

## **Production of Traditional Cheese Coagulant in Farmhouse and Coagulating Effect**

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### **ABSTRACT**

Milk-clotting enzymes are the primary active agents in the manufacture cheeses. Animal rennet, microbial coagulant and plant coagulant are used as milk coagulants in cheese making. However, alternative milk coagulants are investigated instead of animal enzymes due to slaughtering of young ruminant. Manufacturing of milk clotting enzyme in farmhouse have been employed successfully for many centuries in Mediterreanean region and Toros mountain villages of Turkey for the production of traditional Tulum cheese. Figs, raisins, white beans, chickpeas, carob, granulated sugar, salt, yoghurt and home-made rennet (sarkanak) are found in the content of this enzyme. This mixture is left at room temperature for 5-6 days. The enzyme is filtered from using cloth bag and added into milk for coagulation. In this research; chemical composition of cow's milk, goat's milk and ewe's milk were determined and obtained enzymes from different manufacturers were investigated of clotting effects on cow's milk, goat's milk and ewe's milk. Four different coagulants had a strong coagulating effect on raw and pasteurized ewe's milk. The highest milk clotting activity of all coagulant samples were seen in ewe's milk, followed by cow's milk and goat's milk.

**Keywords:** Cow's milk, goat's milk, ewe's milk, milk-clotting enzyme, cheese.

### **INTRODUCTION**

Average total milk production in Turkey is around 18 million tons per year. Cow's milk provides 91.39% of it, 6.04% is ewe's milk and 2.28% is goat's milk<sup>1</sup>. Goat production in Mediterranean countries is particularly important under extensive conditions and ewe's milk with goat milk are consumed locally and processed delicious cheeses that are highly appreciated by the consumers. Their particular sensory characteristics are more preferred than cow's milk cheeses due to the composition of sheep and goat's milk<sup>2</sup>.

Coagulation of milk is the main step in the manufacture of cheese and can be achieved by a number of proteolytic enzymes from various sources, such as different animal species, microbial

proteinases and proteinases extracted from fruits and plants<sup>3</sup>. Calf rennet is still the most commonly used enzyme in cheese making. However, the increasing consumption of cheese and coupled with a world shortage of calf rennet have encouraged a search for alternative milk coagulants<sup>4,5</sup>.

In past times, the clotting enzyme was extracted from cleaned and air-dried stomachs by the cheese-maker. Dried vells are still available and solely used in artisanal cheese-making<sup>6</sup>. In Mediterranean region, especially Toros mountain villages, milk clotting enzyme for using production of Tulum cheese is directly manufactured in farmhouse. Figs, raisins, white beans, chickpeas, carob, granulated sugar, salt, yoghurt and home-made rennet which is salted and dried form are found in the content of this enzyme. This mixture is left at room

temperature for 5-6 days. The enzyme is filtered from using cloth bag before cheese production. In traditional Tulum cheese production; the enzyme is added into raw milk for coagulation. 0,5-1 L enzyme is added into approximately 10 L milk. The obtained curd is mixed by salts and filled into tulum and pottery tightly but nowadays it mostly filled into plastic containers. The cheese is stored in natural caves of produced areas or at refrigerated conditions. The cheese is appreciated for high quality, exotic flavors and texture.

There are limited numbers of studies about coagulating effect on milk. To the authors' knowledge there is no information available of clotting effects on cow's milk, goat's milk and ewe's milk for this type coagulant. However, any comprehensive study on the use of plant and animal coagulant in cheese was found. The objective of this work was to determine chemical composition of cow's milk, goat's milk, ewe's milk and to study the coagulation of raw and pasteurized cow's milk, goat's milk and ewe's milk obtained coagulants from different manufacturers.

## MATERIALS AND METHODS

Raw cow's milk, goat's milk and ewe's milk were obtained from the Animal Husbandry section of Cukurova University, Agricultural Faculty, Adana, Turkey. The coagulants, manufactured using a traditional procedure, were collected from four different farmhouses in Toros mountain villages of Turkey. The samples were kept in jars and transported to the laboratories at Food Engineering Departments at Cukurova University. Coagulant samples were stored at  $4 \pm 1$  °C for analysis.

### Analyses

#### Chemical analyses

The pH values were measured using a digital pH meter (WTW, Weilheim, Germany) in raw cow's milk, goat's milk and ewe's milk. Titratable acidity was determined by the alkali titration method<sup>7</sup>. Total dry matter was determined by drying the samples in an oven at  $100 \pm 5$  °C<sup>8</sup>. Total milk fat content was determined by the Gerber method<sup>9</sup>. Protein was determined by the total nitrogen method of Kjeldahl<sup>10</sup>.

### Milk-clotting activity assay

The milk clotting activities of the traditional cheese coagulant were determined according to TS 3844 for raw and pasteurized cow's milk, goat's milk and ewe's milk<sup>11</sup>. Briefly, 25 mL of assay milk was taken in a beaker and the contents were brought to 35°C. Sample temperature was controlled using a water bath (Memmert). To this 1 mL of enzyme was then added and the curd formation was observed while manually rotating the beaker from time to time. The end point was recorded when discrete particles were discernible. For each experiment, the clotting time of the sample was measured three times and the average reported as the sample clotting time. The enzyme strength (ES) was defined as the number of volumes of coagulated milk clotted by one volume of rennet in 40 min at 35 °C. The calculation is:  $ES = 2400 \times V / t \times v$ , where, V one volume of milk (mL), t the clotting time in seconds and v equals one volume of coagulant (mL).

## RESULTS AND DISCUSSION

The results of the chemical analyses of cow's milk, goat's milk and ewe's milk are presented in Table 1.

Table 1 indicated that the mean values of cow's milk for pH, titratable acidity, dry matter, fat, non-fat dry matter and protein contents were  $6.77 \pm 0.01$ ,  $0.18 \pm 0.01\%$  (as lactic acid),  $11.63 \pm 0.09\%$ ,  $3.40 \pm 0.06$ ,  $8.23 \pm 0.14\%$  and  $4.06 \pm 0.30\%$ , respectively. The cow's milk was within the reported mean values limits for titratable acidity (minimum 0.135%, maximum 0.200%) and protein (minimum 2.8%) according to Turkish Standards for raw cow's milk<sup>12</sup>. The dry matter, fat and non-fat dry matter content were found to be within acceptable levels for raw cow's milk.

The composition of goat's milk was as follows: pH  $6.77 \pm 0.01$ ,  $0.15 \pm 0.00\%$  titratable acidity as lactic acid, dry matter  $12.56 \pm 0.27\%$ , fat  $3.83 \pm 0.06$ , non-fat dry matter  $8.73 \pm 0.22\%$  and protein  $4.26 \pm 0.04\%$ . The goat's milk was within the reported mean values limits for titratable acidity (minimum 0.15%, maximum 0.28%), non-fat dry matter (minimum 8.5%) and protein (minimum 2.8%)

according to Turkish Standards for raw goat's milk<sup>13</sup>. The dry matter and fat value were found to be within acceptable levels for raw goat's milk.

The ewe's milk contained pH  $6.69 \pm 0.02$ ,  $0.21 \pm 0.01\%$  titratable acidity (I.a.%), dry matter  $18.83 \pm 1.23\%$ , fat  $5.80 \pm 1.21$ , non-fat dry matter  $13.03 \pm 1.71\%$  and protein  $6.39 \pm 0.08\%$ . The ewe's milk was within the reported mean values limits according to Turkish Standards for ewe's milk<sup>14</sup>.

Composition of cow's and goat's milk used in the study is very similar to each other. Ewe's milk samples in the dry matter, protein, fat and titratable acidity values were higher than other milks.

The results of the milk-clotting activity of different coagulants on raw and pasteurized cow's milk, goat's milk and ewe's milk are presented in Table 2.

**Table 1: The chemical composition of raw cow's milk, goat's milk and ewe's milk**

Samples	pH	Titratable acidity (%)	Dry matter (%)	Fat (%)	Non-fat dry matter (%)	Protein (%)
Cow's milk	6.76	0.18	11.72	3.30	8.42	4.40
	6.77	0.18	11.54	3.40	8.14	3.85
	6.77	0.17	11.62	3.40	8.22	3.92
	$6.77 \pm 0.01$	$0.18 \pm 0.01$	$11.63 \pm 0.09$	$3.40 \pm 0.06$	$8.23 \pm 0.14$	$4.06 \pm 0.30$
Goat's milk	6.78	0.15	12.29	3.80	8.49	4.27
	6.76	0.15	12.82	3.90	8.92	4.23
	6.77	0.15	12.56	3.80	8.76	4.30
	$6.77 \pm 0.01$	$0.15 \pm 0.00$	$12.56 \pm 0.27$	$3.83 \pm 0.06$	$8.73 \pm 0.22$	$4.26 \pm 0.04$
Ewe's milk	6.70	0.21	17.62	6.50	11.12	6.46
	6.67	0.22	20.08	6.50	13.58	6.30
	6.69	0.21	18.80	4.40	14.40	6.41
	$6.69 \pm 0.02$	$0.21 \pm 0.01$	$18.83 \pm 1.23$	$5.80 \pm 1.21$	$13.03 \pm 1.71$	$6.39 \pm 0.08$

**Table 2: The milk-clotting activity of different coagulants on raw and pasteurized cow's milk, goat's milk and ewe's milk**

Milk	Coagulants	Milk clotting activity	
		Raw milk	Pasteurized milk
Cow's milk	C1	3396	1033
	C2	2717	5142
	C3	3602	4472
	C4	2466	3400
Goat's milk	C1	2937	3157
	C2	3179	5123
	C3	3560	3728
	C4	2128	3218
Ewe's milk	C1	5135	4570
	C2	5014	6535
	C3	5011	4656
	C4	3535	4504

#### Effect on cow's milk

The C3 sample had the highest milk clotting activity on raw and pasteurized cow's milk. However, C4 and C1 had the lowest milk clotting activity on raw cow's milk and pasteurized cow's milk, respectively. Milk clotting activity of pasteurized cow's milk was determined higher than that of raw cow's milk for C2, C3 and C4 samples. According to Egitoa et. al. (2007), specific clotting activity of albizia seed extract was 15 times higher than that of sunflower seed extract<sup>15</sup>.

#### Effect on goat's milk

The highest milk clotting activity was found in C3 for raw goat's milk and C2 for pasteurized goat's milk. Similar to cow's milk results, C4 and C1 samples had also the lowest milk clotting activity on raw goat's milk and pasteurized goat's milk, respectively. All coagulant samples had higher milk clotting activity on pasteurized goat's milk than milk clotting activity on raw goat's milk. The

work by Dayisoğlu *et al.* (2004) on the coagulating time of *Ficus carica* L. latex was depend on heat treatment for goat's milk and it takes between 3 and 5 minutes<sup>16</sup>.

#### Effect on ewe's milk

Milk clotting activity was detected at higher levels in C1 coagulant for raw ewe's milk and C2 coagulants for pasteurized ewe's milk. C4 sample have showed the lowest milk clotting activity on raw ewe's milk and pasteurized ewe's milk. Milk clotting activity of pasteurized ewe's milk was found higher for C2 and C4 coagulants. The coagulation of ewe's milk was studied by using different plant source coagulants and the end coagulation time was achieved very rapidly for milk clotted by *Ficus carica* L.<sup>17</sup>.

The highest milk clotting activity of all coagulant samples were found in raw ewe's milk, followed by raw cow's milk in C1, C3, C4 and raw goat's milk in C2. On the other hand, similar result was observed for pasteurized ewe's milk. The higher

milk clotting activity of pasteurized cow's milk was determined in sample C2, C3, C4, followed by that of goat's milk was found in sample C1. Konar *et al.* (1990) were reported that coagulating effects of *Ficus carica* L. latex varied with the type of milk, being the minimum with the cow's milk and maximum with the goat's milk<sup>18</sup>. Similar result was reported by Dayisoğlu *et al.* (2004) comparison of goat's milk and cow's milk coagulation time showed that cow's milk takes approximately three times longer than goat's milk<sup>16</sup>.

This study in conclusion, revealed that four different coagulants had a strong coagulating effect on raw and pasteurized ewe's milk. The highest milk clotting activity of all coagulant samples were seen in ewe's milk, followed by cow's milk and goat's milk. Traditional farmhouse cheese coagulant's activity has not previously been studied by other researchers so, the present study may be considered as useful data for further research into this type of coagulant. Besides, additional work is necessary and may be useful for the complete characterization of traditional Tulum cheese produced using of this coagulant.

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