PHYSICOCHEMICAL AND TEXTURAL PROPERTIES OF IMITATION FRESH KASHAR CHEESES PREPARED FROM CASEIN, CASEINATES AND SOY PROTEIN

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Abstract

Four batches of filled type processed and two batches of analogous fresh kashar cheeses were produced. For the filled type, rennet casein, sodium caseinate, calcium caseinate and soy protein isolate were added to the sliced elastic cheese curd so that the percentage of each was 5% in total molten mass (CRC, CSC, CCC, CSOY, respectively). The first batch of imitation cheeses was prepared using rennet casein, soy protein isolate, hydrogenated cottonseed oil, NaCl, carrageenan, water, emulsifier (R1) and the other was prepared with sodium caseinate, modified starch, hydrogenated cottonseed oil, water and emulsifier (R2). Natural fresh kashar obtained from a local dairy plant was used as a control. The cheese samples were analysed for physicochemical, textural and melting characteristics. All the imitation groups had lower dry matter ($P<0.01$) and protein ($P<0.01$), but higher fat in dry matter ($P<0.01$) content than the control. The rennet casein filled group and the R2 batch gave the best results among the imitation cheese groups with respect to textural and melting properties.

Keywords: Imitation cheese, cheese analogue, fresh kashar, caseinate, soy protein

KAZEİN, KAZEİNAT VE SOYA PROTEİNİ İLE HAZIRLANAN TAKLİT TAZE KAŞAR PEYNİRLERİNİN FİZİKOKİMYASAL VE TEKSTÜREL ÖZELLİKLERİ

Özet

Bu çalışmada, dört farklı tipte hileli ve iki tipte taklit taze kaşar peyniri üretilmiştir. Hileli taze kaşar üretimlerinde elastik telemeye, her birinin erimiş kitledeki oranı %5 olacak şekilde rennet kazein, sodium kazeinat, kalsiyum kazeinat ve soya proteini izolatı katılmıştır (sırasıyla CRC, CSC, CCC, CSOY). Birinci parti taklit peynirlerin (R1) üretiminde rennet kazein, soya proteini izolatı, hidrojene pamuk yağı, NaCl, carrageenan, emülgatör, ikinci parti taklit peynirlerin (R2) üretiminde ise NaCl, modifiye nişasta, hidrojene pamuk yağı, su ve emülgatör kullanılmıştır. Kontrol amacıyla yerel bir süt işletmesinden taze kaşar peynirleri temin edilmiştir. Tüm peynir örneklerinde fizikokimyasal analizler, tekstür profil analizleri ve erime analizleri yapılmıştır. Taklit taze kaşar gruplarının kontrol ile karşılaştırıldığında, kurumadde ($P<0.01$) ve protein ($P<0.01$) içeriğinin daha düşük, kurumadde yağ içeriğinin ise daha yüksek olduğu görülmüştür ($P<0.01$). Tekstürel özellikler ve eriyebilirlik açısından en iyi sonuçlar rennet kazein içeren grup ve R2 gruplarında elde edilmiştir.

Anahtar Kelimeler: Taklit peynir, hileli peynir, taze kaşar, kazeinat, soya proteini

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INTRODUCTION

Cheese analogues or imitation cheeses are different from natural cheeses as they are made from a high solids molten mass of casein/ate or other protein sources than those native to milk, vegetable oil, emulsifying salts and water without the addition of rennet or starter bacteria. Generally, a flavour system simulating as closely as possible that of the natural product is accompanying (1, 2).

There are two basic types of processes for manufacturing cheese substitutes. The first uses liquid milk and involves conventional cheese making methods, the products often being referred to as "filled cheese". The second type, referred to as "cheese analogue", is made by blending various raw materials together using techniques similar to those for processed cheese manufacture (2). Caseins and their calcium, sodium and potassium and magnesium salts are the most preferred protein sources used in imitation cheese manufacturing. However, the proteins from the vegetable origin have also been used recently. Of all the vegetable proteins, the most important contender is soy bean protein (3). The ability of soy proteins to form a gel upon heating is generally considered as an important functional property. Conditions during gel formation in food products vary greatly due to variations in pH, salt content, the combination of ingredients, etc. and this will affect the properties of formed gel (4). Cavalier-Salou & Chephtel (5) stated that imitation cheeses may also be prepared from pregelatinized or modified high amylose starch in partial replacement of caseinate. A mixture of sodium caseinate, soy protein isolate and corn starch has also been used to prepare imitation cheeses.

Imitation Mozzarellas and other Italian type cheeses, which are primarily sold for pizza preparation, account for the largest portion of the imitations produced (6). Kashar cheese is the second mostly consumed local cheese variety in Turkey. The melting ability of kashar renders it to be used in pizzas and toasted sandwiches. The manufacturing procedure for fresh kashar cheese is as follows; pasteurized milk is cooled to 34 °C, then CaCl2, starter and rennet are added, curd is sliced and heated at 40°C, then left to fermentation until the pH of the sliced curd reaches 5.25-5.30 and curd is cooked in 6% saline water at 72 °C. The elastic curd is moulded and left for cooling and packaged.

In kashar production, the yield is 1 kg of cheese from nearly 10 kg raw milk. However, manufacturers' efforts to increase the cheese yield resulted in obtaining 1 kg cheese from 6-7 kg skimmilk by the addition of soy protein and by replacing the milk fat by various vegetable oils. Besides, kashar cheeses can also be produced using the processed cheese technology, which includes the addition of some ingredients like soy protein, vegetable oil and caseinates into the sliced kashar curd or cheese, to adjust the fat and protein ratio (7). Some imitation fresh kashar cheeses with low quality are also being marketed, the ingredients of which are not declared. However, there is no research on imitation fresh kashar cheeses. This study aims determining physicochemical, textural and melting properties of fresh kashar cheeses manufactured using different ingredients and processing techniques.

MATERIALS AND METHODS

Materials

The ingredients used in the production of cheese batches are; rennet casein, sodium caseinate and calcium caseinate obtained from Tunckaya Company, soy protein isolate and modified starch from Farin Kimya Company, cheese flavour and Carrageenan from Technaroma Company, emulsifiers (JOHA C Neu, JOHA T) from Kipa Chemicals. Hydrogenated cottonseed oil having melting point of 36-40 °C was used as milk fat replacer in imitation cheese batches. Natural fresh kashar cheese obtained from Sütas Company was used as control.

Methods

Production of imitation cheese batches

Six batches of imitation fresh kashar cheeses were produced. For the four batches of filled type imitation cheese, cheese curd was prepared as follows: milk with 3% milkfat was pasteurized and cooled to 34 °C and 1% of thermophilic starter, CaCl2 and rennet were added. The curd was sliced into 1 cm3 slices and then heated to 40 °C. Rennet casein, sodium caseinate, calcium caseinate and soy protein isolate were added to the sliced elastic cheese curd so as the percentage of each was to be 5% in total molten mass (CRC, CSC, CCC, CSOY, respectively). Then 2% emulsifier of total mass was added and cooked at 60 °C.

The two batches were produced without milk but, with caseins and other ingredients. The first batch (R1) was produced according to Berger et al. (3), however the ratios for ingredients were slightly modified and carrageenan was added (Table 1). The second batch (R2) was produced on the basis of the receipt given by Ahmad et al., (8) (Table 2).

Table 1. Receipt for imitation fresh kashar according to Berger et al. (3) (R1)

Ingredients	g/100g
Rennet Casein	22.90
Soy protein isolate	6.62
Hydrogenated cottonsed oil	21.28
Emulsifier (JOHA C Neu)	1.78
NaCl	1.42
Water	45.90
Cerregeenan	0.10

Table 2. Receipt for imitation fresh kashar according to Ahmad et al. (8) (R2)

Ingredients	g/100g
Sodium caseinate	18.00
Modified starch	6.00
Hydrogenated cottonseed oil	24.00
Emulsifier (JOHA C Neu:JOHA T Neu; 1:1	3.20
Water	47.00

In the production of both imitation groups, vegetable oil was heated to 70 °C and emulsion was formed by mixing with water at the same temperature. For the R1 batch, rennet casein and soy protein isolate, and for the R2 batch, sodium caseinate and modified starch were added to the emulsion and texture formation was observed. Then, emulsifiers, and for the R1 batch, NaCl and carrageenan were added. The pH was adjusted to 5.8 by citric acid in both groups. The molten masses were moulded into cylindrical moulds of 400 g and cooled to 4°C.

Physicochemical analysis

In the cheese samples, the following analyses were made; titratable acidity as °SH by titrimetric method (9), pH was measured by WTW pH-320 type pH meter, dry matter by gravimetric method (10), protein by Kjeldahl method (9), fat by Van-Gulik method (11), salt by Mohr method (12), ash by gravimetric method (13). Fat and salt was expressed on dry matter basis. Each sample was analysed in triplicate.

Textural Analysis

Textural parameters including hardness (kg), springiness, adhesiveness (cm2), cohesiveness, gumminess (kg), chewiness were analysed according to the method of Stevens and Shah (14), by using Instron Universal Testing Machine (TA XT plus Texture Analyser, Surrey GU/ 1YL, UK). Cylindrical samples measuring 20 mm x 20 mm were cut using a cheese corer and then were left at room temperature (~20 °C) for 30 min. The samples were compressed to 80% of their original heights using 50-500 kg load cell and a flat plunger. The crosshead speed and the chart speed were adjusted to 50 mm/min and 20 mm/min, respectively. Each sample was analysed in triplicate

Meltability

Meltability of the imitation cheese samples were determined by two different methods; the method described by Olson & Price (15) and the method modified by Savello et al., (16). Cheese plugs weighing 15±1 g and having 30 mm diameter and 22 mm length were placed in a Pyrex glass tube with rubber stoppered end having a 3 mm hole. The tubes were placed in a stainless steel rack and incubated at 30 °C for 120 minutes while they are positioned at a 45 ° angle with the end containing cheese plugs at the bottom. At the end of the incubation time, the tubes were heated in a horizontal position at 110 °C for 50 minutes. The distance to which the plugs spread was measured in millimeters (mm).

Meltability was also measured by Schreiber method (17) with some modifications (18, 19). Cheese discs having 17 mm diameter and 5 mm height were wrapped in aluminium foil and stored overnight at 5 °C. Each cheese disc was placed in the centre of a glass Petri dish and then heated in an oven at 100 °C for 5 minutes. The Petri dishes were removed from the oven and cooled on a flat surface at 30 minutes. The average of 6 measurements around the circumference at equal angular directions was recorded in millimeters (mm) as Schreiber meltability. Each sample was analysed in triplicate.

Statistical analysis

Data were processed with the one way analysis of variance to determine the significance of individual differences on the level of $P<0.01$ and $P<0.05$. Sig-

nificant means were compared with Duncan test and Bonferroni multiple comparison test. Standard deviations of mean values (SD) were also calculated. The correlation analyses were performed with Pearson Correlation analysis. All the statistical analyses were conducted using the SPSS (Version 8.0) commercial statistical package.

RESULTS AND DISCUSSION

Physicochemical characteristics

Titratable acidity (°SH) and pH values of cheese groups were shown in Table 3. The R2 batch had the highest titratable acidity values ($P<0.01$). This might be due to the addition of starch. Ahmad et al. (8), also determined higher titratable acidity values

Table 3. Titratable acidity (°SH) and pH values of cheese samples (Mean ± SD)

Sample	Titratable acidity °SH)	pH
Control	11.90±0.03[b]	5.42±0.00[ab]
CRC	11 .90±0.03[b]	5.35±0.01[a]
CCC	11.90±0.03[b]	5.44±0.01[abc]
CSC	7.93±0.01[a]	6.01±0.01[d]
CSOY	11.90±0.03[b]	5.89±0.01[d]
R1	11.90±0.04[b]	5.81±0.01[cd]
R2	21.42±0.02[c]	5.78±0.00[bcd]

[a,b,c] Subcolumn means within row and treatment category with different superscripts differ ($p<0.05$)

in imitation cheese batch containing starch than the batch produced without starch. Significant differences were found between the cheese batches with respect to pH values ($P<0.05$). pH correlated with total protein (r= -0.920, $P<0.01$) and fat in dry matter (r= 0.699, $P<0.01$).

All the imitation fresh kashar groups had lower dry matter and protein content than the control (Table 4). O'Malley et al., (20), stated that pilot-scale imitation cheeses had higher moisture and lower levels of protein than the commercial ones. Ahmad et al. (8), found that imitation Mozzarella cheeses had higher moisture of about 7-8% than the Mozzarella control. Similarly, dry matter contents of CSOY, the R1 and the R2 groups were 6.5-7.0% lower than natural fresh kashar. However, cheese groups containing different caseinates (CRC, CCC and CSOY) had dry matter content nearly 12-21% lower than the control. Similarly, Marshall (21), found that dry matter content of processed cheese analogues changed between 40-50%. Lobato-Calleros et al., (22), stated that dry matter content of cheese analogue containing vegetable fat was 51%, and Mounsey & O'Riordan (23), found the dry matter content of imitation cheese prepared from rennet casein and vegetable fat was around 52%.

Significant differences were found between samples with respect to fat in dry matter ($P<0.01$), total protein ($P<0.01$) and salt in dry matter ($P<0.01$). Control had the lowest fat in dry matter content. The imitation group containing rennet casein and soy protein isolate had the highest ash content ($P<0.01$).

Table 4. Chemical composition of cheese samples (Mean ± SD)

Sample	Dry matter (%)	Fat in dry matter (%)	Total protein (%)	Salt in dry matter (%)	Ash (%)
Control	56.32±0.04[e]	40.76±0. 24[a]	24.70±0.48[e]	6.20±0.03[f]	2.76±0.08[a]
CRC	50.91±0.22[bc]	45.17±0.19[b]	24.32±0.45[d]	2.35±0.07[a]	3.43±0.07[bc]
CCC	50.53±0.60[b]	49.63±0.90[d]	24.08±0.41[d]	3.32±0.08[b]	3.50±0.05[bc]
CSC	46.34±0.33[a]	53.43±0.33[f]	20.05±0.36[a]	4.13±0.07[c]	3.18±0.08[b]
CSOY	52.22±0.41[cd]	52.66±0.41[e]	23.27±0.33[ec]	4.13±0.07[c]	3.77±0.11[c]
R1	52.62±0.25[d]	47.73±0.57[c]	24.14±0.25[d]	5.49±0.04[e]	5.20±0.19[e]
R2	52.32±0.39[d]	49.69±0.67[d]	22.22±0.16[b]	5.03±0.08[d]	4.43±0.24[d]

[a,b,c] Subcolumn means within row and treatment category with different superscripts differ ($p<0.05$)

Textural characteristics

Significant differences were found between samples with respect to hardness ($P<0.01$), adhesiveness ($P<0.01$), gumminess ($P<0.01$) and chewiness ($P<0.01$). The hardest groups were the batches filled with sodium caseinate and calcium caseinate, while the softest group was the control. However, the two imitation groups were softer than the filled type cheeses (Figure 1a, 1c, 1e, 1f).
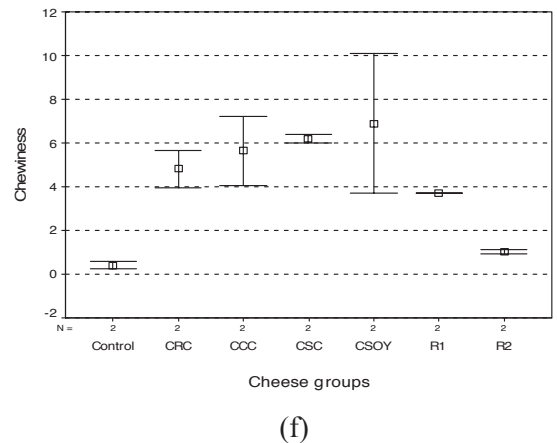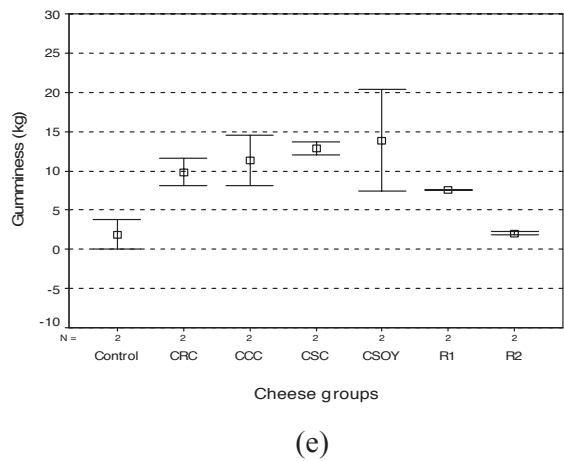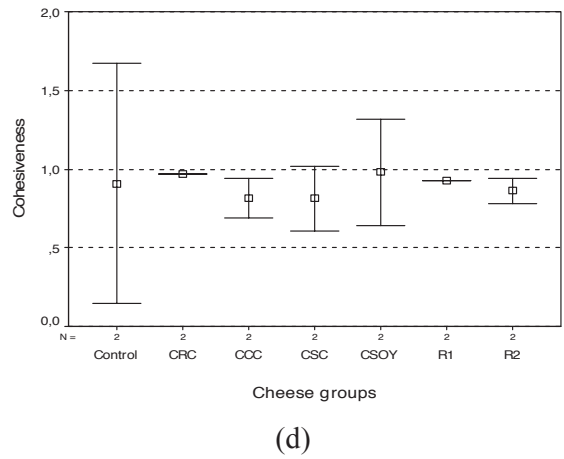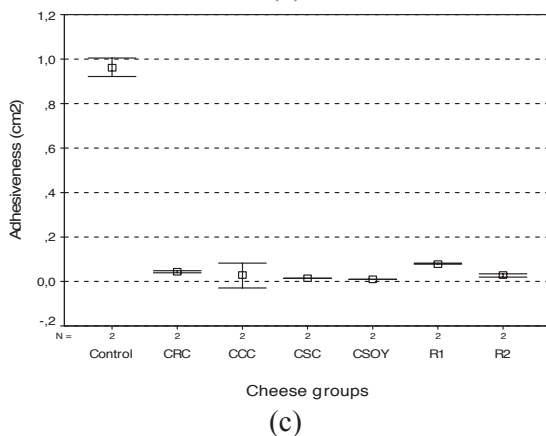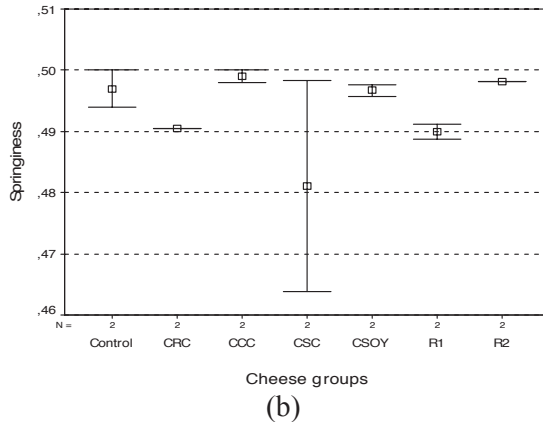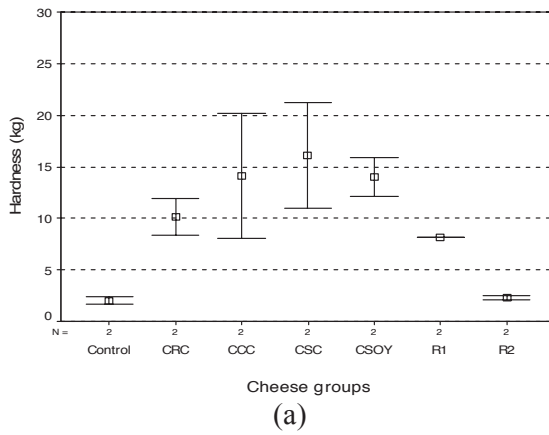

(a)

(b)

(c)

(d)

(e)

(f)

Figure 1. Textural parameters of cheese groups (mean ± SE): (a) hardness (kg), (b) springiness, (c) adhesiveness (cm^2), (d) cohesiveness, (e) gumminess (kg), (f) cheviness.

Control had the lowest gumminess and chewiness values followed by the R1 and the R2 groups (Figure 1b, 1d, 1e, 1f). But, no significant differences were found with respect to springiness, cohesiveness ($P > 0.05$).

Lobato-Calleros et al. (22), stated that soybean fat conferred hardness and adhesiveness to the cheese analogue, however decreased cohesiveness and springiness. Hydrogenated cottonseed oil increased hardness but decreased adhesiveness in both imitation groups. However, the R2 had lower cohesiveness and the R1 had lower springiness values than those for control.

The composition of cheese largely determines its texture (22). Titratable acidity was negatively correlated with hardness (r= -0.621, $P < 0.05$), with gumminess (r= -0.596, $P < 0.05$) and chewiness (r= -0.555, $P < 0.05$). Dry matter correlated with hardness (r= -0.742, $P < 0.01$), with adhesiveness (r= 0.704, $P < 0.01$), with chewiness (r= -0.678, $P < 0.01$). Dimitreli & Thomareis (24), stated there was an increase in springiness and adhesiveness with increasing fat content. Also, fat in dry matter correlated with hardness (r= 0.670, $P < 0.01$), with adhesiveness.

Meltability

With respect to flow measured by Schreiber meltability test, significant differences were recorded between the cheese groups ($P < 0.01$). Differences with respect to flow measured by modified Olson and Price test were also significant ($P < 0.01$). Rennet casein filled group (CRC) had the maximum flow values measured by both tests. El-Nour et al. (25), found that the block type cheese analogue made from %100 rennet casein melted significantly stronger than the samples made with 50% rennet casein + 50% total milk protein. However, the imitation cheese batch containing soy protein isolate (R1) gave the lowest values of flow, measured by Schreiber test (Figure 2a). Similarly, with respect to flow measured by modified Olson and Price test, soy protein containing filled type fresh kashar cheese (TSOY) had the lowest value, which was followed by the R1 (Figure 2b). Lee & Marshall (26) found that soy protein greatly reduced emulsifying capability of casein as evidenced by large size of cavities in microstructures of cheeses containing soy protein.
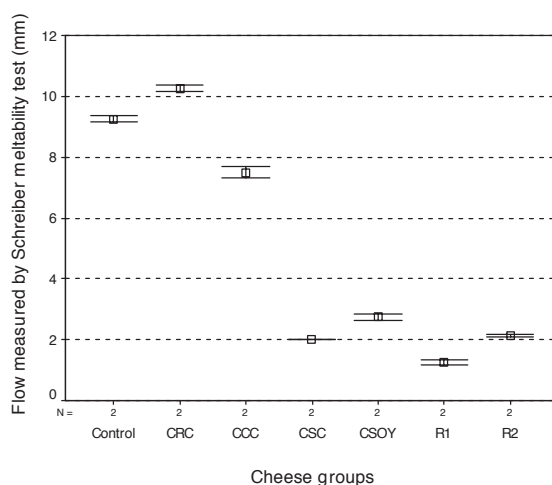
(a)
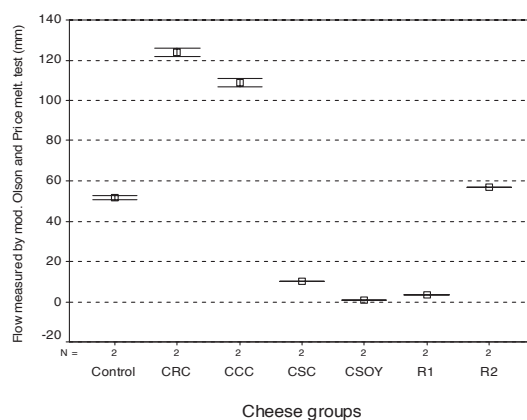
(b)

Within filled groups, calcium caseinate filled sample was the second sample having higher melting capability. Sodium caseinate filled group had also lower values of flow measured by both methods. However, the imitation batch containing sodium caseinate and starch, melted stronger than the batch filled with sodium caseinate, which might arise from the starch addition. Ahmad et al. (8), stated that 6% starch containing imitation Mozzarella cheese had shown significantly higher meltability than the batch produced without starch.

In pizza cheese, the microstructure is characterized by networks of parallel-oriented protein fibres occupied by serum and fat droplets (27). Fat is the only phase in the cheese that truly melts, but at temperatures above the melting point of milk fat,

proteins soften or flow resulting in a melt like phenomenon (28). Increasing the amount of fat will yield a higher meltability and free oil (29). However, a negative correlation was found between Schreiber meltability and fat in dry matter (r= -0.691, $P<0.01$).

Flow measured by Schreiber test also correlated with pH (r= -0.856, $P<0.01$), with protein (r= 0.600, $P<0.05$), with ash (r= -0.641, $P<0.05$). Flow measured by modified Olson and Price test correlated with pH (r= -0.778, $P<0.01$).

CONCLUSION

All the imitation fresh kashar cheese groups had lower dry matter and protein, but higher fat in dry matter values than control.

Significant differences were found between samples with respect to hardness ($P<0.01$), adhesiveness ($P<0.01$), gumminess ($P<0.01$) and chewiness ($P<0.01$). The hardest groups were the batches filled with sodium caseinate and calcium caseinate, while the softest group was the control. However, the two imitation groups were softer than the filled type cheeses.

Soy protein isolate containing samples showed the poorest meltability (CSOY and R1). Sodium caseinate filled group had also lower values of flow measured by both methods (CSC). However, modified starch addition improved meltability in R2 group which also contained sodium caseinate. Better meltability was observed in rennet casein (CRC) and calcium caseinate (CCC) filled groups.

Rennet casein filled batch (CRC) and the R2 batch containing sodium caseinate and modified starch gave the best results among the imitation cheese groups with respect to textural and melting properties.

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