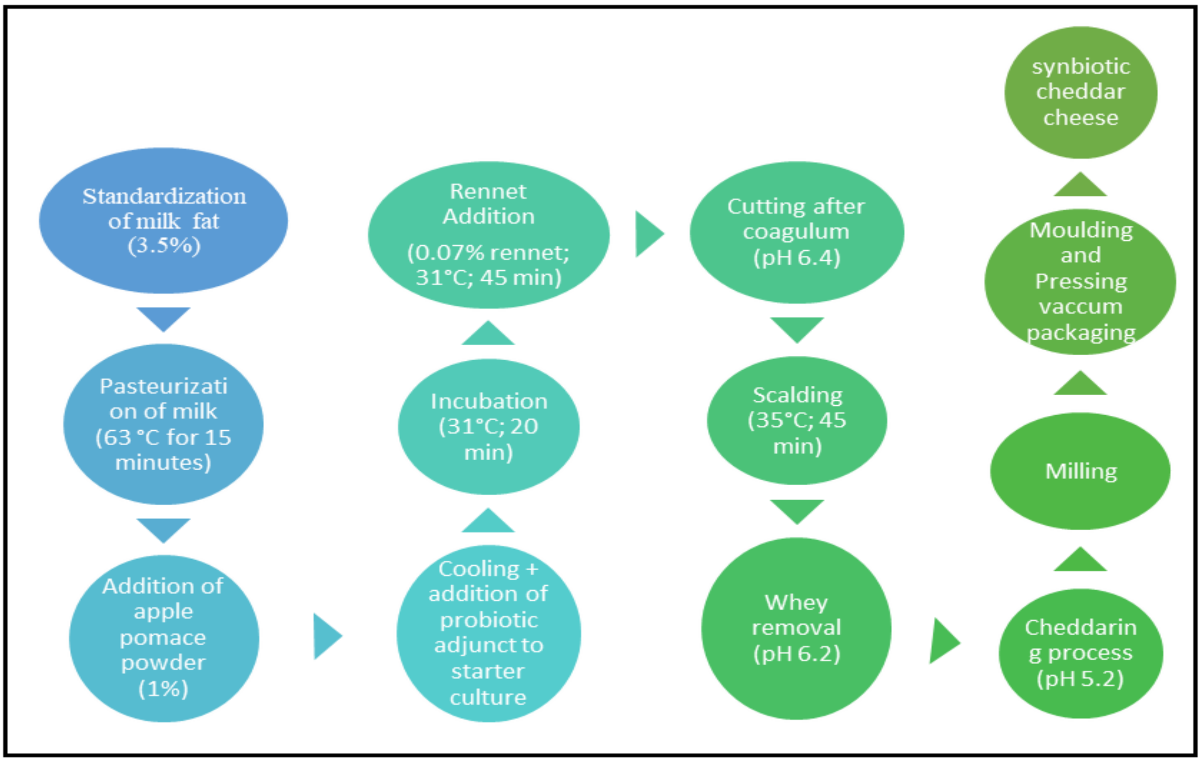

Fig. 1. Preparation of synbiotic cheddar cheese.

There was a significant decrease in total protein with storage time in all the treatments. Fresh SCC cheese sample contained the highest protein content (32.07 ± 0.005) while, the minimum value (31.76 ± 0.004) was observed in control sample on 28th day (Table 6). Fat and protein have a direct relationship, higher the protein content higher the fat content in the milk. That decrease in change is due to some reaction are routinely taken place inside the cheese matrix (Dave *et al.*,2004).The initial breakdown of the casein is one of the factors contributing to quality of cheese during storage (Amarita *et al.*, 2006).

Conclusion

Synbiotic cheddar cheese storage strongly affected the physiochemical parameters. The highest pH value (5.25 ± 0.004) was recorded in fresh samples of SCC while the minimum value (5.17 ± 0.002) was noted in SCA on 28th day of study that showed reduction in pH value of cheese during storage period. In contrary to pH the acidity increased and highest value of acidity (0.95 ± 0.004) was recorded in SCA on the 28th day of storage and the minimum value (0.87 ± 0.003) was noted on day 0 in SCC. There was a decreasing trend noticed during storage and among all the samples, the highest moisture content (37.50 ± 0.010) was observed in SCA on day 0 whereas, the lowest moisture content (36.07 ± 0.004) was calculated in SCC on 28th Day of storage. The maximum level of fat (30.29 ± 0.005) was observed in the fresh SCA samples while the minimum content (30.19 ± 0.005) was computed in control sample on the 28th day of storage. Likewise there was a significant decrease in total protein with storage time in all the treatments.

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