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Changes in Nutritional Behavior of Ladakhi *Churpe* Supplemented with Apricot and Spinach during Storage

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ABSTRACT

Dried dairy products *viz. churpe*-balls and *churpe*-strips were developed with the incorporation of apricot powder into fresh cottage cheese at different levels (05, 10, 15 and 20%) and spinach powder at levels (03, 06, 09 and 12%), respectively. Nutritional attributes of the products were studied during the investigation. The addition of apricot powder in *churpe*-balls resulted in significant ($P < 0.05$) increase in moisture, ash, hydrosoluble vitamins (thiamine, riboflavin and ascorbic acid) and decrease in protein, lactose and fat contents. Similar trend was also observed due to incorporation of spinach powder in *churpe*-strips. Storage studies done for 120 days reveal that except moisture, there were losses of all the nutrients in both products with the advancement of storage. Except lactose in *churpe*-balls, all the interaction effects of supplementation and storage were found to be statistically significant.

HIGHLIGHTS

- The apricot and spinach powders are rich source of hydrosoluble vitamins (thiamine, riboflavin and ascorbic acid) and ash (minerals).
- Their incorporation led to the development of healthy products due to lower contents of lactose and sugar.

Keywords: *Churpe*, apricot, spinach, *churpe*-balls, *churpe*-strips, storage

In Ladakh, *churpe* is generally prepared during summer when the milk production is surplus, for consumption during harsh winter season when the region got cut off from outside world due to heavy snowfall. The purpose of drying cheese i.e. *churpe* is mainly to increase the storability which is not possible in the fresh products. Local people consume it by cooking with *thukpa*, a thick soup and also moistened it in mouth and masticate to get its health benefits as well as to enjoy its characteristic flavor. Its flour is mixed with *kholaq* and *chasrul* and is also an important ingredient of *thut*, a sweet. Therefore, *churpe* is not only a food product but also an integral part of Ladakhis. Like other dairy products, *churpe* is also considered as a nutrient capsule containing quality proteins, vitamins and minerals. The probiotic properties of indigenous microorganisms isolated from the cheese-like product *churpe* have been reported (Tamang *et al*., 2012). Probiotic milk products can have health-promoting benefits such as modulation of the immune system, maintenance of gut flora, regulation of bowel habits, alleviation of constipation, and curing of gastrointestinal infections (Tamang, 2010). Yeast, mold, LAB, and *Bifidobacterium* sp. not play an important role in *churpe* preparation but their synergistic actions convert the milk sugar into beneficial compounds, such as vitamins, lactic acid, etc. (Panda *et al*., 2016). However, it lacks polyphenols like fruits and vegetables which play important role as antioxidants in the human body.

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Fruits and vegetables are good sources of nutrients as well as health promoting agents. Apricot is a carbohydrate-rich stone fruit and is a good source of fibers, minerals and vitamins. The major minerals are potassium, calcium, phosphorus, magnesium, iron and selenium (Ali *et al*., 2011) and vitamins are Vitamin A, C, K, E, B_1, B_2, B_3, B_6 and B_9 (Fatima *et al*., 2018). Soluble fiber lowers blood cholesterol, maintains blood sugar level, prevents constipation and helps in reducing body weight. It is also rich in bioactive phyto-chemicals that have certain roles in the biological system and effective in preventing oxidative stresses (Leccese *et al*., 2011). The polyphenols and carotenoids because of antioxidant properties have possible ability to alleviate chronic diseases such as cancer and cardiovascular diseases (Fatima *et al*., 2018). Spinach is an extremely nutritious vegetable, rich both in core nutrients and phyto-chemicals. The major micronutrients in spinach are Vitamin A (from β-carotene), C, K and folate (El-Sayed, 2020) and the minerals, calcium, iron and potassium (Narsing Rao *et al*., 2017). It also provides fiber and is low in calories. Apart from having nutritional value, it has been also credited with various biological activities. Spinach is known for antimicrobial, anti-carcinogenic and antioxidant activity (Vazquez *et al*., 2013). Anti-aging properties associated with spinach leaves with considerable amount of β-carotene (2-6 mg/100 g), folic acid (120 mg/100g) and riboflavin (0.25 mg/100 g) make this leaf a unique food material (Anon, 2011). Apart from the benefits, spinach powder may be used as replacer of artificial food colour as demand for natural pigments is increasing in present era.

It has been reported that fortification of food products using natural resources like fruits, vegetables, herbal extracts, cereals, nuts, seeds, etc. is necessary to improve nutrient intake (Granato *et al*., 2017). To the best of our knowledge, addition of apricot and spinach powders to dried cheese, *churpe* has not been studied yet. Therefore, the aim of this study was to produce novel *churpe* products with apricot and spinach supplementation. The effect of additives on the nutritional attributes of *churpe* was investigated. Cheese snacks as cheese balls and chips are very popular worldwide (Rakcejeva *et al*., 2009). The value added products developed were apricot added *churpe*-balls and spinach added *churpe*-strips. These products can be used to solve the problem of nutrient deficiency among this tribal population of Ladakh.

MATERIAL AND METHODS

Materials

The raw buttermilk produced from cow milk was procured from the herders of Nyoma and Nidder villages of Changthang region, Leh Ladakh. Dried apricots without stone were procured from the local market of Leh. Fresh spinach leaves (moisture content 94.8%) were obtained from Vegetable Farm, Krishi Vigyan Kendra, Nyoma (Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir).

Drying of spinach

The destalked spinach leaves were washed with tap water. Before drying, the leaves were blanched for 15 seconds at 98°C with a spinach-water ratio of 1:4 with slight modification of blanching time as recommended by Sharma *et al*. (2011). The blanched leaves were then shade dried.

Preparation of products

Dried spinach and dried apricot were converted into powder in a food processor (HR-7629, Philips, China). A sieve with 750 µm pore size was used to sieve the powders. The buttermilk was boiled for 10 min at 70 °C and the coagulum so obtained was subjected to cooling. The holding time in whey was about 5 minutes. The solid mass (cottage cheese) was separated from the whey by straining through a cheese cloth. It is then incorporated with the additives, apricot powder for balls and spinach powder for strips. Blends were prepared by replacing the mass with apricot powder at 5%, 10%, 15% and 20% with 10% ground sugar for balls. For strips, the mass was replaced with spinach powder at 3%, 6%, 9% and 12%. The mixture was then kneaded. Balls were made by rolling the mass between the palms. Strips were made by pressing the mass between the palm and fingers. The products so obtained were dried in a solar *churpe* dryer. After drying, the products were stored in cotton bags at an average temperature of 18 °C and relative humidity of 30 %. The *churpe* without any addition were taken as a control in this study.

Proximate composition

Analysis of moisture, protein, fat, and ash contents of the samples were performed according to the method described by the Association of Official Analytical Chemists (1990).

Lactose

Titrimetric method as described by Adolf Lutz Institute (2005) using Fehling licor (solution containing cupric ions in alkaline medium) was applied to measure lactose in the products. A solution of each product was made using 50 g dissolved in 2 ml acetic acid (2% v/v) and distilled water. The mixture was heated for 5 minutes at 80 °C. After this, the samples were transferred to volumetric flask of 200 ml and volume was completed with distilled water. After filtration, the solutions were used to react with 20 ml of standard Fehling licor.

Hydrosoluble vitamins

The protocol given by Ghosh *et al*. (2015) was followed for the quantification of hydrosoluble vitamins. These vitamins were analyzed by reverse phase-HPLC using an Agilent HPLC system (Agilent Technology) equipped with a Zorbax SB-C18 column and the mobile phase was 0.05M KH_2PO_4 (pH 2.5) and acetonitrile (A). The solvent gradient was as follows: at 0 minutes 0.6% A, at 0.5 minutes 0.6% A, at 4 minutes 6% A, at 12 minutes 0.6% A, at 17 minutes 0.6% A, and the stop time was 20 minutes. The temperature was kept at 15 °C and a constant flow rate of 1 mL/min was maintained. The effluent from the column was monitored by variable wavelength UV detector (204 nm).

Storage studies

The developed products were packed in cotton bags and stored for a period of 120 days at ambient temperature (25 ± 2 ºC). The stored products were analyzed for various nutritional properties at an interval of 30 days following the standard procedures.

Statistical analysis

Results of determinations reported in this study constitute a mean from three replications. For the purpose of objectivity of inference, the recorded results were subjected to statistical analysis. For the determination of significance of differences between means, analysis of variance (ANOVA) was conducted using the OP-Stat software (Version 1.0). Dependencies were considered statistically significant at the level of significance $P < 0.05$.

RESULTS AND DISCUSSION

Moisture content

Incorporation of apricot and spinach powders affected the moisture content of value added products significantly ($P < 0.05$) (Table 1). The average moisture content of the control was 08.02%. The average moisture content of the apricot supplemented (05% to 20%) *churpe*-balls increased significantly from 08.07% to 09.37% whereas that of the spinach supplemented (03% to 12%) *churpe*-strips also increased from 08.09% to 08.69%. This trend might be due to the higher hygroscopic nature of the additives. While upon the storage period of 120 days, the mean moisture content also increased from 07.42% to 09.87% in balls and from 07.49% to 09.13% in strips. With the passage of time, the increase in uptake of moisture from the environment is attributed to the hygroscopic nature of the products because of the substantial amounts of proteins and sugars (lactose). Other research workers also reported increase in moisture content during storage of dudh churpe, whey protein concentrate and dried cheddar cheese snack (Hossain *et al*., 2001; Rathour *et al*., 2017; Rakcejeva *et al*., 2009). The interaction effect of treatments over storage of both products was found to be highly significant.

Crude protein

Table 2 shows that the crude protein of the value added products decreased with the increase in the levels of additives. Control products had 34.90% protein content. In case of supplemented products, it ranged from 31.27% to 28.25% in balls and 34.46% to 32.71% in strips. These results indicated that addition of apricot and spinach adversely affected the protein content of the supplemented products. The decrease in the protein content of the value added products might be the result of the appreciably lower protein contents of the supplements. Mohamed and Shalaby

Table 1: Effect of supplementation and storage on moisture content (%) of value-added *churpe* products (balls and strips)

Supplementation level (%)	Storage period (days)					
	0	**30**	**60**	**90**	**120**	**Mean**
Control (Cottage cheese)	07.43 ± 0.10	07.59 ± 0.09	08.12 ± 0.11	08.39 ± 0.09	08.58 ± 0.07	08.02 ± 0.09
CC:AP:GS						
90:00:10	07.31 ± 0.16	07.54 ± 0.17	08.48 ± 0.12	08.50 ± 0.05	08.53 ± 0.16	08.07 ± 0.13
85:05:10	07. 42 ± 0.03	07.67 ± 0.21	08.54 ± 0.09	08.71 ± 0.06	09.19 ± 0.11	08.52 ± 0.10
80:10:10	07.43 ± 0.12	07.92 ± 0.24	09.14 ± 0.19	09.53 ± 0.12	09.91 ± 0.02	08.78 ± 0.13
75:15:10	07.48 ± 0.26	08.02 ± 0.16	09.54 ± 0.16	10.52 ± 0.12	10.78 ± 0.05	09.26 ± 0.15
70:20:10	07.46 ± 0.17	08.56 ± 0.06	09.78 ± 0.16	10.09 ± 0.09	10.96 ± 0.13	09.37 ± 0.12
Mean	07.42 ± 0.14	07.94 ± 0.16	09.09 ± 0.14	09.47 ± 0.08	09.87 ± 0.09	08.80 ± 0.12
CD ($P \leq 0.05$)	Supplementation = 0.09		Storage = 0.09		Supplementation × Storage = 0.22	
CC:SP						
97:03	07.48 ± 0.06	07.64 ± 0.14	08.22 ± 0.06	08.46 ± 0.13	08.69 ± 0.03	08.09 ± 0.08
94:06	07.50 ± 0.25	07.87 ± 0.20	08.53 ± 0.05	08.71 ± 0.03	08.83 ± 0.19	08.28 ± 0.14
91:09	07.50 ± 0.15	08.03 ± 0.13	08.67 ± 0.07	09.13 ± 0.13	09.45 ± 0.10	08.55 ± 0.11
88:12	07.51 ± 0.09	08.30 ± 0.26	08.80 ± 0.07	09.27 ± 0.10	09.58 ± 0.10	08.69 ± 0.12
Mean	07.49 ± 0.13	07.96 ± 0.18	08.55 ± 0.06	08.89 ± 0.09	09.13 ± 0.10	08.40 ± 0.11
CD ($P \leq 0.05$)	Supplementation = 0.09		Storage = 0.09		Supplementation × Storage = 0.20	

CC = Cottage cheese, AP = Apricot Powder, GS = Ground sugar, SP = Spinach powder; Values are means ± SD of three independent determinations.

Table 2: Effect of supplementation and storage on protein content (%) of value-added *churpe* products (balls and strips)

Supplementation level (%)	Storage period (days)					
	0	**30**	**60**	**90**	**120**	**Mean**
Control (Cottage cheese)	36.16 ± 0.14	35.05 ± 0.05	33.86 ± 0.06	33.42 ± 0.08	33.03 ± 0.08	34.90 ± 0.08
CC:AP:GS						
90:00:10	34.02 ± 0.19	32.71 ± 0.12	32.49 ± 0.04	31.67 ± 0.18	31.03 ± 0.14	32.38 ± 0.13
85:05:10	32.97 ± 0.10	31.45 ± 0.18	31.21 ± 0.17	30.57 ± 0.10	30.18 ± 0.12	31.27 ± 0.13
80:10:10	31.73 ± 0.15	30.38 ± 0.11	30.12 ± 0.07	29.56 ± 0.16	29.34 ± 0.17	30.22 ± 0.13
75:15:10	29.56 ± 0.06	29.22 ± 0.09	28.83 ± 0.15	28.33 ± 0.06	28.17 ± 0.14	28.82 ± 0.10
70:20:10	28.73 ± 0.12	28.69 ± 0.16	28.51 ± 0.17	28.19 ± 0.15	27.15 ± 0.08	28.25 ± 0.13
Mean	31.40 ± 0.12	30.49 ± 0.13	30.23 ± 0.12	29.66 ± 0.13	29.17 ± 0.13	30.19 ± 0.12
CD ($P < 0.05$)	Supplementation = 0.09		Storage = 0.08		Supplementation × Storage = 0.20	
CC:SP						
97:03	36.04 ± 0.06	34.45 ± 0.13	34.13 ± 0.08	34.00 ± 0.03	33.72 ± 0.15	34.46 ± 0.09
94:06	35.53 ± 0.08	34.24 ± 0.04	34.01 ± 0.16	33.71 ± 0.18	32.34 ± 0.11	33.96 ± 0.11
91:09	35.71 ± 0.18	34.08 ± 0.16	33.55 ± 0.18	32.39 ± 0.04	31.53 ± 0.06	33.45 ± 0.12
88:12	34.09 ± 0.07	33.65 ± 0.10	32.59 ± 0.09	31.77 ± 0.13	31.49 ± 0.08	32.71 ± 0.09
Mean	35.34 ± 0.09	34.10 ± 0.10	33.57 ± 0.12	32.96 ± 0.09	32.27 ± 0.10	33.65 ± 0.10
CD ($P < 0.05$)	Supplementation = 0.08		Storage = 0.08		Supplementation × Storage = 0.18	
CD ($P < 0.05$) of all treatments						

CC = Cottage cheese, AP = Apricot Powder, GS = Ground sugar, SP = Spinach powder.

(2016) and Awad *et al*. (2003) observed decrease in protein content in cheese analogue supplemented with apricot pulp and cheese made with guava, mango and banana pulps. Storage was found to have noteworthy (P < 0.05) effect on the protein content of the products. The mean protein of *churpe*-balls and *churpe*-strips at the beginning of storage was 31.40% and 35.34% which decreased significantly to 29.17% and 32.27%, respectively, as the storage period approaches 120 days (4 months). The decline in protein might be due to proteolysis of the samples during storage and is believed to be due to the survival of native as well as bacterial proteases (Lindquist, 1970). Li-Chan (1983) observed that whey protein concentrate (WPC) powder having 35% protein stored at 37°C and after 42 days of storage, protein content was decreased. Similarly Rathour *et al*. (2017) reported decrease in total protein content of whey protein concentrate (WPC-70) stored at different temperature for 18 months. The treatment and storage interaction was found to be significant at 5% level of significance.

Lactose

The results presented in Table 3, shows a significant (P < 0.05) decrease in lactose content of the value added products due to supplementation. Among the incorporated products, the highest mean lactose content of 38.94% was found in *churpe*-balls with 05% apricot followed by 37.18%, 34.51% and 32.39% in balls with 10%, 15% and 20% incorporations, respectively. The highest mean lactose content of 41.15% was found in balls with 03% spinach followed by 40.60%, 40.15% and 40.09% in strips with 06%, 09% and 12% incorporations, respectively. The decreasing trend might be due to the addition of apricot and spinach which are devoid of lactose sugar. Storage also resulted in decrease in lactose content of the products. It decreased from 39.43% to 36.67% in *churpe*-balls and 41.14% to 38.70% in *churpe*-strips during a storage period of 120 days. The decline in lactose content is attributed to the hydrolysis of lactose into lactic acid and alcohol in presence of microbes. Decrease in lactose during storage was also reported by Coulter *et al*. (1948) in dried whole milk and Iqbal *et al*. (2016) in breast milk. The supplementation versus storage was differing significantly at 5% level of significance in case of *churpe*-strips and a non significant interaction effect was found between the two in case of *churpe*-balls.

Table 3: Effect of supplementation and storage on lactose content (%) of value-added *churpe* products (balls and strips)

Supplementation level (%)	Storage period (days)					
	0	30	60	90	120	Mean
Control (Cottage cheese)	42.29 ± 0.29	41.63 ± 0.18	41.32 ± 0.07	40.14 ± 0.18	39.61 ± 0.29	40.99 ± 0.20
CC:AP:GS						
90:00:10	42.06 ± 0.16	40.27 ± 0.13	39.85 ± 0.32	39.12 ± 0.19	38.26 ± 0.04	39.71 ± 0.16
85:05:10	40.64 ± 0.11	39.31 ± 0.36	39.13 ± 0.06	38.51 ± 0.35	38.13 ± 0.06	38.94 ± 0.18
80:10:10	39.76 ± 0.08	37.68 ± 0.15	37.46 ± 0.15	36.76 ± 0.08	36.28 ± 0.17	37.18 ± 0.12
75:15:10	38.04 ± 0.14	35.04 ± 0.11	35.01 ± 0.17	33.86 ± 0.26	33.63 ± 0.23	34.51 ± 0.18
70:20:10	36.45 ± 0.25	32.12 ± 0.16	32.76 ± 0.11	32.53 ± 0.23	32.09 ± 0.16	32.39 ± 0.18
Mean	39.43 ± 0.14	36.88 ± 0.18	36.84 ± 0.16	36.15 ± 0.22	36.67 ± 0.13	36.55 ± 0.16
CD (P < 0.05)	Supplementation = 1.66		Storage = 1.52		Supplementation × Storage = NS	
CC:SP						
97:03	42.13 ± 0.21	41.67 ± 0.21	41.13 ± 0.08	41.10 ± 0.07	39.74 ± 0.03	41.15 ± 0.12
94:06	41.33 ± 0.06	40.92 ± 0.23	40.48 ± 0.19	40.23 ± 0.19	40.05 ± 0.19	40.60 ± 0.17
91:09	40.82 ± 0.14	40.41 ± 0.16	49.57 ± 0.09	37.56 ± 0.24	37.43 ± 0.11	40.15 ± 0.14
88:12	40.29 ± 0.29	39.63 ± 0.18	49.32 ± 0.07	38.14 ± 0.18	37.61 ± 0.29	40.09 ± 0.20
Mean	41.14 ± 0.17	40.65 ± 0.19	45.12 ± 0.11	39.25 ± 0.17	38.70 ± 0.15	40.97 ± 0.16
CD (P < 0.05)	Supplementation = 0.13		Storage = 0.13		Supplementation × Storage = 0.30	
CD (P < 0.05) of all treatments						

CC = Cottage cheese, AP = Apricot Powder, GS = Ground sugar, SP = Spinach powder.

Fat

Incorporation of additives i.e. apricot (up to 20%) and spinach powder (up to 12%) resulted in decrement in the fat content of *churpe*-balls and *churpe*-strips, respectively and the findings are depicted in Table 4. The fat content decreased from 06.43% to 04.36% in balls and 06.43% to 05.45% in strips. The reason behind the trend might be due to the low fat contents of apricot and spinach. Roy *et al*. (2015) also reported significant decrease in fat content of value added yogurts prepared from blends of fresh yogurt and fruit pulp. Addition of spinach powder to UF-soft cheese resulted in decrease in fat content (El-Sayed, 2020). The same trend was also observed during the storage of the value added products. The fat content ranged between 06.21% and 04.31% in balls and ranged between 06.97% and 04.50% in strips. The declining trend might be due to lipolysis of fat because of the activity of lipolytic bacteria which produce the lipase enzyme. Lipase breaks down the fat into fatty acids and glycerol. This outcome is well supported with the observations of Iqbal *et al*. (2016) in breast milk. The findings are also in accordance with that of Batool *et al*. (2018) in cow and buffalo cheddar cheese during 120 days of ripening.

Ash

Table 5 delineates the effect of incorporation on the ash content of the products. Incorporation of apricot and spinach resulted into the gain of the ash content of the products developed. Roy *et al*. (2015) also reported significant ($P < 0.05$) increase in ash contents of yogurt added with banana pulp and El-Sayed (2020) observed same results upon addition of spinach powder to UF-soft cheese. Fruits and vegetables are considered as rich sources of minerals (ash) which might be the reason behind the enhancement of ash content of the products due to supplementation. The ash content was found to decrease during storage in all the treatments. *Churpe*-balls with 20% apricot supplementation had the highest value of 08.17% and that of others ranged from 06.81% to 07.13% after 120 days of storage. Similarly, the *churpe*-strips with 09% spinach supplementation had highest value of 07.31% and that of others ranged from 04.90% to 06.82% after storage of 120 days. Some other studies have also shown increasing storage period decreased ash content of baked products as that reported by Shalini and Sudesh (2005) and Nwabueze and Atuonwu (2007) while assessing nutritional evaluation of wheat biscuits

Table 4: Effect of supplementation and storage on fat content (%) of value-added *churpe* products (balls and strips)

Supplementation level (%)	Storage period (days)					
	0	30	60	90	120	Mean
Control (Cottage cheese)	07.65 ± 0.16	07.32 ± 0.15	06.27 ± 0.16	05.99 ± 0.20	04.92 ± 0.16	06.43 ± 0.16
CC:AP:GS						
90:00:10	07.47 ± 0.11	07.03 ± 0.11	06.14 ± 0.23	05.73 ± 0.10	04.84 ± 0.06	06.24 ± 0.12
85:05:10	07.33 ± 0.15	06.75 ± 0.21	06.13 ± 0.17	05.62 ± 0.09	04.58 ± 0.13	06.08 ± 0.15
80:10:10	06.42 ± 0.06	06.35 ± 0.15	06.09 ± 0.06	04.16 ± 0.18	04.10 ± 0.08	05.42 ± 0.10
75:15:10	05.12 ± 0.21	05.05 ± 0.06	04.78 ± 0.03	04.12 ± 0.06	04.04 ± 0.19	04.62 ± 0.11
70:20:10	04.75 ± 0.19	04.63 ± 0.16	04.41 ± 0.16	04.02 ± 0.16	04.02 ± 0.06	04.36 ± 0.14
Mean	06.21 ± 0.14	05.96 ± 0.13	05.51 ± 0.13	04.73 ± 0.11	04.31 ± 0.10	05.34 ± 0.12
CD (P < 0.05)	Supplementation = 0.09		Storage = 0.10		Supplementation × Storage = 0.23	
CC:SP						
97:03	07.51 ± 0.39	07.24 ± 0.27	06.22 ± 0.21	05.64 ± 0.05	04.79 ± 0.04	06.28 ± 0.19
94:06	07.17 ± 0.03	06.80 ± 0.03	06.01 ± 0.19	05.12 ± 0.13	04.56 ± 0.06	05.93 ± 0.08
91:09	06.89 ± 0.18	06.53 ± 0.10	05.73 ± 0.09	04.90 ± 0.10	04.34 ± 0.27	05.67 ± 0.14
88:12	06.33 ± 0.16	06.25 ± 0.07	05.69 ± 0.11	04.66 ± 0.11	04.34 ± 0.12	05.45 ± 0.11
Mean	06.97 ± 0.19	06.70 ± 0.11	05.91 ± 0.15	05.08 ± 0.09	04.50 ± 0.12	05.83 ± 0.19
CD (P < 0.05)	Supplementation = 0.12		Storage = 0.12		Supplementation × Storage = 0.26	
CD (P < 0.05) of all treatments						

CC = Cottage cheese, AP = Apricot Powder, GS = Ground sugar, SP = Spinach powder.

Table 5: Effect of supplementation and storage on ash content (%) of value-added *churpe* products (balls and strips)

Supplementation level (%)	Storage period (days)					
	0	**30**	**60**	**90**	**120**	**Mean**
Control (Cottage cheese)	07.02 ± 0.21	07.01 ± 0.23	06.85 ± 0.19	06.85 ± 0.25	06.81 ± 0.09	06.90 ± 0.19
CC:AP:GS						
90:00:10	07.02 ± 0.10	07.01 ± 0.26	06.85 ± 0.16	06.85 ± 0.14	06.81 ± 0.07	06.90 ± 0.14
85:05:10	07.02 ± 0.06	07.00 ± 0.38	06.82 ± 0.10	06.67 ± 0.08	06.28 ± 0.04	06.75 ± 0.13
80:10:10	07.57 ± 0.08	07.42 ± 0.05	07.37 ± 0.20	07.19 ± 0.11	07.13 ± 0.12	07.33 ± 0.11
75:15:10	08.12 ± 0.17	08.01 ± 0.07	07.73 ± 0.11	07.40 ± 0.21	07.13 ± 0.08	07.67 ± 0.12
70:20:10	09.68 ± 0.04	09.54 ± 0.13	09.36 ± 0.15	08.52 ± 0.04	08.17 ± 0.18	07.05 ± 0.10
Mean	07.88 ± 0.09	07.79 ± 0.17	07.62 ± 0.14	07.32 ± 0.11	07.10 ± 0.09	07.54 ± 0.12
CD (P < 0.05)	Supplementation = 0.11		Storage = 0.10		Supplementation × Storage = 0.25	
CC:SP						
97:03	07.12 ± 0.13	07.09 ± 0.28	07.00 ± 0.18	06.88 ± 0.15	06.82 ± 0.26	04.98 ± 0.20
94:06	07.58 ± 0.27	07.43 ± 0.19	07.16 ± 0.07	06.99 ± 0.06	04.90 ± 0.09	05.21 ± 0.13
91:09	08.69 ± 0.18	08.15 ± 0.18	08.03 ± 0.03	07.62 ± 0.19	07.31 ± 0.03	05.96 ± 0.12
88:12	09.11 ± 0.09	09.00 ± 0.04	08.78 ± 0.09	07.18 ± 0.14	06.61 ± 0.21	06.53 ± 0.11
Mean	08.12 ± 0.16	07.91 ± 0.17	07.74 ± 0.09	07.16 ± 0.13	06.41 ± 0.14	07.47 ± 0.14
CD (P < 0.05)	Supplementation = 0.12		Storage = 0.12		Supplementation × Storage = 0.28	
CD (P < 0.05) of all treatments						

CC = Cottage cheese, AP = Apricot Powder, GS = Ground sugar, SP = Spinach powder.

supplemented fenugreek flour and African bread with fruit seed flour respectively. The interaction effect between treatment and storage was significant.

Thiamin

The addition of apricot and spinach powders and storage period tangibly affected the thiamin content of the dried dairy products (Table 6). Among the value added *churpe*-balls, the mean thiamin content (36.77 µg/g) was found to be higher for balls with 20% apricot supplementation, whereas lowest mean values were obtained for balls with 05% supplementation level (35.81 µg/g). Significant variations were observed in thiamin content of balls with different levels of apricot added. Similarly, the mean thiamin content (37.58 µg/g) was found to be higher for *churpe*-strips with 12% spinach supplementation, whereas lowest mean values were obtained for strips with 03% supplementation level (36.12 µg/g). On comparison between the products, the increase in thiamin content in strips was much higher than in balls, despite the lower incorporation level of the former than that of the latter. Storage also manifested a conspicuous effect on the thiamine content of the products. There was a subsequent decrease in the thiamin content of value added *churpe* with storage. At 0 periods the average thiamin content recorded was 37.08 µg/g in balls and 37.49 µg/g in strips. These values were found to decrease considerably every month with mean values of 34.78 µg/g and 36.49 µg/g respectively, after 4 months of storage. Lavigne *et al*. (1989) reported 10% thiamin loss in goat milk after 3 weeks of storage. Scott and Bishop (1984) also observed loss of thiamin in market milk during storage.

Riboflavin

The data presented in Table 7 reveals, how the incorporation and storage period influenced the riboflavin content of the dried cheese products. Significant variations were noticed in riboflavin content of value added *churpe* products. The balls prepared from 20% apricot powder incorporation had higher values for riboflavin content (106.45 µg/g) followed by product with 15% supplementation (105.82 µg/g) whereas, 05% supplementation level had lowest riboflavin content (104.87 µg/g) among the treatments. *Churpe*-strips prepared from 12% spinach powder incorporation

Table 6: Effect of supplementation and storage on thiamine (μg/g) of value-added *churpe* products (balls and strips)

Supplementation level (%)	Storage period (days)					
	0	**30**	**60**	**90**	**120**	**Mean**
Control (Cottage cheese)	37.02 ± 0.21	37.01 ± 0.23	36.85 ± 0.19	36.85 ± 0.25	36.81 ± 0.09	36.90 ± 0.19
CC:AP:GS						
90:00:10	36.02 ± 0.10	36.01 ± 0.26	35.85 ± 0.26	34.85 ± 0.14	34.21 ± 0.07	35.38 ± 0.14
85:05:10	37.02 ± 0.26	37.00 ± 0.38	36.12 ± 0.10	34.67 ± 0.08	34.28 ± 0.04	35.81 ± 0.13
80:10:10	37.12 ± 0.17	37.01 ± 0.07	36.33 ± 0.11	35.20 ± 0.21	35.13 ± 0.08	36.15 ± 0.12
75:15:10	37.57 ± 0.28	37.42 ± 0.05	36.67 ± 0.20	36.19 ± 0.11	35.13 ± 0.12	36.59 ± 0.11
70:20:10	37.68 ± 0.04	37.54 ± 0.13	36.96 ± 0.15	36.52 ± 0.04	35.17 ± 0.18	36.77 ± 0.10
Mean	37.08 ± 0.09	36.99 ± 0.17	36.38 ± 0.14	35.48 ± 0.11	34.78 ± 0.09	36.14 ± 0.12
CD (P < 0.05)	Supplementation = 0.11		Storage = 0.12		Supplementation × Storage = 0.28	
CC:SP						
97:03	37.00 ± 0.13	36.79 ± 0.28	36.43 ± 0.18	36.28 ± 0.15	36.12 ± 0.26	36.52 ± 0.20
94:06	37.38 ± 0.27	36.93 ± 0.19	36.50 ± 0.07	36.37 ± 0.06	36.20 ± 0.09	36.67 ± 0.13
91:09	37.69 ± 0.18	37.55 ± 0.18	37.43 ± 0.33	36.38 ± 0.19	36.30 ± 0.03	37.07 ± 0.12
88:12	37.91 ± 0.09	37.70 ± 0.04	37.58 ± 0.09	37.38 ± 0.24	37.35 ± 0.21	37.58 ± 0.11
Mean	37.49 ± 0.16	37.24 ± 0.17	36.98 ± 0.09	36.60 ± 0.13	36.49 ± 0.14	36.96 ± 0.14
CD (P < 0.05)	Supplementation = 0.13		Storage = 0.13		Supplementation × Storage = 0.30	
CD (P < 0.05) of all treatments						

CC = Cottage cheese, AP = Apricot Powder, GS = Ground sugar, SP = Spinach powder.

Table 7: Effect of supplementation and storage on riboflavin content (μg/g) of value-added *churpe* products (balls and strips)

Supplementation level (%)	Storage period (days)					
	0	**30**	**60**	**90**	**120**	**Mean**
Control (Cottage cheese)	106.16 ± 0.14	105.05 ± 0.05	103.86 ± 0.06	103.42 ± 0.08	103.03 ± 0.08	104.30 ± 0.08
CC:AP:GS						
90:00:10	105.02 ± 0.19	104.71 ± 0.12	103.49 ± 0.04	103.27 ± 0.18	103.03 ± 0.14	103.90 ± 0.13
85:05:10	105.97 ± 0.10	105.45 ± 0.18	104.21 ± 0.17	104.57 ± 0.10	104.18 ± 0.12	104.87 ± 0.13
80:10:10	106.13 ± 0.15	105.38 ± 0.11	105.12 ± 0.07	104.56 ± 0.16	104.34 ± 0.17	105.10 ± 0.13
75:15:10	106.56 ± 0.06	106.22 ± 0.09	105.83 ± 0.15	105.33 ± 0.06	105.17 ± 0.14	105.82 ± 0.10
70:20:10	106.73 ± 0.12	106.69 ± 0.16	106.51 ± 0.17	106.19 ± 0.15	106.15 ± 0.08	106.45 ± 0.13
Mean	106.08 ± 0.12	105.69 ± 0.13	105.03 ± 0.12	104.78 ± 0.13	104.57 ± 0.13	105.23 ± 0.12
CD (P < 0.05)	Supplementation = 0.08		Storage = 0.09		Supplementation × Storage = 0.20	
CC:SP						
97:03	106.04 ± 0.06	105.45 ± 0.13	104.13 ± 0.08	104.00 ± 0.03	103.72 ± 0.15	104.66 ± 0.09
94:06	106.53 ± 0.08	106.24 ± 0.04	106.01 ± 0.16	105.71 ± 0.18	104.34 ± 0.11	105.76 ± 0.11
91:09	106.71 ± 0.18	106.58 ± 0.55	105.16 ± 0.18	104.39 ± 0.04	104.03 ± 0.06	105.37 ± 0.12
88:12	106.95 ± 0.07	106.59 ± 0.10	105.09 ± 0.09	104.77 ± 0.13	104.49 ± 0.08	105.57 ± 0.09
Mean	106.55 ± 0.09	106.21 ± 0.10	105.09 ± 0.12	104.71 ± 0.09	104.14 ± 0.10	105.34 ± 0.10
CD (P < 0.05)	Supplementation = 0.11		Storage = 0.11		Supplementation × Storage = 0.25	
CD (P < 0.05) of all treatments						

CC = Cottage cheese, AP = Apricot Powder, GS = Ground sugar, SP = Spinach powder.

Table 8: Effect of supplementation and storage on ascorbic acid content (µg/g) of value-added *churpe* products (balls and strips)

Supplementation level (%)	Storage period (days)					
	0	**30**	**60**	**90**	**120**	**Mean**
Control (Cottage cheese)	10.43 ± 0.10	10.19 ± 0.09	09.02 ± 0.11	07.39 ± 0.09	06.18 ± 0.07	08.64 ± 0.09
CC:AP:GS						
90:00:10	10.31 ± 0.16	09.04 ± 0.17	08.08 ± 0.12	06.00 ± 0.05	05.53 ± 0.16	07.79 ± 0.13
85:05:10	10.42 ± 0.03	09.27 ± 0.21	08.24 ± 0.09	06.31 ± 0.06	05.69 ± 0.11	07.98 ± 0.10
80:10:10	10.46 ± 0.17	09.76 ± 0.06	08.48 ± 0.16	06.69 ± 0.09	05.96 ± 0.13	08.27 ± 0.12
75:15:10	10.48 ± 0.26	10.02 ± 0.16	07.70 ± 0.16	06.52 ± 0.12	05.18 ± 0.05	07.98 ± 0.15
70:20:10	11.73 ± 0.12	10.52 ± 0.24	08.73 ± 0.19	07.53 ± 0.12	05.41 ± 0.02	08.78 ± 0.13
Mean	10.68 ± 0.14	09.72 ± 0.16	08.24 ± 0.14	06.61 ± 0.08	05.55 ± 0.09	08.16 ± 0.12
CD (P < 0.05)	Supplementation = 0.09		Storage = 0.09		Supplementation × Storage = 0.22	
CC:SP						
97:03	10.48 ± 0.06	09.14 ± 0.14	08.92 ± 0.06	07.46 ± 0.13	06.69 ± 0.03	08.53 ± 0.08
94:06	10.50 ± 0.25	09.27 ± 0.20	08.03 ± 0.05	07.71 ± 0.03	06.13 ± 0.19	08.32 ± 0.14
91:09	11.50 ± 0.15	10.33 ± 0.13	09.67 ± 0.07	07.13 ± 0.13	06.05 ± 0.10	08.93 ± 0.11
88:12	11.71 ± 0.09	09.60 ± 0.26	08.10 ± 0.07	06.87 ± 0.10	06.58 ± 0.10	08.57 ± 0.12
Mean	11.04 ± 0.13	09.58 ± 0.18	08.68 ± 0.06	07.29 ± 0.09	06.36 ± 0.10	08.59 ± 0.11
CD (P < 0.05)	Supplementation = 0.09		Storage = 0.09		Supplementation × Storage = 0.20	
CD (P < 0.05) of all treatments						

CC = Cottage cheese, AP = Apricot Powder, GS = Ground sugar, SP = Spinach powder.

had higher values for riboflavin content (105.57 µg/g) followed by product with 09% supplementation (105.37 µg/g) whereas, 03% supplementation level had lowest riboflavin content (104.66 µg/g) among the treatments. Statistically, significant variation for riboflavin content of products was noticed upto 4 months (120 days) of storage, where the mean values were 106.08 µg/g (0 day) and 104.57 µg/g (120 days) for balls and 106.55 µg/g (0 day) and 104.14 µg/g (120 days). Decrease in riboflavin during storage is also reported by Scott and Bishop (1984) in market milk. According to Chowdhury and Bhattacharyya (2014), riboflavin is very sensitive to oxygen and that could be a reason of its decline during storage. Lavigne *et al*. (1989) reported 10% to 25% riboflavin loss in goat milk after 3 weeks of storage.

Ascorbic acid

Ascorbic acid (Vitamin C) is the water-soluble antioxidant, rendering harmless dangerous free radicals in all water-soluble areas of the human body. A significant (P < 0.05) increase in the ascorbic acid content in the products was observed due to the incorporation of additives, however, the increment in balls was higher as compared to the strips (Table 8). Ascorbic acid increased with the addition of green pea puree in yogurt (Yildiz and Ozcan, 2018). Significant loss in ascorbic acid was observed during storage. The most significant decrease was observed for 20% level of supplementation with lowest decrease for 10% level on 120 days storage, in case of *churpe*-balls. Similarly, most significant decrease was observed for 9% level of supplementation with lowest decrease for 3% level on 120 days storage, in case of *churpe*-strips. A similar pattern of ascorbic acid losses was reported by Sogi and Singh (2001) while studying the shelf life of candy from different varieties of fruits. Scott and Bishop (1984) and Lavigne *et al*. (1989) also observed loss of vitamin C in milk during storage. Degradation of ascorbic depends upon many factors such as oxygen, heat, light, storage temperature and storage time (Rooney, 1995). The ascorbic acid is gradually oxidized during storage (Coulter *et al*., 1948). The interaction effect between the treatment and storage was found to be statistically significant.

CONCLUSION

It may be inferred from the present study that addition of apricot powder and spinach powder increase the vitamins (thiamin, riboflavin and ascorbic acid) and ash (minerals) along with decrease in fat and lactose contents. These are considered as good quality attributes of a healthy food product. Hence, development and utilization of such functional foods will not only improve the nutritional status but also help in controlling the prevailing degenerative diseases of the tribal population of Ladakh.

REFERENCES

Adolf Lutz Institute. 2005. Chemistry and physical methods for food analysis (4th ed.) Sao Paulo, Brazil.

Ali, S., Masud, T. and Abbasi, K.S. 2011. Physico-chemical characteristics of apricot (*Prunus armeniaca* L.) grown in Northern Areas of Pakistan. *Scientia Horti.*, **130**(2): 386-392.

Anon. 2011. National Institute of Nutrition, Low cost Nutritious Supplements. NIN, Hyderabad, India.

AOAC. 1990. Washington, DC, USA: Association of Official Analytical Chemists. Official methods of analysis (15th ed).

Awad, R.A., El-Shabrawy, S.A., Osman, S.G. and Saad, S.A. 2003. Chemical composition of flavoured processed cheese spreads with different fruit flavours. *Egypt J. Dairy Sci.*, **31**: 335-344.

Batool, M., Nadeem, M., Imran, M., Khan, I.T., Bhatti, J. and Ayaz, M. 2018. Lipolysis and antioxidant properties of cow and buffalo cheddar cheese in accelerated ripening. *Lipids in Health Disease*, pp. 1-10.

Chowdhury, S.R. and Bhattacharyya, A.K. 2014. Production, characterization and value addition of dahi made from raw, pasteurized and double pasteurized milk. *Inter. J. Res. Eng. Technol.*, **3**: 602e7.

Coulter, S.T., Jenness, R. and Crowe, L.K. 1948. Some changes in dry whole milk during storage. Minnosota Agriculture Experimental Station. 2146.

El-Sayed, S.M. 2020. Use of spinach powder as functional ingredient in the manufacture of UF-Soft cheese. *Heliyon*, 6 e03278.

Fatima, T., Bashir, O., Gani, G., Bhat, T. and Jan, N. 2018. Nutritional and health benefits of apricots. *Inter. J. Unani Integ. Medicine*, **2**(2): 5-9.

Ghosh, K., Ray, M., Adak, A., Halder, S.K., Das, A., Jana, A., Parua, S., Mohapatra, P.K.D., Pati, B.R. and Mondal, K.C. 2015. Role of probiotic *Lactobacillus fermentum* KKL1 in the preparation of a rice based fermented beverage. *Biores. Technol.*, **188**: 161e8.

Granato, D., Nunes, D.S. and Barba, F.J. 2017. An integrated strategy between food chemistry, biology, nutrition, pharmacology, and statistics in the development of functional foods: a proposal. *Trends Food Sci. Technol.*, **62**: 13-22.

Hossain, S.A., Pal, P.K., Sarkar, P.K. and Patil, G.R. 2001. Extension and prediction of shelf life of *dudh churpi*. *J. Food Sci. Technol.*, **38**(2): 124-128.

Iqbal, M., Lestari, L.A., Kurdanti, W. and Mardiyati, N.L. 2016. Effect of temperature and storage duration on lactose, protein and fat content of breast milk. International Conference on Health and Well-Being (ICHWB).

Lavinge, C., Zee, J.A., Simard, R.E. and Beliveau, B. 1989. Effect of processing and storage conditions on the fate of vitamins B_1, B_2 and C and on the shelf life of goat's milk. *J. Food Sci.,* **54**: 1.

Leccese, A., Bartolini, S. and Viti, R. 2011. The effect of solvent extraction on antioxidant properties of apricot fruit. *Central Euro. J. Biol.*, **6**(2): 199-204.

Li-Chan, E. 1983. Properties and molecular interactions of whey protein concentrate upon storage. *J. Dairy Sci.*, **66**: 1843-1853.

Lindquist, B. 1970. Residual proteolytic activity in UHT milk. In: Proceedings of 18th International Dairy Congress. 1 E, 191.

Mohamed, A.G. and Shalaby, S.M. 2016. Texture, chemical properties and sensory evaluation of a spreadable processed cheese analogue made with apricot pulp (*Prunus armeniaca* L.). *Inter. J. Dairy Sci.*, **11**(2): 61-68.

Narsing Rao, G., Balaswamy, K., Prabhakarara Rao, P.G., Balaswamy, K., Math Rudrayya, G., Satyanarayana, A. 2017. Nutritional, textural and sensory quality of biscuits supplemented with spinach (*Spinacia oleracea* L.). *Inter. J. Gastro. Food Sci.,* 7: 20-26.

Nwabueze, T.U. and Atuonwu, A.C. 2007. Effect of malting African bread fruit (*Treculia african*) seeds on flour properties and biscuits, sensory and quality characteristics as composite. *J. Food Technol.*, **5**(1): 42-48.

Panda, A., Ghosh, K., Ray, M., Nandi, S.K., Parua, S., Bera, D., Singh, S.N., Dwivedi, S.K. and Mondal, K.C. 2016. Ethnic preparation and quality assessment of Chhurpi, a home-made cheese of Ladakh, India. *J. Ethnic Foods*, **3**: 257-262.

Rakcejeva, T., Zagorska, J., Dukalska, L., Galoburda, R. and Eglitis E. 2009. Physical-chemical and sensory characteristics of Cheddar cheese snack produced in vacuum microwave dryer. *Chemine Technologija,* **3**(52).

Rathour, A.K., Rathore, V., Mehta, B.M., Patel, S.M., Chauhan, A. and Aparnathi, K.D. 2017. Standardization and storage study of whey protein concentrate (WPC-70) prepared from buffalo milk using ultrafiltration membrane technology. *J. Food Process. Preser.*, **41**: e12882

Rooney, M.L. 1995. Active food packaging, London, UK: Chapman amp; Hall. Roy, D.K.D., pp. 272.

Roy, D.K.D., Saha, T., Akter, M., Hosain, M., Khatun, H., and Roy, M.C. 2015. Quality Evaluation of yogurt supplemented with fruit pulp (banana, papaya, and water melon). *Inter. J. Nutri. Food Sci.*, **4**(6): 695-699.

Scott, K.J. and Bishop, D.R. 1984. Nutrient content of milk and milk products: vitamins of the B complex and vitamin-C in retail market milk and milk product. *J. Society Dairy Technol.*, **39**: 32.

Shalini., H. and Sudesh, J. 2005. Organoleptic and nutritional evaluation of wheat biscuits supplemented with untreated and treated fenugreek flour. *Food Chem.*, **90**: 427-435.

Sharma, K.D., Stahler, K., Smith, B. and Melton, L. 2011. Antioxidant capacity, polyphenolics and pigments of broccoli-cheese powder blends. *J. Food Sci. Technol.*, **48**(4): 510-514.

Sogi, D.S. and Singh, S. 2001. Studies on bitterness development in Kinnow juice, ready-to-serve, squash, jam and candy. *J. Food Sci. Technol.*, **38**: 433-438.

Tamang, J.P. 2010. Himalayan Fermented Foods: Microbiology. *In:* Nutrition and Ethnic Values, Boca Raton, CRC press. pp. 117-136.

Tamang, J.P., Tamang, N., Thapa, S., Dewan, S., Tamang, B., Yonzan, H., Rai, A.K., Chettri, R., Chakrabarty, J. and Kharel, N. 2012. Microorganisms and nutritional value of ethnic fermented foods and alcoholic beverages of North East India. *Indian J. Trad. Know.,* **11**: 7-25.

Vazquez, E., Garcia-Risco, M., Jaime, L., Reglero, G. and Fornari, T. 2013. *J. Supercritic. Fluids*, **82**: 138-145.

Yildiz, E. and Ozcan, T. 2018. Functional and textural properties of vegetable-fibre enriched yoghurt. *Inter. J. Dairy Technol.*, **70**: 1-9.