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RESEARCH PAPER

Process Development of Low Fat *Quarg* Cheese Using Fat Replacer

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ABSTRACT

Quarg is a sparkling cheese having a smooth texture, barely bitter flavor and is a type of natural un-ripened and clean cheese. *Quarg* cheese contains more fat and lacks in whey protein which affects its nutritional quality, therefore it is essential to produce low fat *quarg* cheese using fat replacers. Initially two fat replacers were tried i.e. carragennan and Simplesse-100 @ 0.5 of *quarg* and after selecting one, its level was optimized. The optimized product was assessed for its storage stability. During investigation cheese was analyzed for its sensory, physico-chemical and microbial analysis. Maximum score was awarded to the *quarg* cheese prepared using 0.5 per cent Simplesse-100 when added to *quarg* after removal of whey. The superior product contained 0.62±0.03, 12.68±0.08, 3.33±0.02, 1.32±0.04, 17.87±0.02 % fat, protein, lactose, ash and total solids, respectively whereas, its pH was 4.36±0.06. During the storage, there were significant ($p<0.05$) differences in change in all the sensory qualities, proximate composition of fat replacer added *quarg* cheese.

Keywords: *Quarg* cheese, fat replacer, storage study, sensory and proximate analysis

Fermentation is the oldest and most economical method in food preservation. It has been well documented that fermentation enhances mineral bioavailability and digestibility of proteins and carbohydrates as well as improves sensory qualities of the product. Numbers of fermented dairy products are being prepared all over the world including *dahi*, yoghurt, *lassi* and cheese. Cheese is a well known milk product that is valued for its nutritional superiority. Several types of chesses are manufactured with wide ranging flavours, texture, and forms. There are more than 2000 varieties of cheese, although many have little differences. The most popular varieties of cheese are *cheddar*, *mozzarella*, *feta*, cottage and *quarg* cheese.

Quarg is a sparkling cheese having a smooth texture and barely bitter flavor. It is a protein-rich, milky white or slight yellowish acidic coagulated and is a type of natural un-ripened and clean cheese which is most popular in countries like Germany. It is made from pasteurized skim milk or entire milk by incorporating *Streptococcus cremoris* and *Leuconostoc citrovorum* or any other starter culture and with a little quantity of rennet enzyme. Precipitation of the casein proteins occurs due to the combined action of these substances.

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The obtained coagulum is subsequently cooked and allowed draining the whey to get *quarg*. The moisture content in *quarg* is more (82%, w/w) (Yadav *et al.* 2019).

On an average, *quarg* cheese contain 11 per cent fat, 18 per cent protein, 4.5 per cent carbohydrate and 1.4 per cent ash. Presence of 18% protein is significant of *quarg* cheese, however presence of 11 per cent fat may increase its production cost and decreases consumption. As incidence of various chronic diseases such as elevated blood pressure, obesity and atherosclerosis is increasing rapidly and it has been found to be associated with high fat intake by people (Tiwari, 2005). Saturated fats are found mainly in foods of animal origin like whole milk, butter, cheese and also in coconut and palm oil. Nutrition experts recommend that the total intake of dietary fat should not exceed 30 percent of daily energy intake. Health conscious people look for the ways to improve nutritional habits without sacrificing psychological satisfaction so peoples prefer low fat diet. This has led to the increasing demand for low fat or no fat dairy food products with good taste. However, development in fat reduced products is associated with a number of difficulties. Defatted dairy products most often have a number of flaws: too hard, resilient of coarse consistency, poor taste and aroma (Simrnova, 2014).

In case of cheese, reduction in fat in also adversely affects its textural, functional and sensorial attributes such as rubbery texture, poor meltability, bitter taste, lack of flavor and undesirable colour (Alfonso and Norma, 2008). Few substances have been identified which can be incorporated in low fat food to improve its sensory properties, without affecting the aroma and flavor of foods formulated with the fat replacer.

Therefore, fat replacer possesses such potential to provide an alternative to high fat product to meet the expectation of the consumers' requirement for healthy food (Tiwari, 2005). Accordingly, food industries have focused on the production of low fat /low calorie, high fiber as a functional food in response to the public interest in the last couple of decades (Agarwal *et al*. 2016).

Fat replacer is a substance which chemically resembles fats, proteins or carbohydrates and possesses certain desirable physical or organoleptic properties of fat (Ahmed *et al*. 2015). These are of low calorie and possess some of functional properties of fat (Chavan *et al.* 2016). Fat replacers can be successfully utilized in the development of low fat cheese, yoghurt, spreads, frozen dessert, cream cheese and sour cream. It gives a sense of lubricity and creaminess in these products. Considering the health benefits of low fat *quarg* cheese and functional properties of fat replacer, the present investigation was undertaken. The objective of this study was to determine the effects of fat replacers on the physico-chemical, sensory and microbial quality of low-fat *quarg* cheese and also to find the storage stability of the product.

MATERIAL AND METHODS

Buffalo milk was procured from Dairy Farm, Rajarshi Chhatrapati Shahu Maharaj College of Agriculture, Kolhapur. Starter culture LF 40 was procured from National Collection of Dairy Culture, ICAR-NDRI, Karnal, Haryana (India) and microbial rennet was procured from CHR Hansen Ltd. Mumbai. Simplesse-100 from CP Kelco, Denmark and Carragennan from Marine Hydrocolloids Cochin, Kerala (India) were utilized as fat replacer.

Preparation of low fat *quarg* cheese

Initially *quarg* cheese was prepared as per protocol developed by Patange *et al.* (2018) for spiced *quarg* cheese with suitable modification. Buffalo milk was separated to get the milk of desired fat per cent as per treatment. The milk was heated to 80°C for 10 min in SS made cheese vat of size 25×16×16 cm and then, cooled to 28–30°C followed by inoculation of LF-40 starter culture @1 per cent and allowed to hold in undisturbed condition for at least one hr. to lower down the pH to 6.2-6.3. Subsequently microbial rennet was added @ 0.5g per 100 ml of milk and mix was incubated for 14-16 hr at 31°C to achieve the pH of 4.9 to 5.0. Obtained firmed curd was then, cut using both vertical and horizontal MS framed knife with nylon wire followed by cooking it by keeping

cheese vat in water bath. The heating process was accomplished slowly upto 65°C (rate of rising 1°C / 2 min of time). After cooking the expelled whey was drained out by hanging the coagulum in doubled layered cotton muslin cloth to get *quarg*. The process is shown in Fig. 1.

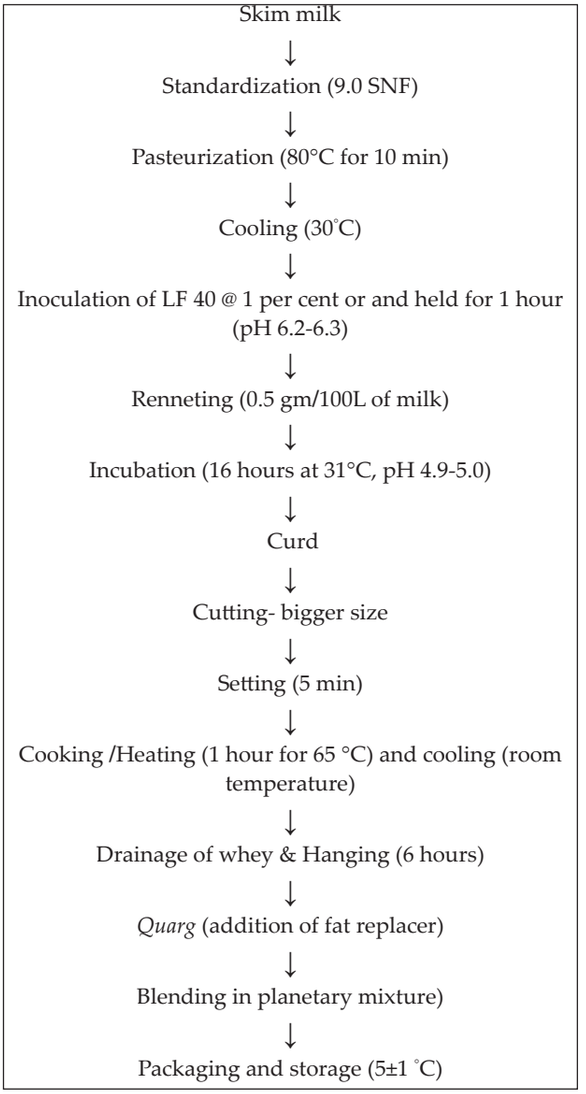

Fig. 1: Flow diagram of low fat *quarg* cheese added with fat replacer

Selection of type and stage of fat replacer in *quarg* cheese

Carragennan (T_2) and Simplesse-100 (T_3) fat replacer were mixed in the *quarg* cheese (@0.5 % of *quarg*) after the drainage of whey and compared with *quarg* cheese made from standardized milk (T_0) and skim milk (T_1). One fat replacer was selected on the basis of sensory evaluation of *quarg* cheese.

Optimization of level of fat replacer in *quarg* cheese

From above trail, the selected fat replacer was tested @ 0.2 (S_1), 0.4 (S_2), 0.6 (S_3) and 0.8 % (S_4) of *quarg* and compared with the *quarg* prepared from standardized milk (S_0) was added at following level of *quarg* and analyzed for sensory and physico – chemical properties. The best level of fat replacer was optimized on the basis of sensory evaluation.

Storage stability study of low fat *quarg* cheese

The optimized product (P_2) was packed in food grade plastic sterilized container of 100 g size and stored at 5±1°C for storage stability study and compared with control (P_1) i.e. low fat *quarg* cheese without addition of fat replacer. The samples were evaluated after 3 days of interval for changes in sensory, physico-chemical and microbial qualities till their sensory acceptability.

Analysis of *quarg* cheese

Sensory evaluation was carried out with scoring test by five panelists who were the faculty members of the department. The panelists were selected on the basis of their interest in sensory evaluation of cheese The different samples of cheeses were evaluated for flavour, colour and appearance, spreadability, body and texture and overall acceptability using a score from '1' to '9'. Approximately, 15 to 20 g of each sample was presented to panelists, to clean palates of panelists between samples potable drinking water and bread were provide. Panelists were also requested to tick-mark the defects on the scale in order to determine the reasons of decrease in scores. The samples of cheeses were analyzed for proximate composition as per AOAC, (2000); during the storage period along with sensory and chemical analysis microbial load in terms of total plate count, yeast and

mould coliform and count were enumerated as per manual of dairy bacteriology, ICAR (1982).

Statistical Analysis

All data are presented as mean ± SD for three replicates for each sample. The experimental design was completely randomized design (CRD) in factorial arrangement using three replications as suggested by (Snedecor and Cochran, 1994).

RESULTS AND DISCUSSION

Effect of type of fat replacer on sensory properties of low fat *quarg* cheese

The diagrammatic representation (Fig. 1) of score for colour and appearance of low fat *quarg* cheese was significantly ($p<0.05$) affected by the level of fat replacer. The highest score (8.25±0.03) was obtained by *quarg* cheese where in simplesse-100 was mixed. For this treatment, judges made the comments that the product had shiny and creamy colour with uniform appearance. The effect of simplesse- 100 was at par with the *quarg* produced from 4.5% milk. Nurcan and Mustafa (2004) also reported that the colour of the low-fat fresh *kashar* cheeses containing fat replacers was different from that of low-fat control cheese. Moreover, the use of simplesse D-100 corrected all appearance defects which were determined in low fat fresh *kashar* cheese. Further they reported that the low-fat control cheese had a more translucent surface and denser colour than full-fat cheese. Fat replacers, can also act as light-scattering centers and increase the opaqueness of low fat cheese (Mcmahon *et al.* 1996). It was observed that the score of body and texture obtained was significantly ($p<0.05$) highest (8.35±0.02) for *quarg* cheese under treatment T_3 (Fig. 2) and it possessed soft body and smooth texture. The *quarg* prepared from skim milk was comparatively compact and had firm body and coarse texture. When tapioca starch and lecithin as a fat replacer were used to produce a reduced-fat Feta cheese, the hardness and yield loss values decreased and the moisture content were increased (Sipahioglu *et al.* 1999). The addition of some hydrocolloids, mainly carrageenan, may replace the addition of fat and emulsifying salts. The *quarg* prepared by addition of carragennan recorded significantly ($p<0.05$) highest score for spreadability (score 8.21±0.02) as compared to simplasee-100 (Fig. 3). Processed cheese with added carragennan was found to be hard and impossible to spread was reported by Cernikova *et al.* (2010). However, improvement in spreadability score of carragennan added *quarg* cheese over cheese made from skim milk is supported by the facts of Blaszak *et al.* (2018) who reported that even small amounts of carragennan can increase cheese firmness and maintain cheese structure after cheese curd heating. Further, they mentioned that any modifications in cheese composition can destroy the natural cheese structure, but the addition of carragennan can be useful for creating modified cheese-like products with desirable attributes. The good quality *quarg* has characteristics like clean and mildly acidic flavour and has optimum sourness and acidic taste as good as *Chakka* and yoghurt. The effect of all treatments were statistically different ($p< 0.05$) with respect to flavour score, the *quarg* prepared by addition of Simplesse-100 recorded highest score for flavour (score 8.10±0.02), followed by the *quarg* prepared from the milk containing 4.5 % fat (score 8.00 ±0.05). Improvement in flavor score was in accordance with the facts reported by Smirnova (2014), who found that the advantages of protein fat imitators are not only to increase the protein content but also to add a creamy flavor to nonfat products. The flavour score of *quarg* cheese with carragennan and Simplesse-100 were close to each other (Fig. 4). The mean flavour scores SimplessesD-100 added low fat cheese were closer scores to full-fat cheese was informed by Nurcan and Mustafa (2004). Among the four treatments under study, the *quarg* prepared from skim milk had lowest score which could be due to low-fat cheeses commonly present a poor aroma and a typical flavors caused by the lack of aromatic compounds that are produced by lower levels of lipolysis. In addition, their typical high moisture content cause excessive growth of the starter culture, which accelerates acid production, resulting in bitter flavors (Diamantino *et al.* 2014). Cheeses with lower fats usually have less

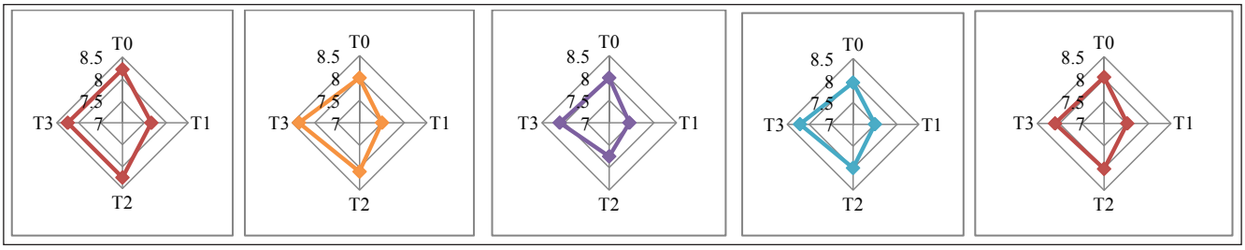

Fig. 1: Effect of type of fat replacer on colour and appearance score

Fig. 2: Effect of type of fat replacer on body and texture score

Fig. 3: Effect of type of fat replacer on flavour score

Fig. 4: Effect of type of fat replacer on spreadability score

Fig. 5: Effect of type of fat replacer on overall acceptability score

pronounced flavour, possibly because of its dilution in reduced and low-fat cheeses because of excessive moisture retention, and the fats in cheese are responsible for most of the flavors, therefore when fats are decreased, the cheeses flavour was decreased by as described earlier Tareq *et al.* (2016).

The effect of type of fat replacer was also examined on the overall acceptability of *quarg* cheese (Fig. 5) The overall acceptability score ranged from 7.52±0.04 to 8.10±0.02. The maximum score was obtained by the product containing Simplesse-100, it may be because of higher water holding capacity of carragennan resulted in too firm body of product along with resistance to spread and poor mouth-feel. The difference in the score of T_0 and T_1 were supported by the findings of Gokhan *et al*. (2004) who reported that in full-fat and low-fat white pickled cheeses added with fat replacer showed that, as the fat content of cheese milk decreased, fat in total solids, total solids and cheese yield of white pickled cheese significantly decreased but the moisture and total nitrogen values significantly increased which affected the sensory qualities of cheese. Tareq *et al*. (2016) also studied the effect of Kappa Carrageenan, locust bean and Xanthan gums had on sensory score of Domiati cheese and found that higher scores on the evaluated attributes of cheese were to the moisture content enhancement, thereby resulting in a decrease in the differences noted between the sensory evaluation of full and low-fat cheese. After looking into these results, in subsequence study the product was prepared by addition of Simplesse-100 as a fat replacer.

Effect of level of fat replacer on sensory attributes of low fat *quarg* cheese

The score for colour and appearance of *quarg* cheese were significantly affected by the level of Simplesse-100. The highest score (8.45±0.03) was awarded to quarg wherein Simplesse-100 was added @ 0.6 per cent (Table 2). For these treatment, judges made the comments that the product had shiny and slight creamy colour with uniform appearance. With the increasing quantity of WPC in *quarg* the improvement in coloour and appearance was also observed by Patange *et al.* (2018) and the colour was shining and slight creamy colour with uniform appearance. Statistically, the colour and appearance difference within S_2, S_3, and S_4 were at par with each other. The *quarg* prepared by addition of Simplesse-100 at 0.6 per cent recorded highest score for body and texture (8.50±0.06). Lowest score was noticed for skim milk *quarg* cheese (7.50±0.02). Statistically the body and texture difference within S_3 were at par with S_2 and S_4. The score for these three treatments were in narrow range and ranged from 8.35 to 8.50. It is clearly illustrated from the Table 1 that at 0.6 per cent level of addition Simplesse-100 the score for spreadability of *quarg* was highly significant ($p<0.05$) compared to the treatments. The spreadability score for So, S_1, S_2, S_3 and S_4 were 7.46±0.02, 8.07±0.03, 8.21±0.02, 8.30±0.05, 7.90±0.01. The score within S_1, S_2, S_3 were at par with each other.

The good quality *quarg* has characteristic clean and mildly acidic flavour and has optimum sourness and acidic taste as good as like *chakka* and yoghurt. It was observed that treatment differences are statistically

Table 1: Effect of level of fat replacer on sensory attributes (score) of low fat *quarg* cheese

Treatment	Sensory attributes				
	Colour and appearance	Body and texture	Spreadability	Flavor	Overall acceptability
S_0 (Control)	7.66^{a}±0.02	7.50^{a}±0.02	7.46^{a}±0.02	7.50^{a}±0.02	7.53^{a}±0.03
S_1 (0.2)	7.92^{b}±0.02	8.10^{b}±0.05	8.07^{bc}0.03	8.05^{b}±0.03	8.05^{b}±0.04
S_2 (0.4)	8.32^{c}±0.02	8.40^{c}±0.05	8.21^{c}±0.02	8.30^{c}±0.03	8.32^{c}±0.05
S_3 (0.6)	8.45^{c}±0.03	8.50^{cd}±0.06	8.30^{c}±0.05	8.40^{d}±0.03	8.39^{c}±0.02
S_4 (0.8)	8.40^{c}±0.02	8.35^{d}±0.01	7.90^{b}±0.01	8.50^{e}±0.05	8.28^{b}±0.05
SEm	0.01	0.01	0.09	0.01	0.01
CD(p<0.05)	0.16	0.15	0.27	0.04	0.10

Mean± of four replication within column followed by same letter are non-significantly different at p<0.05.

Table 2: Effect of fat replacer physico-chemical properties* of low fat *quarg* cheese

Treatment	Physico-chemical properties of low fat quarg cheese					
	Fat (%)	Protein (%)	Lactose (%)	Ash (%)	TS (%)	pH
S_0 (control)	0.45^{a} ± 0.02	12.00^{a} ± 0.02	3.00^{a} ± 0.15	1.01^{a} ± 0.13	16.46^{a} ± 0.02	4.47^{d} ± 0.03
S_1 (0.2)	0.53^{b} ± 0.03	12.33^{b} ± 0.05	3.17^{b} ± 0.03	1.20^{b} ± 0.06	17.17^{b} ± 0.06	4.45^{c} ± 0.05
S_2 (0.4)	0.45^{a} ± 0.02	12.50^{c} ± 0.05	3.25^{b} ± 0.01	1.29^{c} ± 0.04	17.54^{c} ± 0.02	4.42^{b} ± 0.01
S_3 (0.6)	0.62^{d} ± 0.03	12.68^{d} ± 0.08	3.33^{b} ± 0.02	1.32^{d} ± 0.04	17.87^{d} ± 0.02	4.36^{a} ± 0.06
S_4 (0.8)	0.69^{e} ± 0.05	12.74^{e} ± 0.06	3.40^{b} ± 0.05	1.37^{e} ± 0.01	18.08^{e} ± 0.02	4.34^{a} ± 0.02
SEm	0.01	0.03	0.02	0.03	0.01	0.02
CD(p<0.05)	0.03	0.10	0.07	0.10	0.03	0.02

* *Mean± of four replication within column followed by same letter are non-significantly different at p<0.05.*

significant at 5 per cent level of significance. The perusal of data from showed that the *quarg* prepared by addition of Simplesse-100 at 0.8 per cent was recorded highest score for flavour (8.50±0.05). The flavour score for S_1, S_2, and S_3 were 8.05±0.03, 8.30±0.03 and 8.40±0.03, respectively. Slightly sourish with an expressed flavor and odor of pasteurization with a slight cooked flavor of whey proteins was noticed in protein based fat replacer products by Smirnova (2014). From overall acceptability scores, it is clear that *quarg* prepared by addition of 0.6 per cent Simplesse-100 had scored significantly highest score (8.39±0.02), followed by *quarg* of S_2 (8.32±0.05) treatments. Statistically there were no significant differences between S_2 and S_3. Study results of Nurcan and Mustafa (2004) indicated that SimplessesD-100 can improve the instrumental texture properties and sensory properties of low-fat fresh *kashar* cheese. Fuangpaiboon and Kijroongrojana (2017) studied the effects of Simplesse® 100 on the sensory and physical properties of reduced-fat (4%) and low-fat (2%) coconut-milk ice cream in comparison with a control containing 8% fat. The reduced-fat ice cream with Simplesse 100 added exhibited the sensory characteristics (firmness, iciness, melt-down, mouth-coating, sweetness, coconut flavour and skimmed milk powder flavour) mostly similar to the control.

Effect of level of fat replacer on physico-chemical properties of low fat *quarg* cheese

The effect of level of fat replacer on physico-chemical properties of low fat *quarg* cheese were also measured and presented in Table 2. The average fat content of low fat *quarg* was 0.45±0.02, 0.53±0.03, 0.45±0.02, 0.62±0.03 and 0.69±0.05 for S_0, S_1, S_2, S_3 and S_4, respectively. The slight but significant rise

in the fat content of *quarg* cheese may be because of presence of fat in Simplesse as reported by Smirnova, (2014). The highest (12.74%) level of protein content was noticed in low fat *quarg* cheese added with 0.8 percent Simplesse-100. It was observed that protein content showed gradual but significant ($p<0.05$) increase in the level of Simplesse-100.Contradictory findings were reported by Tareq *et al.* (2016) who reported that adding mixture of hydrocolloids as fat mimetic didn't significantly affect the cheese protein content. However, lactose content in *quarg* cheese S_1, S_2, and S_3 were at par with each other and values for these chesses were 3.17 ±0.03, 3.25 ±0.01 and 3.33 ±0.02, respectively. The Average ash content (%) in *quarg* were 1.01±0.13 (S_0), 1.20±0.06 (S_1), 1.29±0.04 (S_2), 1.32±0.04 (S_3), and 1.37±0.01 (S_4). It was observed that the ash content of low fat *quarg* cheese gradual increase with increase in level of Simplesse-100. It was observed that the TS content showed gradual increased with the increase in level of Simplesse-100. Average TS was ranged from 16.46±0.02 to 18.08±0.02 %. Comparatively higher TS content in Sudanese low fat cheese was reported by Elkhidier and Hamid (2017) and Patange *et al*. (2018) in WPC increased *quarg* cheese. The acidity of low fat *quarg* in was ranged from 1.68±0.09 to 1.80±0.02 (% LA) whereas pH was ranged from 4.47±0.03, to 4.34±0.02.

Effect of storage period on sensory attributes (score) of low fat *quarg* cheese

As the storage period was increased, then score of colour and appearance decreased in both the cheeses. Initially the score for colour and appearance for control sample and *quarg* with fat replacer was 7.66±0.02 and 8.50±0.05, respectively (Fig. 6). However, the rate of decline was higher in P_1 than P_2 cheese. Controlled sample was best up to 9 days while fat replacer *quarg* sample was up to 12 days and after that the microbial (yeast and mould) visible growth was observed in the product. The decline in body and texture scores during storage (Fig. 6) may be attributed to increase in the free moisture content in the product and contributed to the softness of the product. The average flavour score was decreased from 8.50 to 6.25 for P_2 (Fig. 7). Smirnova (2014) recorded decreasing flavour score of dairy product added with Simplesse- 100 had the main taste defect, which is intensified during storage, is a caramelization flavor, which is associated with a higher content of whey protein. Improvement in flavour score of low-fat kashar cheeese added with Simplesse- 100 up to 22 days of storage was observed by Nurcan and Mustafa (2004).

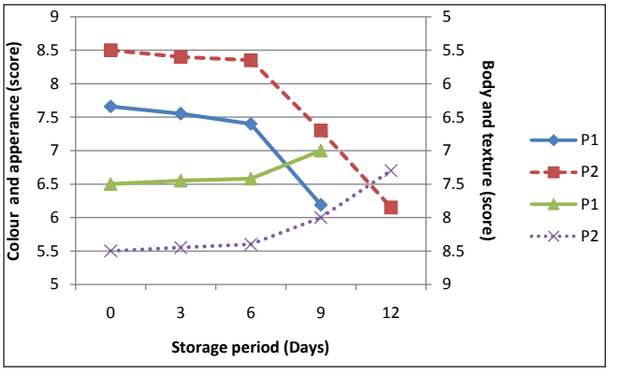

Fig. 6: Changes in color and appearance and body and texture score of *quarg* cheese during storage

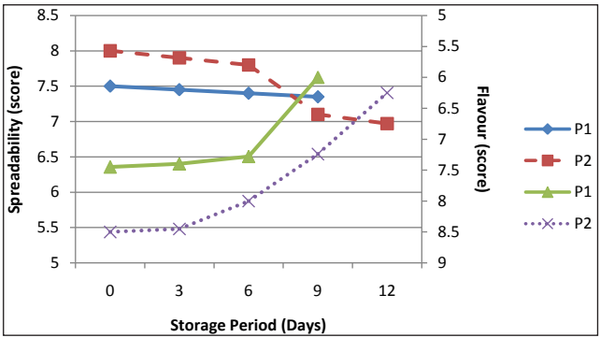

Fig. 7: Changes in spreadability and flavour score of *quarg* cheese during storage

During storage, development of stale bitter and metallic flavour was observed by Sachdeva *et al* (1993) in *quarg* cheese. Similar type of observation was also recorded by Kadiya *et al.* (2014) and who observed a prominent purification odour in *quarg* cheese due to yeast and mould growth. Spreadability score was ranged from 8.00 ±0.05 to 6.97 ±0.3 for same sample. The score for overall acceptability on last day of storage period were 6.55±0.01 and 6.35±0.01 for P_1 and P_2 samples (Fig. 7). Similar result was obtained by Yadav (2015) where author reported that the *quarg*

sample stored under refrigeration (4ºC) was same in appearance up to six days, thereafter the quality decreased slightly and remained acceptable for 10 days.

Effect of storage period on physico-chemical properties of low fat *quarg* cheese

Fat content (%) of freshly prepared control sample and Simplesse-100 added *quarg* cheese was found to be 0.47±0.03 and 0.50±0.02. The fat content of P_2 sample was reduced to 0.32±0.01 during 12th day of storage (Fig. 8). The decrease in fat content of *quarg* cheese during storage period might be attributed to the fact of lipolysis activity in the product. Similarly the protein content of P_1 and P_2 sample shown significant ($p<0.005$) differences throughout the storage period. The protein content in P_2 sample was decreased up to 11.28±0.08 on 12th day of storage (Fig. 8). Decrease in protein content in low-fat *kashar* cheese was also observed by Nurcan and Mustafa (2004). It was revealed from the Fig. 9 that there was a slightly decrease in lactose content during storage. The overall reduction in lactose content from 3.00±0.05 to 2.76±0.04 in P_1 while 3.25±0.04 to 2.63±0.05 in P_2. The average per cent ash content of control low fat *quarg* cheese was 1.00±0.01 on 0 days whereas ash content in *quarg* of blended with fat replacer on same day was 1.29±0.01. The ash content of the *quarg* of blended with fat replacer increased to 1.45±0.01 (Fig 9). Hence, it is clear that there was significant increase during storage period. The initial Total solid content in P_1 and P_2 was 17.18±0.02 and 17.54±0.02 per cent, respectively. The P_2 sample showed the significant decrease in total solid over a storage period. The average total solid per cent recorded was 17.46±0.04, 17.44±0.02, 17.40±0.02 and 17.36±0.04 per cent on 3rd, 6th, 9th and 12th day of storage respectively (Fig. 10). Somewhat similar trend in TS content of with and without fat replacement fresh low-fat *kashar* cheese was reported by Nurcan and Mustafa (2004). The result of Vajihel *et al*. (2012) are closely associated with the present finding where in they reported that moisture content was significant low or fat replacer added sample.

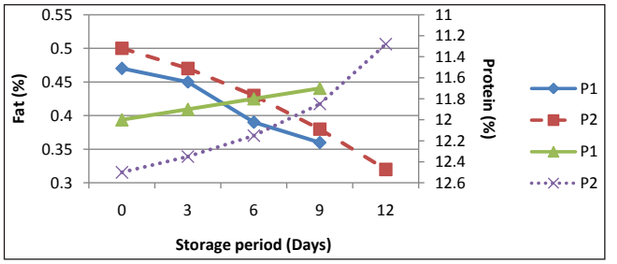

Fig. 8: Changes in fat and protein content (%) of *quarg* cheese during storage

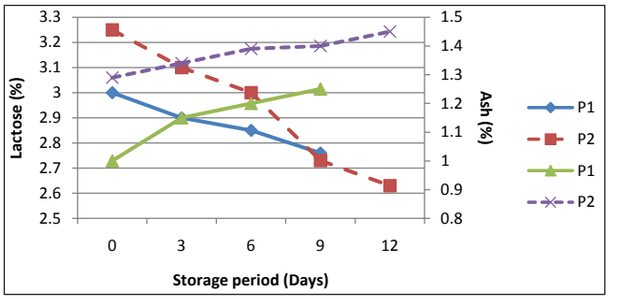

Fig. 9: Changes in lactose and ash content (%) of *quarg* cheese during storage

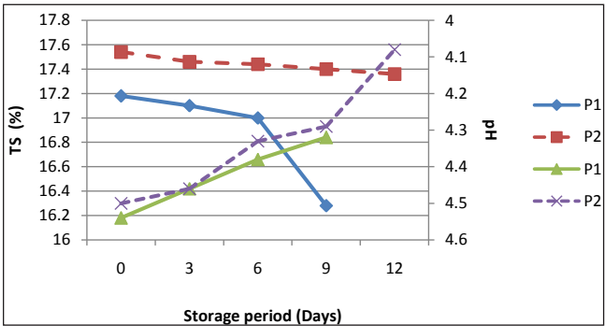

Fig. 10: Changes in TS (%) and pH of *quarg* cheese during storage

The pH of fresh *quarg* cheese sample was 4.54±0.01 (P_1) and 4.50±0.05 (P_2). It decreased during the storage period in all the samples but at different rate. The effect was found to be statistical significant ($p<0.05$) on each day of evaluation. In the P_1 sample the rate of decrease was rapid as pH decreased from initial value of 4.54±0.01 to 4.46±0.02, 4.38±0.02, and 4.32±0.03 after 3, 6 and 9 days respectively. In case of P_2 cheese, pH was decreased from 4.50±0.05 to 4.46±0.01, 4.33±0.02, 4.29±0.04 and 4.08±0.12 after 3, 6,

9 and 12 days of storage respectively. Shekhar (2014) and Patange *et al*. (2018) also observed decrease in pH of *quarg* during storage.

Effect of storage on microbial load of low fat *quarg* cheese

The rate of growth of microorganism in control sample was significantly (P<0.05) faster in P_1 than P_2. The average of SPC count was observed to be 1.85±0.01, 2.25±0.01, and 3.60±0.05 log10 /g on 3rd, 6th and 9th day of storage respectively. In case of *quarg* cheese with fat replacer, the average SPC count observed was 2.16±0.01, 3.22±0.01, 3.42±0.02, 3.65±0.01 log10/g on 3rd, 6th, 9th and 12th day of storage respectively. In treatment P_1 the average YMC on 6th and 9th day of storage was observed to be 0.32±0.01and 0.54±0.02 log10/g. There was no effect of addition of fat replacer on coliform count in *quarg* cheese and it compared with control during storage.

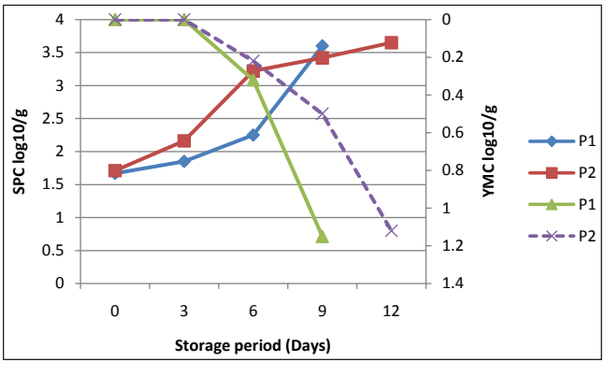

Fig. 11: Changes in SPC and YMC of *quarg* cheese during storage

CONCLUSIONS

From the study it is concluded that compared to carragennan, use of simpleese-100@ 0.6 %, as a fat replacer found to be the most suitable in terms of sensory qualities of low fat *quarg* cheese. The optimized *quarg* cheese scored 8.45±0.03, 8.50±0.06, 8.30±0.05, 8.40±0.03 and 8.39±0.02 for colour and appearance, body and texture, spreadability, flavour and overall acceptability, respectively. Whereas, it contained 0.62±0.03, 12.68±0.08, 3.33±0.02, 1.32±0.04 and 17.87±0.02 fat(%), protein(%), lactose (%), ash(%) and TS (%), respectively. The product had 4.36±0.06 pH. The experimental low-fat *quarg* cheese added with fat replacer could be stored upto 12 days without any marked deteoration.

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