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PRODUCTION AND UTILIZATION OF GOAT'S MILK IN SOFT CHEESE MAKING

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ABSTRACT

Control (G1) and three additives representing caraway (*Carvum carvi L.*) (G2) ; fennel (*Foeniculum vulgare*) (G3) and fenugreek (*Trigonella foenum-graecum*) (G4) were exqmined out on the daily feed intake of Damascus goats at the rate of 100, 100 and 200 mg dried seeds/kg live body weight, respectively.

After the suckling period, milk yield and composition were recorded during lactation period from April to August. Rennet clotting time (RCT), curd tension (CT) and curd syneresis (CS) were determined as affected by the experimental rations (G1-G4). The yield, composition and sensory propertied of the manufactured soft cheese were also assessed.

Results revealed that daily milk yield was the highest in G2 and was the lowest in G4, while it was greatly affected by lactation period. Milk fat, casein, TS, SNF, ash and TVFA were not affected by the applied additives, whereas protein content was significantly lower in G1. RCT was significantly higher in G3 and lower in G4, whereas CT was significantly higher in G1 and the differences due to G2, G3 and G4 additives were insignificant. CS showed higher and lower significant values in G1 and in G4, respectively.

Cheese yield was significantly higher in G4 and total solids and protein contents of cheese were significantly higher in G3, whereas the organoleptic properties were not significantly affected by the applied additives

INTRODUCTION

The milk of small ruminants such as goats is of particular economic interest in the developing countries. The production of this type of milk has to be a useful strategy to tackle the problem of under nutrition (Haenlein, 2004). However, the use of goat becomes an opportunity to diversify the dairy market since it allows us to develop added value to the milk and dairy products in general.

In addition, the worldwide goat population, goat's milk production and its nutritional and healthy properties as well as its suitability for making some dairy products compared to cow's milk are recently given by Eissa *et al.* (2010).

On the other hand, using medicinal herbs and seeds to be a trend globally and medicinal plants instead of hormones and antibiotics could be widely accepted as feed additives to improve the efficiency of feed utilization and animal productivity (Aboul-Fotouh *et al.*, 1999).

Simon *et al.* (1984) observed that Fennel is a good herb for the entire digestive system as a laxative, appetite stimulant, antispasmodic and carminative, relieves abdominal pain, and is useful for gastrointestinal and colon disorders. Duke (2002) and Sahalian (2004) reported that fenugreek benefits the digestive system as a laxative, intestinal lubricant, carminative, vomiting, colitis, swell, vermifuge, digestive and tonic, helps dissolve fat and cholesterol deposits, prevents fat accumulation and water retention, and helps lower blood sugar levels.

Allam *et al.* (1999) observed that using fenugreek seeds, nigella sativa seeds and garlic cloves as feed additives in the rations of Zaraibi goats improved the nutritive values, feed conversion and economic return; and minimized feed cost during suckling period. Fenugreek was increased feed intake by 13.64%. Also, Khattab *et al.* (2001) observed that the addition of 200 g fenugreek seeds, 50 g caraway, 50 g black seeds and 100 g *Lepidium sativum* to the basal diet of lactating buffaloes increased ($P<0.05$) milk yield and 4% FCM. The nutrients digestibility increased significantly in the treated rations.

Concentrate supplementation to lactating goats is a major method of manipulating milk yield and composition (Sauvant and Morand-Fehr, 2000). There is insufficient information regarding feeding systems and other factors affecting chemical composition of goat's milk and its soft cheese.

Therefore, the present study was conducted to evaluate effects of addition of caraway (*Carvum carvi L.*); fennel (*Foeniculum vulgare*) and fenugreek (*Trigonella foenum-graecum*) seeds to the rations of Damascus goats on milk yield and composition as well as yield and quality of the resultant soft cheese.

MATERIALS AND METHODS

A number of 28 exotic Damascus goats belonging to herd of Sakha Animal Production Research Station, Animal Production Research Institute were used in the present study. All does were given the NRC feeding requirements (NRC, 1996) for does production of 1-2 kg milk/head/day. The daily feed intake per doe composed of 1.250 kg concentrate mixture + 4 kg fresh berseem (in winter) or 1.2 kg berseem hay (in summer). Does were divided into four groups: G1 represented the control (with no additives), whereas in G2, G3 and G4 treated groups additives caraway (*Carvum carvi* L.); fennel (*Foeniculum vulgare*) and fenugreek (*Trigonella foenum-graecum*) seeds were added to concentrate mixture at the rate of 100, 100 and 200 mg dried seeds/kg live body weight/head/day, respectively.

After kidding, during the suckling period, all does groups were milked twice/day by hand biweekly. Milk yield was individually measured, recorded and samples were taken for chemical analysis. The total milk yield for a doe at the day of milking was considered to represent her average daily milk yield during the previous two weeks. During the day of milking, kids were removed from their dams and allowed to suckle other goats. After the suckling period, machine milking was applied twice daily up to the end of lactation. Milk yield was individually measured at each milking time using True-Test milk meter fixed on the milk line. 100 ml from each doe was taken monthly for chemical analysis. Each doe was dried up to when her daily milk yield declined to 200 g for three successive days. The daily milk and duration of lactation were individually recorded and lactation curve was established for goats of each treatments group.

During suckling period, at the day of hand-milking, the morning milk from goats of each treatment groups was pooled, cooled at 5°C, added to the evening milk, mixed well and representative samples were taken. During machine milking period, morning milk samples - taken by the milk meter – kept ay 5°C and were added to the evening ones, pooled and the representative treatment groups samples were taken for chemical analysis and for some properties.

Fat and total solids (TS) were measured according to Ling (1963) whereas ash was as described in AOCA (1984). Total volatile fatty acids (TVFA) content was measured as given by Kosikowski (1978). Total nitrogen (TN) was determined using micro-Kjeldahl as recommended by Rowland (1938). Non-casein nitrogen (NCN) and non protein nitrogen (NPN) were determined in the collected filtrate after precipitation of casein and protein, respectively. Casein nitrogen (CN) and whey protein nitrogen (WPN) were quantified by the differences as given by Rowland (1938) as follows: CN = TN-NCN; casein = CN x 6.38 and whey protein = (NCN-NPN) x 6.38.

Rennet coagulation time (RCT) was determined according to Berridge (1952), curd tension (CT) was measured at room temperature (27-30°C) as given by Chandrasekhara *et al.* (1957), whereas curd syneresis (CS) was followed according to Mehanna and Mehanna (1989).

Soft cheese was manufacture mainly as given by Fahmi and Sharara (1950). Yield of fresh cheese (kg /100 kg milk) was calculated from each milk treatment groups. All cheese samples were analyzed for total solids (TS), fat and TN as described by Ling (1963). The organoleptic properties were assessed as recommended by Naguib *et al.* (1974).

Analysis of variance and Duncan's test as well as average and standard error were carried out suing a SPSS computer program (SPSS, 1999).

RESULTS AND DISCUSSION

Milk yield and composition:

Table (1) shows the differences in average daily milk yield (ADMY) among the experimental groups. The values were the highest in G2 and the lowest in G4, whereas G1 and G3 had nearly the same figures. The changes in ADMY at the different lactation periods in all experimental groups (Fig. 1) showed that the control groups had the lowest values while, G2, G3 and G4 had the highest values and were recorded the highest yield at 1st month followed by gradual decrease up to the end of lactation.

These increases in milk yield for the treatment groups (G, G2 and G3) might be attributed to the glactopoetic effect of seeds supplemented diets. It was found that fenugreek seeds contains the steroidal saponin, diosgenin, trigofoenosides A-G, alkaloid and trogonelline (Ghazanfar, 1994). Saponin is the major constituent of these appetite and discourahe constipation caraway, fennel and fenugreek seeds, also decreased blood urea (Sharma *et al.*, 1996) and there was a negative relationship between blood urea and milk yield (Kholif, 1999). Singh *et al.* (1993) concluded that the positive effect of galactogogues on milk production due to decreasing the circulating biogenic amines (histamine, tryptamine and tyramine) in blood which cause excessive release of catecholamines in mobile pool leading to suspension of milk secretion as well as cause indigestion by inhibiting the ruminal mobility and absorption. Similar results were given for milk yield from goats (Malinowski *et al.*, 1996 using fenugreek), and from buffaloes or goats (Khurana *et al.*, 1996 using Nigella sativa).

Table (1): Milk production and milk composition of goat's milk as affected by experimental rations

Property	Treatment groups			
	G1	G2	G3	G4
Milk yield (kg/d)	0.937±0.08^a	0.989±0.06^a	0.938±0.05^a	0.816±0.06^b
Milk composition:				
Fat %	2.58±0.17	2.75±0.16	2.53±0.30	2.83±0.11
Fat yield	74.01±2.91	82.03±3.75	67.55±6.60	73.77±9.00
Protein %	2.884±0.24^b	3.005±0.19^{ab}	2.903±0.19^b	3.394±0.08^a
Protein yield	90.41±3.82	89.64±4.74	81.35±1.31	80.62±8.21
Casein%	2.90±0.32	2.396±0.16	2.36±0.12	2.710±0.07
Casein/TN%	77.26±0.53^a	78.075±0.73^a	77.97±0.78^a	74.14±0.33^b
Whey protein %	0.491±0.03^a	0.364±0.04^b	0.410±0.02^{ab}	0.425±0.02^{ab}
TS%	10.31±0.341	10.53±0.25	10.32±0.46	10.64±0.31
SNF%	7.73±0.52	7.78±0.12	7.79±0.11	7.246±0.33
Ash%	0.77±0.01	0.77±0.02	0.74±0.01	0.75±0.01
TVFA*	0.209±0.01	0.182±0.01	0.199±0.01	0.210±0.01

* ml 0.1 N-NaOH/10 g milk.

Means a, b and c...etc in the same row with different superscripts differ significantly (P<0.05).

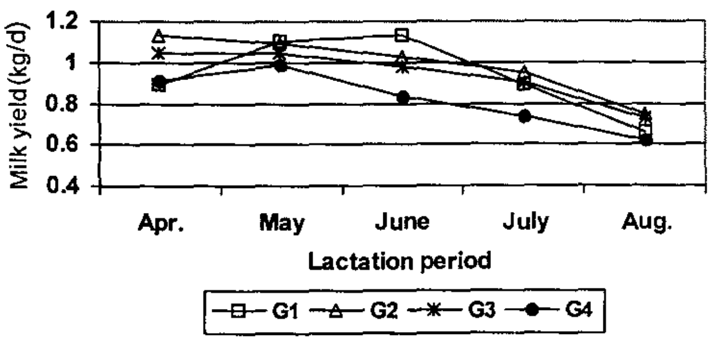

Fig. (1): Milk yield (kg) of goat's milk during lactation period as affected by the experimental rations.

Percentage of milk fat did not differ significantly among the experimental group (Table 1). The values ranged between 2.53 in G3 and 2.83% in G4 and showed the same trend during lactation, while in all treatment groups the maximum value was recorded in 3rd month but the minimum one was at the beginning and end days of lactation, respectively (Fig. 1), G2 showed almost the highest values for fat content among the feeding treatments.

Percentage of protein was significantly ($P<0.05$) different among the experimental groups, being lower in G1, followed by G3, but the differences were not significant between G1, G2 and G3 (Table 1). At lactation time, protein content was the highest in G2 at the first period. It is of interest to note that protein content of groups G3 and G4 showed similar trend of changes during the lactation period (Fig. 2).

Results presented in Table (1), revealed that percentage of casein was not significantly affected by the applied feeding treatments. In spite of the insignificant casein differences the ratio of casein/TN values was the lowest in G4. The whey protein value was higher in G1 followed by G4 and G3 respectively, while the lowest values were in case of G2 (Table 2).

Total solids (TS) contents did not differ significantly among the experimental groups ranging between 10.31 and 10.64% (Table 1). According to the changes in fat and TS contents in all groups, solids not fat (SNF) content did not differ significantly among the experimental groups. SNF showed nearly similar trend to that occurred in fat and TS contents (Fig. 2).

Ash content was not significantly affected by the applied treatments and the values ranged between 0.74 and 0.77% (Table 1 and Fig. 2). Total volatile fatty acids (TVFA) content was also not affected significantly by feeding treatments (Table 1 and Fig. 2) since all the experimental groups showed nearly similar figures. Generally, it is well known that the gross composition of goat's milk is affected by many factors such as diet, breed, parity, stage of lactation and environmental conditions (Guo *et al.*, 2001).

In general stage of lactation seems to have the same impact given in the literature on the gross chemical composition of goat's milk (Guo *et al.*, 2001 and Soryal *et al.*, 2004).

Characteristics of milk coagulum:

Table (2) reveals that the trend of rennet clotting time (RCT) was different as affected by the applied treatments. The values of RCT were insignificantly different between G1 and G2 and were in between those of G3 and G4. G3 samples had the highest significant values, whereas G4 had the lowest significant figures. This trend of results reflected on curd tension and curd syneresis. Thus, the control samples had the highest curd tension value, which differed significantly than those of the other treatments. However, the differences in curd tension values due to G2, G3 and G4 treatments were insignificant. Such trend of results was accompanied by similar trend for the curd syneresis. Thus, G1 had the highest curd syneresis values, which significantly differed than those of the other treatments especially at the late syneresis time. Curd from G4 gave the lowest values in this respect followed by those of G3 and G2, respectively.

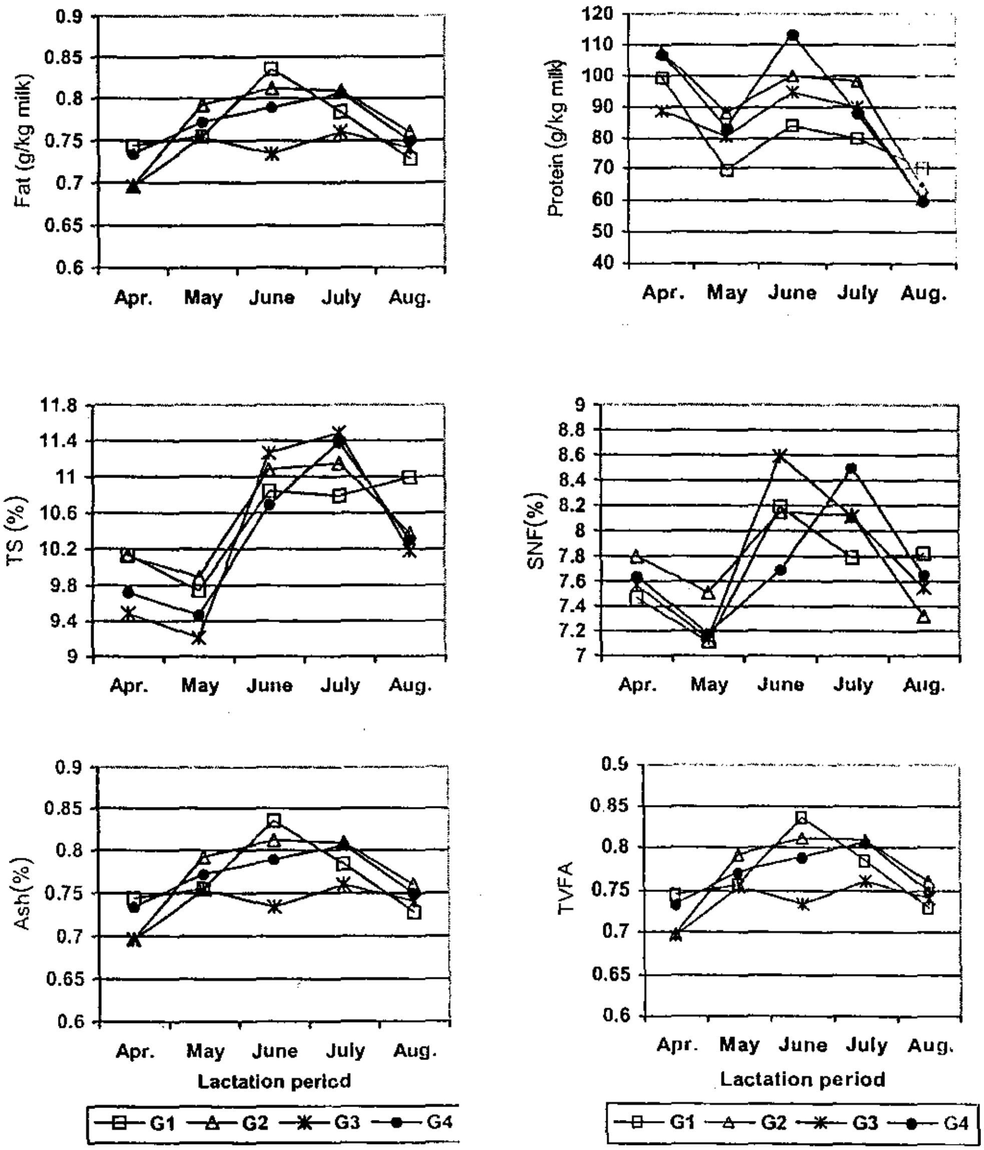

Fig. (2). Yield of fat and protein (g/kg milk) and chemical composition of milk during the lactation period from April to August as affected by the feeding treatments groups.

Table (2): Rennet clotting time (min), curd tension (g) and curd syneresis (g/15 g) of goat's milk as affected by experimental rations (G1-G4)

Treat.	Item	Clotting time	Curd tension	Curd syneresis after			
				10 min	30 min	60 min	120 min
G1	Min.	12.58	14.0	5.33	6.47	7.63	7.94
	Max.	12.95	19.0	5.64	6.75	7.27	8.53
	Mean	12.72^{b}	16.0^{b}	5.54^{a}	6.66^{a}	7.45^{a}	8.26^{a}
	SE	0.115	0.730	0.103	0.080	0.180	0.290
G2	Min.	11.18	10.0	5.34	6.01	7.05	7.44
	Max.	13.00	18.0	5.85	6.46	7.36	7.56
	Mean	12.10^{b}	13.83^{a}	5.59^{a}	6.33^{a}	7.26^{b}	7.53^{b}
	SE	0.525	0.325	0.256	0.126	0.100	0.020
G3	Min.	16.78	10.0	5.01	5.86	6.77	7.09
	Max.	18.00	16.0	5.25	6.00	6.82	7.23
	Mean	17.20^{a}	13.67^{a}	5.13^{a}	5.94^{ab}	6.79^{b}	7.12^{b}
	SE	0.398	0.918	0.118	0.060	0.020	0.010
G4	Min.	10.26	11.0	4.04	4.93	5.96	6.39
	Max.	10.41	15.0	4.57	5.73	6.36	6.55
	Mean	10.31^{c}	13.50^{a}	4.31^{b}	5.33^{b}	6.16^{c}	6.52^{c}
	SE	0.050	0.710	0.264	0.390	0.201	0.030

Means a, b and c... etc in the same column with different superscripts differ significantly ($P<0.05$).

Soft cheese:

Data in Table (3) showed that yield of the fresh cheese was significantly higher in G4 than the values from the other treatments. In spite of cheese yield from treatment G3 was the lowest, the differences in this respect between G3, G2 and G1 were insignificant. It may of interest to note that the lowest cheese yield (17.77%) was correlated with the corresponding longest clotting time (17.2 min, Table 2) from G3 treatment that due to the coagulation of milk is fundamental to cheese manufacturing. On the other hand, the highest cheese yield was accompanied with the lowest curd syneresis given for G4 in Table (2). So, retention of more moisture was the main factor herein in increasing the yield of the resultand cheese. However, cheese yield in the present study was higher than those given by Mehanna and Hefnawy (1991) who gave value of 15.17% for yield of Domiati cheese made from goat's milk. Soryal *et al.* (2004) gave values of 12 to 18% and attributed such range of results to variations in moisture content.

Total solids of the resultant cheese was the highest in G3 and was the lowest in G4 treatments, whereas insignificant differences were recorded between TS of G1 and G2 cheese. The differences in fat content due to the applied treatments were insignificant in spite of the control cheese had the highest fat content. Protein content was the highest in G3 cheese with insignificant differences with that of G2 cheese. G1 and G4 had the lowest protein content. Such figures of chemical cheese composition confirmed our finding that characteristics of the curd were responsible for cheese yield. i.e. curd tension and curd syneresis contributed greatly in holding more water in the curd, that by turn greatly affected yield of the resultant cheese.

The orgaoleptic evaluation (Table 3) revealed that the falvour of the resultant cheese was not affected by the applied treatments with exception of cheese from G3 treatment, which ranked the lowest scoring points. The differences in this respect between cheese falvour of the other treatments were insignificant. The attained goaty flavour in all cheeses was attributed to the abundant amount of short-chain fatty acids in goat's milk as compared with cow milk. However, in order to understand the relationships that may exist between cheese flavour and types of feed, it is necessary to identify the possible origin of the components responsible for cheese flavour and particularly the origin of volatile fatty acids and other volatile compounds. In this respect, Bugaud *et al.* (2001) demonstrated that most of the volatile compounds in cheese result from the metabolism cheese microorganisms, endogenous microflora of raw milk or starters. In some cases, they came directly from the feed. The body and texture, saltiness and appearance were not affected by the applied treatments since the scoring points given were not significantly different, however, the total score given for G3 cheese was significantly lower than those given for the other cheeses.

Table (3): Effect of experimental rations on cheese yield, chemical composition and organoleptic properties of fresh Domitte cheese

Property	Treatment groups			
	G1	G2	G3	G4
Yield, %	19.84 ± 0.84^{b}	19.17 ± 0.84^{b}	17.77 ± 0.57^{b}	23.08 ± 0.08^{a}
Total solids, %	31.73 ± 0.20^{ab}	31.85 ± 0.38^{ab}	36.67 ± 0.16^{a}	28.83 ± 0.57^{b}
Fat, %	14.50 ± 0.05	12.00 ± 0.20	13.25 ± 0.25	12.75 ± 0.75
Protein, %	8.62 ± 0.53^{b}	10.15 ± 0.18^{a}	11.01 ± 0.86^{a}	8.79 ± 0.07^{b}
Sensory scores*				
Flavour (60)	49.62 ± 2.32^{a}	49.75 ± 2.22^{a}	42.38 ± 1.19^{b}	48.00 ± 1.20^{a}
Body & texture (30)	25.13 ± 1.60	26.38 ± 1.12	25.88 ± 1.15	26.50 ± 1.23
Saltiness (5)	3.13 ± 0.30	4.25 ± 0.25	4.25 ± 0.25	4.00 ± 0.33
Appearance (5)	4.25 ± 0.25	4.38 ± 0.33	3.87 ± 0.29	4.00 ± 0.33
Total (100)	82.13 ± 1.52^{a}	84.76 ± 2.05^{a}	76.38 ± 1.85^{b}	82.50 ± 1.63^{a}

*** Average±SE of 15 evaluations from 3 replicates.**
Means a, and b in the same row with different superscripts differ significantly ($P<0.05$).

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تأثير بعض الاضافات الغذائية على إنتاج لبن الماعز وتصنيع الجبن الطرى

هناء سيداحمد صقر
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قسمت ٢٨ معزة دمشقي الى اربع مجموعات متساوية: المجموعة الاولى مقارنة ، تم اضافة بذور الكراوية ، الشمر ، الحلبة الجافة يوميا على الغذاء بمعدل ١٠٠ ، ١٠٠ ، ٢٠٠ ملجم /كجم من وزن الماعز للمجموعات الثانية والثالثة والرابعة على الترتيب.

بعد نهاية فترة الرضاعة ، تم تقدير محصول اللبن وتركيبة الكيماوى خلال فترة الحليب التى تبدأ من أبريل الى نهاية أغسطس. تم حساب الوقت اللازم للتجبن RCT وصلابة الخثرة CT و تشريش الخثرة CS تحت تأثير المعاملات الغذائية من الاولى الى الرابعة. تم حساب محصول والتحليل الكيماوى والخواص الحسية للجبن الطرى المصنع من لبن تلك المعاملات.

اوضحت النتائج ان اعلى انتاج اللبن كان للمجموعة الثانية بينما كان اقل المجموعات للمجموعة الرابعة تحت تأثير الفترة من الحليب. دهن اللبن والكازين والمواد الصلبة والجوامد الصلبة اللادهينة والرماد والمحتوى من الاحماض الدهنية لم تتأثر بالمعاملات الغذائية للمجموعات بينما كان محتوى المجموعة الرابعة من البروتين عاليا وبفروق معنوية عن باقى المجموعات . الوقت اللازم للتجبن كان عاليا للمجموعة الثالثة ومنخفضا للمجموعة الرابعة وبفروق معنوية بينما صلابة الخثرة كانت عالية وبفروق معنوية للمجموعة الاولى عن باقى المجموعات المعاملة . كان تشريش الخثرة عاليا للمجموعة الاولى وكان منخفضا للمجموعة الرابعة.

تصافى الجبن الناتج كان عاليا للمجموعة الرابعة عن باقى المجموعات وقد يكون ذلك راجعا لاحتفاظ الخثرة بكميات عالية من الرطوبة نتيجة طردها لكمية شرش أقل ، اما الجوامد الصلبة والبروتين كان عاليا وبفروق معنوية للمجموعة الثالثة ، بينما الخواص الحسية لم تكن معنوية تحت تأثير معاملات الاضافات الغذائية.

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