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Organoleptic evaluation of Ladakhi *churpe* enriched with apricot and spinach

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Abstract

Dried dairy products viz. churpe-balls and churpe-strips were developed with the incorporation of apricot powder into cottage cheese at different levels (05, 10, 15 and 20%) and spinach powder at levels 03, 06, 09 and 12 percent, respectively. The sensory attributes of the products were studied during the investigation. The appearance of balls first decreased, then increased and again decreased and that of strips first increased and then decreased. The supplementation resulted in significant (P < 0.05) decline in texture of both products. Flavor increased in balls and decreased in strips with the addition of supplements. Overall acceptability first got increased and then decreased with the increase in the level of supplementation of the products. The titratable acidity increased whereas pH decreased in both products upon the incorporation of additives. Storage studies done for 360 days reveal that except texture and titratable acidity, there were losses in all the parameters in both products with the advancement of storage. Except flavor in case of balls and overall acceptability and pH in case of strips, all the interaction effects of supplementation and storage were found to be statistically significant.

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

Churpe is a traditional dried dairy product which is very much popular in Himalayan regions of Nepal, Bhutan, Tibet and India. In India, it is consumed in Sikkim, Assam, Darjeeling, Kalimpong and Ladakh. It is a nutrient capsule for the tribal people of these regions and also has tremendous health benefits. In Ladakh the fresh cheese is shaped into small strips and dried in open sun. However in other regions it is moulded into cuboidal pieces and hung over fire to harden it.

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 is mainly to increase the storability

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which is not possible in the fresh products. Local people consume it either by cooking with *thukpa*, a thick soup or by chewing it in mouth and masticate to get its health benefits as well as to enjoy its characteristic flavour. Its flour is mixed with *kholaq* and *chasrul* and is also an important ingredient of *thut*, a sweet. *Kholaq* is a traditional dish in which the roasted barley flour, *namphey*, is mixed with tea to a consistency, where it does not stick to the hand. It does not require cooking. When *namphey* is added to tea up to a consistency thicker than soup, then it is called as *chasrul*. Therefore, *churpe* is not only a food product but also an integral part of food culture 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*., 2000). 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, lactic acid bacteria (LAB), and Bifidobacterium species do 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. 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).

Apricot is the major fruit crop of Ladakh which is the only source of income to a large section of population (Hussain *et al*., 2012; Hussain *et al*., 2013). Spinach is also one of the major vegetable crops of Ladakh. These crops in their dried form provide nutrients to the nutrient-deficient people during the winter months when the region remains cut off from the outside world due the closure of roads because of heavy snowfall. Therefore, the aim of this study was to produce novel *churpe* products with apricot and spinach supplementation. In the current investigation, the effect of additives on the sensory attributes of *churpe* during storage 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 (Wiley 2004; Attenborough *et al*., 1994; Cvejic *et al*., 1997) among this tribal population of Ladakh.

Materials 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

The method given by Hussain *et al*. (2022) was followed for the preparation of the value added dairy 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. Since

balls were to be eaten as such thus apricot being a fruit was added and strips were first to be cooked in *thukpa* thus spinach was added. Blends were prepared by replacing the mass with apricot powder at 5%, 10%, 15% and 20% with 10% ground sugar for *churpe*-balls. For *churpe*-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 for 3 days. After drying, the products were stored in cotton bags at an average temperature 25 ± 2 ºC and relative humidity of 30 %. The *churpe* strips 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 (AOAC, 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 (balls and strips) 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 obtained were used to react with 20 mL of standard Fehling licor.

Minerals

The determination of calcium, sodium and magnesium was carried out by flame photometry (direct method) as given by Kravic*et al*. (2012) using flame photometer (Systronics, India) in air-butane flame. After the homogenization by mixing, 2.5 g of the sample was transferred to a calibrated flask, 2 cm^3 of 10% solution of lanthanum was added and diluted to a final volume of 50 cm^3 with distilled water, filtered and the resulting solution was used for the analysis.

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 0.05MKH_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 0.6% A, at 12 minutes 0.6% A, at 17 minutes 0.6% A, and the stop timewas 20 minutes. The temperature was kept at 15 °C and a constantflow rate of 1 mL/min was maintained. The effluent from the column was monitored by variable wavelength UV detector (204 nm).

Antioxidant activity

The antioxidant activity was determined by DPPH (1,1, diphenyl-2-picryihydrazyl) scavenging activity using DPPH as a free radical as per the method given by Brand-Williams *et al*. (1995). 100 µl of sample extract solution was added to 1ml of 0.01 percent methanolic solution in a cuvette. The sample was then incubated for 30 minutes at room temperature. The reaction solution was examined at 515 nm using a spectrophotometer. The inhibition percentage of DPPH solution was calculated according to the below equation:

$$\text{Inhibition (\%)} = \frac{(Abs_{t0min} - Abs_{t30min})}{Abs_{t0\ min}} \times 100$$

Where, $Abs_{t0\ min}$ = absorbance of DPPH at initial stage and $Abs_{t30\ min}$ = absorbance of DPPH after 30 minutes of incubation

Titratable acidity

Acidity in dried cheese products was estimated by Titration Method No.920.124 of AOAC (1990). 1 g of each cheese sample was mixed with warm water and volume was made up to 10 mL in 100 mL conical flask; Sample containing flask was shaken vigorously and filtered. The

filtrate was titrated with 0.1 N NaOH using phenolphthalein as indicator. The percent of titratable acidity was calculated according to the following expression:

$$\text{Titratable acidity (\%)} = \frac{0.0090 \times \text{volume of NaOH used} \times 100}{\text{Weight of sample}}$$

pH

The pH of the products was estimated according to the method of Panda *et al*. (2016). The pH of the product (10 g) was determined by homogenizing the sample with sterile distilled water (100 mL) in a ratio of 1:10, followed by shaking for 5 minutes. The pH of the fermented substrate was then measured by a glass probe digital pH meter (Eutech, Singapore).

Storage studies

The developed products were packed in cotton bags and stored for a period of 360 days at ambient temperature (25 ± 2 ºC). The stored products were analyzed for various sensory properties at an interval of 90 days following the standard procedures.

Sensory evaluation

The organoleptic attributes of the value-added dairy samples were assessed by semi-trained panelists comprising of professionals, non-professionals and consumers using the evaluation criteria described by Demirci *et al*. (2017). The panel was asked to evaluate the samples using a 9-point Hedonic scale (1, Very bad; 2, Bad; 3, Imperfect; 4, Sufficient; 5, Mediocre; 6, Satisfactory; 7, Good; 8, Very good; and 9, Excellent) for appearance, flavor, texture, and overall acceptability. The balls were analyzed as such but the strips were soaked in water prior to analysis because the strips are usually consumed after cooking.

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

Nutritional composition

On the basis of organoleptic study, 15% and 9% incorporations of apricot and spinach, respectively, gave best results and were selected for analysis of nutritional composition of value added *churpe* products. The nutritional composition of the *churpe* (control), *churpe*-balls and *churpe*-strips have been shown in Table 1.

The effect storage period of 360 days on *churpe* (control) (Fig.1), *churpe*-balls (Fig. 2) and *churpe*-strips (Fig.3) are discussed below.

Sensory properties

Appearance of the *churpe* added with apricot and spinach powders are given in Table 2. Supplementation shows significant ($P < 0.05$) effect on the appearance of the value-added dairy products. The mean appearance score of the *churpe*-balls first decreased from 7.20 (at 5%) to 7.10 (at 10%), then increased upto 7.60 (at 15%) and then again decreased upto 5.10 (at 20%) with the increase in the level of supplementation of apricot. Appearance also increased in papaya and watermelon added yogurt (Roy *et al*. 2015). The mean appearance score of *churpe*-strips increased with increase in the level of supplement (spinach) from 7.10 (at 3%) to 8.20 (at 6%) followed by decrease upto 6 (at 12%). Sharma *et al*. (2011) observed significant decrease in appearance scores of broccoli-cheese powder blends. Storage studies revealed that the mean appearance scores of balls and strips decreased from 7.70 to 6.10 and 8.0 to 6.40, respectively, after 360 days (12 months). Appearance decreased during storage of fruit-based yogurt (Roy *et al.* 2015) and Whey Protein Concentrate-70 (Rathour *et al*., 2017).

A decreasing trend in texture was shown by both products with the increase in

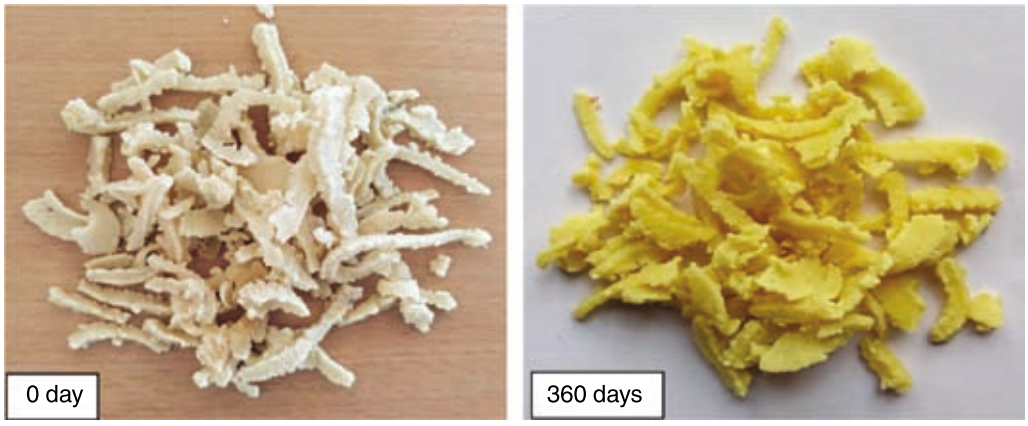

Fig. 1. Effect of storage period on *Churpe* (Control)

Fig. 2. Effect of storage period on *Churpe*-balls

Fig. 3. Effect of storage period on *Churpe*-strips

the levels of the additives as depicted in Table 3. The mean texture score decreased from 6.1 to 5.1 at 5% and 20% apricot incorporations respectively, in case of *churpe*-balls. This might be due to increase in the hardness of the products because of apricot. Mean texture score also decreased from 7.5 to 6.6 at 3% and 12% spinach incorporations, respectively, in case of *churpe*-strips. Similar observations were found by other workers for the changes in texture due to the incorporation of spinach powder (Lucera *et al*., 2018). Loose texture (low firmness) could be due to higher concentration of spinach powder which has fibrous attribute. With the advancement of storage period (360 days), the mean texture scores of balls increased from 5.4 to 6.2 and of strips increased from 7.2 to 7.6.

Table 1. Nutritional composition of *churpe* and value added *churpe* products

Parameters	*Churpe*	*Churpe*-balls	*Churpe*-strips
Moisture (%)	07.43 ± 0.10	07.48 ± 0.26	07.50 ± 0.15
Lactose (%)	42.29 ± 0.29	38.04 ± 0.14	40.82 ± 0.14
Protein (%)	36.16 ± 0.14	29.56 ± 0.06	35.71 ± 0.18
Fat (%)	07.65 ± 0.16	05.12 ± 0.21	06.89 ± 0.18
Ash (%)	07.02 ± 0.21	08.12 ± 0.17	08.69 ± 0.18
Titratable acidity (%)	06.27 ± 0.11	06.67 ± 0.26	06.68 ± 0.19
pH	04.17 ± 0.23	04.12 ± 0.07	04.68 ± 0.18
Thiamine (µg/g)	37.02 ± 0.21	37.57 ± 0.28	37.69 ± 0.18
Riboflavin (µg/g)	106.16 ± 0.14	106.56 ± 0.06	106.71 ± 0.18
Ascorbic acid (µg/g)	10.43 ± 0.10	10.48 ± 0.26	11.50 ± 0.15
Antioxidant activity (%)	37.16 ± 0.13	47.72 ± 0.21	41.28 ± 0.16
Calcium (mg/100g)	616.14 ± 0.21	608.43 ± 0.15	780.52 ± 0.09
Magnesium (mg/100g)	530.66 ± 0.16	460.63 ± 0.10	601.74 ± 0.17
Sodium (mg/100g)	883.47 ± 0.18	689.13 ± 0.03	832.57 ± 0.08

The experiments were carried out thrice and the values are represented as mean ± standard deviation, n = 3.

Table 2. Effect of supplementation and storage on appearance of value-added *churpe* products (balls and strips)

Supplementation level (%)	Storage period (days)					
	0	30	60	90	120	Mean
Control (Cottage cheese)	08.30 ± 0.18	08.00 ± 0.18	07.40 ± 0.28	07.00 ± 0.13	06.50 ± 0.28	07.40 ± 0.21
CC:AP:GS						
90:00:10	08.30 ± 0.15	08.00 ± 0.28	07.40 ± 0.21	07.00 ± 0.27	06.50 ± 0.38	07.40 ± 0.25
85:05:10	07.50 ± 0.15	07.50 ± 0.26	07.40 ± 0.20	07.20 ± 0.37	06.70 ± 0.17	07.20 ± 0.23
80:10:10	08.00 ± 0.27	07.70 ± 0.13	07.30 ± 0.12	06.60 ± 0.32	06.20 ± 0.17	07.10 ± 0.20
75:15:10	08.50 ± 0.22	08.00 ± 0.10	07.70 ± 0.19	07.00 ± 0.30	06.80 ± 0.21	07.60 ± 0.20
70:20:10	06.30 ± 0.15	05.50 ± 0.25	04.90 ± 0.20	04.70 ± 0.25	04.30 ± 0.26	05.10 ± 0.22
Mean	07.70 ± 0.18	07.30 ± 0.20	06.90 ± 0.18	06.50 ± 0.30	06.10 ± 0.23	06.90 ± 0.22
CD (P < 0.05)	Supplementation = 0.15		Storage = 0.16		Supplementation x Storage = 0.37	
CC:SP						
97:03	08.00 ± 0.20	07.70 ± 0.16	07.30 ± 0.14	06.60 ± 0.29	06.20 ± 0.20	07.10 ± 0.19
94:06	08.50 ± 0.31	08.50 ± 0.29	08.40 ± 0.26	08.20 ± 0.17	07.70 ± 0.21	08.20 ± 0.24
91:09	08.50 ± 0.12	08.00 ± 0.31	07.70 ± 0.24	07.00 ± 0.19	06.80 ± 0.28	07.60 ± 0.22
88:12	07.00 ± 0.32	07.00 ± 0.37	06.00 ± 0.17	05.20 ± 0.34	05.00 ± 0.14	06.00 ± 0.26
Mean	08.00 ± 0.23	07.80 ± 0.28	07.30 ± 0.20	06.70 ± 0.24	06.40 ± 0.20	07.20 ± 0.23
CD (P < 0.05)	Supplementation = 0.17		Storage = 0.17		Supplementation x Storage = 0.39	
CD (P < 0.05) of all treatments						

CC = Cottage cheese, AP = Apricot Powder, GS = Ground sugar, SP = Spinach powders, n = 3.

The data presented in Table 4, reveals that the flavour got enhanced in *churpe*-balls and declined in *churpe*-strips with the addition of apricot powder and spinach powder, respectively. Sucrose, γ-decalactone, β-Ionone and citrate are the key flavoring compounds while alcohols are identified as the main volatiles compounds present in apricot that contribute to the consumer acceptance of the balls (Xi *et al*., 2016). The presence of fibre in spinach is responsible for savory-sour taste of the *churpe*-strips. The mean flavor score ranged between 6.9 and 8.2 in *churpe*-balls and the same ranged between 6.4 and 4.8 in *churpe*-strips. Flavour increased in fruit added yogurt with the increase in the levels

Table 3. Effect of supplementation and storage on texture of value-added *churpe* products (balls and strips)

Supplementation level (%)	Storage period (days)					
	0	90	180	270	360	Mean
Control (Cottage cheese)	06.70 ± 0.27	06.80 ± 0.20	06.80 ± 0.18	07.10 ± 0.20	07.30 ± 0.21	06.90 ± 0.21
CC:AP:GS						
90:00:10	06.20 ± 0.32	06.50 ± 0.12	06.80 ± 0.11	07.40 ± 0.21	07.60 ± 0.11	06.90 ± 0.17
85:05:10	05.90 ± 0.21	05.90 ± 0.14	06.00 ± 0.28	06.30 ± 0.24	06.50 ± 0.17	06.10 ± 0.20
80:10:10	05.30 ± 0.35	05.30 ± 0.17	05.60 ± 0.31	05.90 ± 0.28	06.00 ± 0.15	05.60 ± 0.25
75:15:10	05.00 ± 0.18	05.20 ± 0.18	05.30 ± 0.28	05.70 ± 0.18	05.70 ± 0.19	05.30 ± 0.20
70:20:10	05.00 ± 0.25	05.00 ± 0.14	05.00 ± 0.16	05.20 ± 0.15	05.50 ± 0.10	05.10 ± 0.16
Mean	05.40 ± 0.26	05.50 ± 0.15	05.70 ± 0.22	06.10 ± 0.21	06.20 ± 0.14	05.80 ± 0.19
CD (P < 0.05)	Supplementation = 0.15		Storage = NS		Supplementation x Storage = 0.34	
CC:SP						
97:03	07.70 ± 0.14	07.80 ± 0.15	07.80 ± 0.29	07.00 ± 0.13	07.30 ± 0.13	07.50 ± 0.16
94:06	07.20 ± 0.18	07.40 ± 0.23	07.50 ± 0.38	07.60 ± 0.32	07.70 ± 0.10	07.40 ± 0.24
91:09	06.90 ± 0.14	06.90 ± 0.16	07.00 ± 0.17	07.30 ± 0.19	07.50 ± 0.20	07.10 ± 0.19
88:12	06.30 ± 0.23	06.30 ± 0.27	06.60 ± 0.28	06.90 ± 0.39	07.00 ± 0.30	06.60 ± 0.27
Mean	07.20 ± 0.17	07.30 ± 0.20	07.40 ± 0.20	07.40 ± 0.25	07.60 ± 0.18	07.40 ± 0.22
CD (P < 0.05)	Supplementation = 0.16		Storage = 0.16		Supplementation x Storage = 0.38	

CC = Cottage cheese, AP = Apricot Powder, GS = Ground sugar, SP = Spinach powder, n = 3

Table 4. Effect of supplementation and storage on flavour of value-added *churpe* products (balls and strips)

Supplementation level (%)	Storage period (days)					
	0	90	180	270	360	Mean
Control (Cottage cheese)	05.60 ± 0.18	05.20 ± 0.18	05.00 ± 0.28	04.70 ± 0.28	04.50 ± 0.12	05.00 ± 0.20
CC:AP:GS						
90:00:10	07.20 ± 0.28	07.00 ± 0.15	06.80 ± 0.38	06.20 ± 0.21	06.00 ± 0.18	06.60 ± 0.24
85:05:10	07.50 ± 0.13	07.30 ± 0.27	07.20 ± 0.17	06.40 ± 0.12	06.20 ± 0.24	06.90 ± 0.18
80:10:10	08.00 ± 0.10	08.00 ± 0.22	07.80 ± 0.21	07.00 ± 0.19	06.90 ± 0.17	07.50 ± 0.17
75:15:10	08.50 ± 0.26	08.30 ± 0.15	08.30 ± 0.17	07.40 ± 0.20	07.10 ± 0.18	07.90 ± 0.19
70:20:10	08.70 ± 0.25	08.50 ± 0.15	08.30 ± 0.26	07.90 ± 0.20	07.80 ± 0.28	08.20 ± 0.22
Mean	07.90 ± 0.20	07.80 ± 0.18	07.60 ± 0.23	06.90 ± 0.18	06.80 ± 0.21	07.40 ± 0.20
CD (P < 0.05)	Supplementation = 0.14		Storage = 0.15		Supplementation x Storage = NS	
CC:SP						
97:03	07.00 ± 0.16	06.70 ± 0.20	06.40 ± 0.20	06.00 ± 0.14	05.90 ± 0.25	06.40 ± 0.19
94:06	07.20 ± 0.29	06.50 ± 0.31	05.90 ± 0.21	05.70 ± 0.26	05.00 ± 0.24	06.00 ± 0.26
91:09	06.00 ± 0.31	05.60 ± 0.12	05.20 ± 0.28	04.70 ± 0.24	04.30 ± 0.29	05.10 ± 0.24
88:12	05.60 ± 0.37	05.00 ± 0.32	04.80 ± 0.14	04.60 ± 0.17	04.30 ± 0.27	04.80 ± 0.25
Mea n	06.70 ± 0.28	06.20 ± 0.23	05.80 ± 0.20	05.50 ± 0.20	05.10 ± 0.26	05.80 ± 0.23
CD (P < 0.05)	Supplementation = 0.17		Storage = 0.17		Supplementation x Storage = 0.39	

CC = Cottage cheese, AP = Apricot Powder, GS = Ground sugar, SP = Spinach powder, n = 3

of additives (Roy *et al*. 2015).Sharma *et al*. (2011) observed significant decrease in flavour score of broccoli-cheese powder blends. The mean flavour scores declined from 7.9 to 6.8 in case of balls and from 6.7 to 5.1 in case of strips during the storage period of 360 days. Do Boer *et al*. (1977) and Rathour *et al*. (2017) studied the deterioration of flavour of whey protein concentrate during storage. Flavour of spinach added ultra-filtrated-soft cheese

decreased during storage (El-Sayed, 2020). Flavour decreased during storage of fruit-based yogurt (Roy *et al.* 2015). The off flavor in stored product may be due to lipid oxidation and Maillard browning (Ferretti and Flanagan, 1972; Min *et al*. 1990).

The overall acceptability of the *churpe*-balls and *churpe*-strips shows an increasing trend with increase in the level of incorporation (Table 5). The mean overall acceptability score of balls increased from 6.7 to 8.1 and then decreased to 5.8 corresponding to 5%, 15% and 20% levels of incorporations, respectively, while, it got increased from 5.3 to 6.9 and then decreased to 6.3 corresponding to 3%, 9% and 12% levels, respectively, in case of strips. A similar trend was also found by Mohamed and Shalaby, (2016) in apricot-cheese analogue. Feng *et al*. (2019) showed a potential improvement in sensory properties of goat yogurt supplemented with jujube pulp. Overall scores were highly acceptable in low concentration of spinach supplemented soft cheese (El-Sayed, 2020) and biscuits (Narsing *et al*., 2017). The mean overall acceptability scores decreased from 7.5 to 6.1 in balls and from 6.9 to 5.5 in strips after 12 month (360 days). Overall acceptability decreased during storage of fruit-based yogurt (Roy *et al*. 2015). Decrease in sensory scores with the increase in storage period could be explained as a result of interactions of all the physico-chemical parameters. The changes in multiplicity of physico-chemical parameters like contents of moisture, hydroxymethyl furfural (HMF), free fatty acid (FFA) and reflectance governed the sensory scores of the product. Storage temperature and time, relative humidity and gaseous concentration in storage environment are major factors responsible for degradation of the sensory characters (Kaikadi *et al.* 2006). Based on the above results *churpe*-balls and *churpe*-strips containing 15% apricot powder and 09% spinach powder, respectively, were found to be most acceptable by the panelists. However, overall acceptability scores of the all the supplemented products were still in the category of 'like'.

Titratable acidity of *churpe* products are presented in Table 6. The products demonstrated an excellent improvement in it with the rise in the levels of supplements. The mean titratable acidity increased from 6.24% to 6.74% at 5% and 20% levels of apricot

Table 5. Effect of supplementation and storage on overall acceptability of value-added *churpe* products (balls and strips)

Supplementation level (%)	Storage period (days)					
	0	90	180	270	360	Mean
Control (Cottage cheese)	06.30 ± 0.32	06.30 ± 0.13	06.00 ± 0.27	05.90 ± 0.18	05.40 ± 0.27	05.90 ± 0.23
CC:AP:GS						
90:00:10	07.40 ± 0.21	07.20 ± 0.21	06.90 ± 0.29	06.30 ± 0.15	06.00 ± 0.17	06.70 ± 0.20
85:05:10	07.60 ± 0.30	07.10 ± 0.19	06.70 ± 0.21	06.40 ± 0.26	06.10 ± 0.19	06.70 ± 0.23
80:10:10	07.90 ± 0.14	07.70 ± 0.18	07.40 ± 0.16	07.20 ± 0.20	07.20 ± 0.29	07.40 ± 0.19
75:15:10	08.50 ± 0.19	08.50 ± 0.28	08.20 ± 0.20	07.80 ± 0.16	07.60 ± 0.12	08.10 ± 0.19
70:20:10	07.20 ± 0.13	06.00 ± 0.37	05.80 ± 0.18	05.40 ± 0.11	05.00 ± 0.10	05.80 ± 0.17
Mean	07.50 ± 0.19	07.10 ± 0.24	06.80 ± 0.20	06.40 ± 0.17	06.10 ± 0.17	06.80 ± 0.19
CD (P < 0.05)	Supplementation = 0.14		Storage = 0.15		Supplementation x Storage = 0.35	
CC:SP						
97:03	06.10 ± 0.18	05.70 ± 0.30	05.30 ± 0.29	05.10 ± 0.21	04.50 ± 0.33	05.30 ± 0.26
94:06	07.00 ± 0.17	06.60 ± 0.12	06.10 ± 0.24	05.80 ± 0.13	05.50 ± 0.34	06.20 ± 0.20
91:09	07.70 ± 0.23	07.40 ± 0.35	06.90 ± 0.10	06.60 ± 0.14	06.20 ± 0.30	06.90 ± 0.22
88:12	06.90 ± 0.18	06.60 ± 0.29	06.40 ± 0.19	06.00 ± 0.36	06.00 ± 0.29	06.30 ± 0.26
Mean	06.90 ± 0.19	06.50 ± 0.26	06.10 ± 0.20	05.80 ± 0.21	05.50 ± 0.31	06.20 ± 0.23
CD (P < 0.05)	Supplementation = 0.18		Storage = 0.18		Supplementation x Storage = NS	

CC = Cottage cheese, AP = Apricot Powder, GS = Ground sugar, SP = Spinach powder, n = 3

Table 6. Effect of supplementation and storage on titratable acidity of value-added *churpe* products (balls and strips)

Supplementation level (%)	Storage period (days)					
	0	90	180	270	360	Mean
Control (Cottage cheese)	06.27 ± 0.11	06.73 ± 0.14	06.52 ± 0.11	06.49 ± 0.16	06.32 ± 0.05	06.46 ± 0.11
CC:AP:GS						
90:00:10	05.05 ± 0.17	05.46 ± 0.16	05.33 ± 0.25	05.12 ± 0.23	05.02 ± 0.27	05.19 ± 0.21
85:05:10	05.82 ± 0.15	05.97 ± 0.19	06.33 ± 0.15	06.47 ± 0.17	06.61 ± 0.03	06.24 ± 0.13
80:10:10	06.41 ± 0.08	06.01 ± 0.07	06.12 ± 0.18	06.36 ± 0.03	06.73 ± 0.04	06.32 ± 0.08
75:15:10	06.47 ± 0.26	06.62 ± 0.25	06.80 ± 0.06	06.85 ± 0.06	06.96 ± 0.06	06.74 ± 0.13
70:20:10	06.63 ± 0.12	06.64 ± 0.06	06.70 ± 0.13	06.82 ± 0.16	06.95 ± 0.18	06.74 ± 0.13
Mean	06.07 ± 0.15	06.14 ± 0.14	06.25 ± 0.16	06.32 ± 0.13	06.45 ± 0.11	06.24 ± 0.14
CD (P < 0.05)	Supplementation = 0.11		Storage = 0.10		Supplementation x Storage = 0.25	
CC:SP						
97:03	06.06 ± 0.09	06.08 ± 0.04	06.18 ± 0.03	06.46 ± 0.31	06.63 ± 0.06	06.28 ± 0.16
94:06	06.30 ± 0.05	06.44 ± 0.04	06.76 ± 0.28	06.81 ± 0.21	06.88 ± 0.35	06.63 ± 0.17
91:09	06.48 ± 0.19	06.81 ± 0.19	06.84 ± 0.09	06.92 ± 0.19	06.96 ± 0.24	06.80 ± 0.20
88:12	06.60 ± 0.07	06.66 ± 0.14	06.67 ± 0.14	06.89 ± 0.09	06.96 ± 0.24	06.75 ± 0.12
Mean	06.36 ± 0.10	06.49 ± 0.10	06.61 ± 0.20	06.77 ± 0.20	06.85 ± 0.22	06.61 ± 0.16
CD (P < 0.05)	Supplementation = 0.12		Storage = 0.12		Supplementation x Storage = 0.27	

CC = Cottage cheese, AP = Apricot Powder, GS = Ground sugar, SP = Spinach powder, n = 3

Table 7. Effect of supplementation and storage on pH of value-added *churpe* products (balls and strips)

Supplementation level (%)	Storage period (days)					
	0	90	180	270	360	Mean
Control (Cottage cheese)	05.17 ± 0.23	05.15 ± 0.25	05.07 ± 0.08	04.76 ± 0.15	04.64 ± 0.09	04.95 ± 0.16
CC:AP:GS						
90:00:10	05.26 ± 0.26	05.19 ± 0.14	05.14 ± 0.05	05.05 ± 0.07	04.75 ± 0.18	05.07 ± 0.14
85:05:10	05.11 ± 0.38	04.74 ± 0.08	04.58 ± 0.19	04.44 ± 0.09	04.47 ± 0.14	04.66 ± 0.17
80:10:10	04.78 ± 0.05	04.43 ± 0.11	04.31 ± 0.24	04.94 ± 0.18	04.11 ± 0.08	04.51 ± 0.13
75:15:10	04.52 ± 0.07	04.37 ± 0.21	04.19 ± 0.28	04.71 ± 0.29	04.51 ± 0.04	04.46 ± 0.17
70:20:10	04.02 ± 0.13	04.73 ± 0.04	04.56 ± 0.04	04.25 ± 0.16	04.07 ± 0.16	04.32 ± 0.10
Mean	04.76 ± 0.17	04.69 ± 0.11	04.55 ± 0.05	04.67 ± 0.15	04.38 ± 0.12	04.60 ± 0.14
CD (P < 0.05)	Supplementation = 0.12		Storage = 0.11		Supplementation x Storage = 0.28	
CC:SP						
97:03	04.93 ± 0.04	04.76 ± 0.14	04.73 ± 0.20	04.60 ± 0.15	04.54 ± 0.28	04.71 ± 0.16
94:06	04.68 ± 0.18	04.53 ± 0.19	04.49 ± 0.06	04.46 ± 0.04	04.37 ± 0.24	04.50 ± 0.14
91:09	04.29 ± 0.19	04.29 ± 0.06	04.28 ± 0.17	04.24 ± 0.06	04.12 ± 0.16	04.24 ± 0.12
88:12	04.18 ± 0.28	04.10 ± 0.15	04.10 ± 0.12	04.03 ± 0.25	04.00 ± 0.07	04.08 ± 0.17
Mean	04.52 ± 0.17	04.42 ± 0.13	04.40 ± 0.13	04.33 ± 0.12	04.25 ± 0.18	04.38 ± 0.15
CD (P < 0.05)	Supplementation = 0.12		Storage = 0.12		Supplementation x Storage = NS	

CC = Cottage cheese, AP = Apricot Powder, GS = Ground sugar, SP = Spinach powder, n = 3

powder, respectively and the same increased from 6.28% to 6.75% at 3% and 12% levels of spinach powder. The increased titratable acidity of the supplemented *churpe* products seems to be, due to the direct effect of the higher amount titratable acids present in apricot and spinach. The acetic acid, citric acid, malic acid and tartaric acid are the main organic acids that are present in apricot (Ghnimi *et al*., 2018) thus conferring high acid content to the product. Similar results were reported for probiotic yogurt supplemented with passion

fruit or pineapple peel powders (Espirito *et al*., 2012; Sah *et al*., 2016). The addition of apricot to fruit-cheese bar, spinach powder to UF-soft cheese and *Moringa oleifera* leaves powder to soft cheese enhanced acid development (Jabeen *et al*., 2020; El-Sayed, 2020; Hassan *et al*., 2017). Storage led to increase in titratable acidity, from 6.07 to 6.45 in balls and from 6.36 to 6.85 in strips. Similar results were reported by El-Sayed (2020) in soft cheese.

It was observed that pH of *churpe*-balls decreased with increase in the level of fortification of apricot powder in fresh cheese (Table 7). Control *churpe* had mean pH of 4.95 which got reduced significantly ($P < 0.05$) from 4.66 to 4.32 at 05% to 20% levels of apricot powder. This effect may be attributed to higher acid contents in apricot. The addition of apricot to fruit-cheese energy bar significantly reduced the pH (Jabeen *et al*., 2020). The mean pH decreased significantly ($P < 0.05$) upon increasing the fortification levels of spinach powder in *churpe*-strips. It was found that, at 03% level of supplementation, the mean pH was 4.71 which got declined up to 4.08 at 12%. This could be contributed to higher acidity of spinach powder. Similar results were also reported by El-Sayed (2020) and Hassan *et al*. (2017) in cheeses supplemented with spinach powder and *Moringa oleifera* leaves. Storage period of 120 days resulted in decline of pH of both products i.e. from 4.76 to 4.38 in balls and 4.52 to 4.25 in strips. The pH values of parsley added cheeses were also reported to be decreased gradually during the storage period. (El-Taweel *et al.* 2017). pH of spinach powder supplemented UF-soft cheese decreased during 4 weeks of storage (El-Sayed, 2020). The pH of whey protein concentrate decreased significantly ($P < 0.05$) after 18 months (Tunick *et al*., 2015) and up to 2 months (Rathour *et al*., 2017) of storage. Decrease in pH during storage was reported by Coulter *et al*. (1948) in dried whole milk and suggested that amino group binding with lactose in Millard reaction as the cause which was also supported by (Kehrberg and Johnson, 1975). Free fatty acid formation presumably contributed to its pH decrease. The pH value of the samples might also be decreased during storage due to the lactic acid produced by the lactic acid bacteria (Yildiz and Ozcan, 2018).

Conclusion

The traditional *churpe* of Ladakh when incorporated with apricot and spinach become more nutritious having health benefits. Upon comparing the various levels of additives, it was found that 15% supplementation of apricot in *churpe*-balls and 9% supplementation of spinach in *churpe*-strips provide the best combinations in terms of organoleptic scores. The sensory attributes of the value- added products remain stable with minor changes during the storage period of 120 days.

Conflict of interest

The authors declare that they have no conflict of interest.

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