Journal of Food and Nutrition Research, 2013, Vol. 1, No. 6, 128-131
Available online at http://pubs.sciepub.com/jfnr/1/6/3

DOI:10.12691/jfnr-1-6-3

Effect of Whey Protein Concentrate and Cornstarch on Chemical, Rheological and Sensorial Properties of White Feta Cheese

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Received August 27, 2013; Revised September 28, 2013; Accepted November 12, 2013

Abstract This study examined the effect of whey protein concentrate and cornstarch on the chemical, rheological, and sensorial properties of feta cheese. Four combinations were tested: C (control; no additive), A (1.5% cornstarch), B (1.5% whey protein concentrate), AB (0.75% cornstarch and 0.75% whey protein concentrate).Sampling was done at 3, 7, 14, 28 days after production and sensory testing was performed 28 day after production. All treatments exhibited significant differences in sensory (flavor, appearance, overallacceptance), chemical (acidity, pH, dry matter, lactic and acetic acid content), and rheological properties ($p< 0.05$). Results showed positive effects from these two components on cheese properties. The addition of either cornstarch whey protein or a mixture of them increased dry matter in the cheese samples. The addition of whey protein increased lactic and acetic acid and softness. The mixture of whey protein concentrate and cornstarch scored the highest grade on the sensorial evaluation.

Keywords: *whey protein concentrate, cornstarch, feta cheese, rheological properties*

Cite This Article: A. Tashakori, S.A. Yasini-Ardakani, and M. Daneshi, "Effect of Whey Protein Concentrate and Cornstarch on Chemical, Rheological and Sensorial Properties of White Feta Cheese." *Journal of Food and Nutrition Research* 1, no. 6 (2013): 128-131. doi: 10.12691/jfnr-1-6-3.

1. Introduction

White feta cheese is a soft cheese that matures in saltwater and has a maturation period on the industrial scale of 45-90 days. It has an acidic and salty taste and 18%-20% fat [1,5]. Whey protein concentrate is a food product produced by eliminating the lactose and salt in whey. The US Food and Drug Administration defines whey concentrate as obtained by separating the non-protein components from the whey so that the final product after drying contains at least 25% protein. The amount of lactose should not exceed 60% and it is generally recognized as safe [13].

When whey proteins are heated, they aggregate and gelatinize under suitable conditions and display various performance propertie similar to fat, such as emulsification, water absorption, viscosity, and adherence [14]. These determine rheological and structural network properties and define the water retention capacity of the protein gel in this substance. It is possible to increase the food value and quality of this product with the addition of whey protein concentrate, especially if it improves the taste. Whey protein concentrate has been substituted for fat in ice cream [16], for albumen protein in cake [15], and as a stabilizer for cornmeal bakery products [11]. It has been used with starch sources, such as cornstarch, to improve the properties and quality of food products [2,7].

This research examined the effect of whey protein concentrate and cornstarch on the chemical and rheological properties of white feta cheese.

2. Materials and Methods

2.1. Cheese Production

The milk used in this research was first cooled to 4°C. After microfiltration, fat standardization (3% to 4.5%), pasteurization (72°C for 12 s), ultra-filtration, the retentate was moved to the culture tank (Hansen, Denmark).The cornstarch and whey protein were pasteurized separately and then added. After bringing the contents of the tank to 32°C, rennet was added (Sangyo, Japan). In the sealing process, 2.5% to 3%(wt) salt was poured onto parchment paper which was placed over the surface of the cheese and covered with aluminum foil. Then the tank was closed and heat sealed. During maturation, cheese kept in 4-6°C until testing time.

2.2. Method

Acidity was measured by titration using NaOH at 0.1 N (Merck, Germany) in the presence of phenolphthalein (Merck, Germany), pH was measured using a pH meter (Knick766, Germany) according to Iranian national standard no. 2852 [9].

The amount of dry matter was measured according to Iranian national standard no. 1753.This method is based on the evaporation of water in the sample mixed with sand, the oven (pls Memmert 600.Germany) at 102°C.

The HPLC system (Shimadzu LC-64) was used to determine organic acid. This system was equipped with an ultraviolet indicator (Shimadzu SPD-6AV), column oven (CTO-6A), controller system (SCL-6A), and computer analyzer chromotropic (CR4A). One ion exclusion separator column, (shimadzo model SCR-44 10H) 7.9 x 300 mm in size was used in the oven at 70°C; each sample was injected into the injection port. The ultraviolet indicator was adjusted to 214 nm. The mobile phase was isocratic and 0.009 N dilute sulfuric acid was used. The solution was passed through filters under a 0.145 µ vacuum and then exhausted under vacuum for 20 min. The mobile phase speed was 0.7 mm/min, chart speed was 5 mm/min. The method recommended by the manufacturer was used to determine the percentage of recovered organic acid.

Uniaxial compression, the simplest fundamental test, was done by the universal Experiment Machine HTE (Hounfield test, UK S-series Bench UTM model H 5k- S, Redhill, Equipment Ltd).This machine was equipped with loadcell of 500N.To do the experiment, a flat piston with 49 mm diameter was connected to machines forwarding front. Cheese pieces were cut into cylinders of 25 mm diameter and 10 mm height in 5°C. To prevent losing their moisture quickly, they were put in airtight containers and potted. Cheese samples were selected from depth of at samples at have temperature equal with room temperature, they were kept in room at least 4 hours before testing. The samples were pressed in uniaxial way with forwarding frnt speed of 50 mm/min to 57% of the samples primary height in amunch. The shear stress (σ) was calculated by dividing the force at the shear point on the deformation curve of the first area of the sample and the secant modulus of elasticity (E) at the shear point.

Sensorial assessment was done by a 10 member group of trained panelists according to the hedonic method and according to Iranian national standard no.4983. Sensory evaluation was carried out with scoring test by ten trained panelists who are the members of Food Engineering Department. The panelists were selected on the basis of their interest in sensory evaluation of cheeses. The cheeses were evaluated for appearance, flavour, texture and overall acceptability using a score from 1 to 5. Panelists were also requested to tick the defects on the panel scale in order to determine the reasons of decrease in scores

3. Results and Conclusion

3.1. Acidity and pH

The acidity of the samples increased and the pH decreased during the 28 days production process. The results showed that the control sample had the lowest acidity and highest pH and the sample with 1.5% whey protein had the highest acidity and lowest pH. There was a significant difference between the cheese samples ($p<0.05$) (Table 1 and Table 2). Since the whey protein concentrate was obtained by separating the non-protein from the whey, samples with whey protein had more lactose and their acidity increased during storage. The decrease in pH during days after production was attributed to the increase in lactic acid production due to the activity of starter culture [6,8].

Table 1. Tests of significant differences in acidity of the cheese samples (in basis of Lactic Acid)

	3days	7days	14days	28days
Control	0.42^{Dbc}	0.44^{Dd}	0.51^{Bd}	0.56^{Ad}
Cheese with 1.5% corn starch	0.41^{Cc}	0.45^{BCc}	0.53^{ABc}	0.63^{Ac}
Cheese with 1.5% whey protein	0.64^{Da}	0.72^{Ca}	0.76^{Ba}	0.82^{Aa}
Cheese with 0.75 % corn starch and 0.75 % whey protein	0.52^{Db}	0.58^{Cb}	0.60^{Bb}	0.66

Small shared letters indicate no significant differences in each column and Large shared letters indicate no significant difference in each row

Table 2. Tests of significant differences in pH of the cheese samples

	3days	7days	14days	28days
Control	6.32^{Aa}	6.32^{Bb}	6.24^{Ca}	6.14^{Da}
Cheese with 1.5% corn starch	6.32^{Ba}	6.32^{Ba}	6.24^{Ca}	5.97^{Dc}
Cheese with 1.5% whey protein	5.33^{Ab}	5.28^{Bc}	5.22^{Cd}	5.15^{Dd}
Cheese with 0.75 % corn starch and 0.75 % whey protein	6.24^{Aa}	6.19^{Bb}	6.11^{Cc}	6.02^{Db}

Small shared letters indicate no significant differences in each column and Large shared letters indicate no significant difference in each row

3.2. Dry Matter

74 In the initial days of production, the highest amount of dry matter was recorded for the sample that contained 1.5%corn starch and the control sample had the lowest amount. There was a significant difference between cheese samples ($p<0.05$) (Figure 1). At the end of production, again, the sample with 1.5%corn starch had the most dry matter and the control had lowest dry matter (Figure 1). Sant Eve et al had showed in study of effects of dry matter, and salt on cheese properties. They found that an increase in dry matter increased stiffness (texture mechanical and taste test) and elasticity. An increase in salt decreased stiffness (texture mechanical test) [17].

3.3. Organic Acid (Acetic Acid and Lactic Acid)

Organic acid production increased during production ($p<0.05$) (Figure 2 and Figure 3). Lactic acid increased in the sample containing 1.5% whey protein 3 days after production from 9200µg in the dry matter to 11300µg at 28 days after production. This sample contained the highest amount of acid. The acetic acid in this sample after 28 days had increased from 225µg in dry matter to 145µg. Overall, there was a significant difference between the cheese samples ($p<0.05$) (Table 3 and Table 4). The lactose is converted into lactic acid during cheese making by the starter culture [3]. Therefore lactic acid is the most abundant organic acid in all type of cheese [10]

3.4. Texture

The texture survey was done using a single shaft press 28 days after production. There was a significant difference in texture between the cheese samples ($p<0.05$) (Table 5 and Table 6).

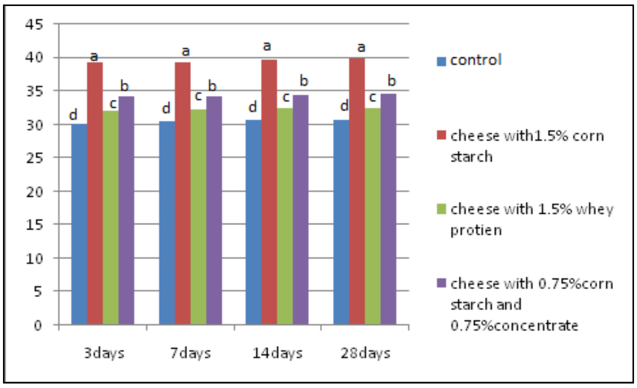

Figure 1. compare dry matter amount in cheese samples(in basis of percent); Small shared letters indicate no significant differences in each column

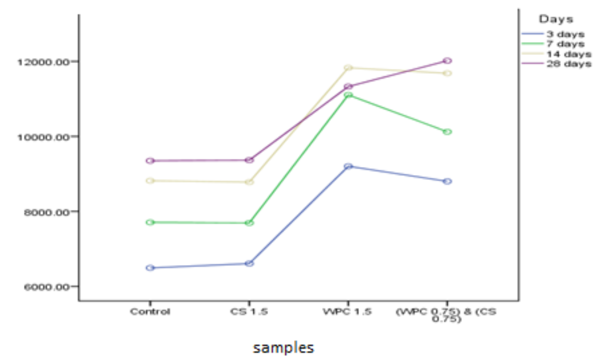

Figure 2. Changes in lactic acid content of cheese samples (in basis of microgram in dry matter)

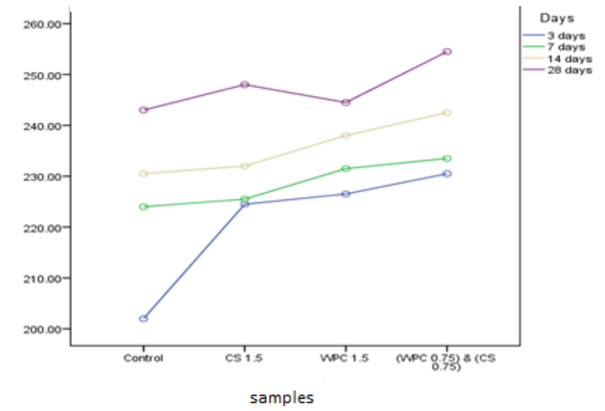

Figure 3. Changes in Acetic acid content of cheese samples (in basis of microgram in dry matter)

Table 3. Lactic acid amount in cheese samples (in basis of microgram in dry matter)

	3days	7days	14days	28days
Control	6492.5^{Dd}	7706^{Cc}	8817^{Bc}	9349.5Ac
Cheese with 1.5% corn starch	6608^{Dc}	7692^{Cc}	8780^{Bd}	9365^{Ac}
Cheese with 1.5% whey protein	9202.5^{Da}	11105^{Ca}	11829^{Ba}	11328^{Ab}
Cheese with 0.75 % corn starch and 0.75 % whey protein	8801.5^{Db}	10122.5^{Cb}	11682.5^{Bb}	12015^{Aa}

Small shared letters indicate no significant differences in each column and Large shared letters indicate no significant difference in each row

Table 4. Acetic acid amount in cheese samples (in basis of microgram in dry matter)

	3days	7days	14days	28days
Control	202^{Dc}	224^{Ba}	230.5^{Ba}	243^{Ab}
Cheese with 1.5% corn starch	224.5^{Bb}	225.5^{Ba}	232^{ABa}	248^{Aab}
Cheese with 1.5% whey protein	226.5^{Dab}	231.5^{Ca}	238^{Ba}	244.5^{Aab}
Cheese with 0.75 % corn starch and 0.75 % whey protein	230.5^{Ca}	233.5^{Ca}	242.5^{Ba}	254.5^{Aa}

Small shared letters indicate no significant differences in each column and Large shared letters indicate no significant difference in each row

Table 5. Shear stress of chesse sample by survey test of texture according to single press(in basis of kpa)

	3days	7days	14days	28days
Control	17.3^{Da}	25.14^{Ca}	37.07^{Bb}	46.58^{Ac}
Cheese with 1.5% corn starch	15.23^{Db}	24.64^{Cb}	42.57^{Ba}	69.19^{Ab}
Cheese with 1.5% whey protein	7.36^{Dd}	11.55^{Cd}	19.88^{Bd}	26.22^{Ad}
Cheese with 0.75 % corn starch and 0.75 % whey protein	12.99^{Dc}	22.71^{Cc}	36.07^{Bc}	72.29^{Aa}

Small shared letters indicate no significant differences in each column and Large shared letters indicate no significant difference in each row

Table 6. Elastic young module E, of cheese sample by survey test of texture according to single shaft press method (in basis of kpa)

	3days	7days	14days	28days
Control	34.18^{Da}	51.34^{Ca}	74.27^{Bb}	94.26^{Ac}
Cheese with 1.5% corn starch	31.12^{Db}	49.18^{Cb}	86.14^{Ba}	101.18^{Ab}
Cheese with 1.5% whey protein	14.13^{Dd}	26.08^{Cd}	39.20^{Bd}	54.20^{Ad}
Cheese with 0.75 % corn starch and 0.75 % whey protein	26.16^{Dc}	45.32^{Cc}	73.60^{Bc}	144.11^{Aa}

Small shared letters indicate no significant differences in each column and Large shared letters indicate no significant difference in each row

The shear stress and secant modulus of elasticity increased for all samples by 28 days after production. The maximum shear stress and secant modulus of elasticity was recorded for the sample with 0.75% cornstarch and 0.75 whey protein. The sample with 1.5% whey protein had the lowest shear stress and secant modulus of elasticity. Stress in the shear point is directly related to cheese stiffness. The more stress at the shear point, the more stiffness, and vice versa. Similar to stress at the shear point, the greater the secant modulus of elasticity, the greater the stiffness of the cheese. Therefore, according to the results of the texture test, the sample with 1.5% whey protein, the samples with 0.75%cornstarch and 0.75% whey protein, and the sample with 1.5%cornstarch had the highest to lowest amounts of softness. Brigheti et al examined the taste, texture, and rheological properties of 18 cream cheese samples with different amounts of fat and assessed the softness using a penetration test. They found that a decrease in fat or increase in the protein surface enhanced softness of the cheese texture [4]. In another study, Sheriaber et al reported that using less than 0.5% whey protein increased humidity and efficiency [18].

3.5. Sensory Evaluation

Sensory evaluation showed that the sample containing 0.75% cornstarch and 0.75%whey protein concentrate had highest score (Figure 4). Zalazar et al studied the effect of Dairy-Lo (a fat substitute made from whey protein) on the rheological and sensory characteristics of low-fat soft cheese. They found that the best rheological properties observed for the whey protein composition after 30 days [19].

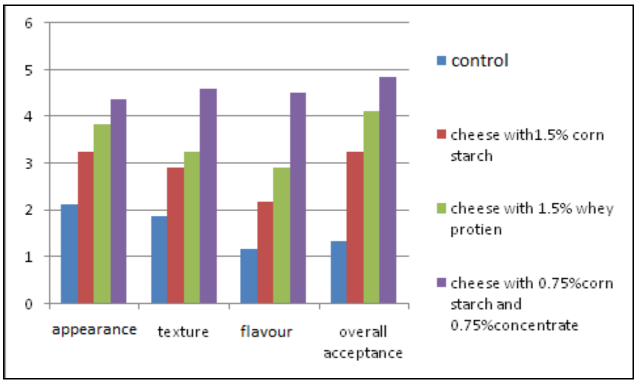

Figure 4. comparing panelists s scores(scores between 0-5)

3.6. Statistical Analysis

All figures were done using Excel software. two-way analysis of variance for the all data except sensory analysis were carried out to determine the significance of the individual differences. Significant means were compared using Duncan test on the level of $P<0.05$. All the statistical analyses were conducted using the SPSS (Version 8.0) commercial statistical package.

4. Conclusion

The results of this research showed the positive effect of adding whey protein and corn starch on the taste, rheological, and Physicochemical properties of cheese. Adding cornstarch alone or in combination with whey protein increased dry matter content in the cheese samples. The addition of whey protein increased the acetic and lactic acid and the softness of the cheese samples. Cheese samples with a mixture of cheese whey and cornstarch had best panelists scores.

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