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IMPACT OF PHYSICAL-CHEMICAL PROPERTIES ON MILK COAGULATION ABILITY FOR SOME ALBANIAN BREEDS OF COW, SHEEP AND GOAT

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Abstract- **Previous studies shows that content of protein, casein and fat as well as coagulation properties of milk were influenced from genetic factors, lactation period, growth conditions, seasonal factors etc. The aim of this study was to investigate the influences of milk composition in coagulation properties, with regard to the market demand for good quality dairy products.**
The milk was sampled by morning milking of cow, sheep and goat breeds raised in domestic conditions, in two Albanian regions from June to July 2011. Milk samples were analyzed for physical and chemical properties (density, acidity, pH, added water, content of casein, protein, fat, lactose and non fat solids) as well as coagulation parameters such as R (coagulation time in minutes), curd firmness measured in volt after 20 minutes (A20) or 30 minutes (A30) and the rate of firming K20 (in minutes).
The results showed that the clotting time of cow's milk samples were lower than those of goat's milk. Firmness values A20 and A30 of cow's milk resulted several times higher than those of goat's milk. Regarding to rate firmness (K20) the values resulted several times higher or out of range of optigraph for goat's milk samples compared to cow's milk.
Sheep's milk was assessed by means of dilution on 10, 20, 30, 40 and 50% by volume. The analyzed values taken from optigraph for A20 and A30 parameters resulted two times higher for sheep's milk than cow's milk, while the time to reach the standard curd firmness (hardness) suitable for cutting (K20) resulted from 2 to 3 times lower than those of cow's milk.

Keyword- ***milk coagulation time, curd firmness, rate of curd firming, optigraph.***

I. INTRODUCTION

Coagulation of milk is a complex process, influenced by many different factors [5]. Physical, chemical and technological milk properties are influenced by genetic, physiological, nutritional, zoo technical, climatic and pathological factors.Breeds of caws, sheep and goats influence on quantitative content of casein, fat, calcium, and phosphate, colloidal Ca, casein genotype and acidity, determining so the coagulation capability and technological behavior of milk as raw material for cheese production, its transformation's efficiency (variations of fat and casein) as well as the quality of cheese produced.
Different studies have been focused on assessment of coagulation traits and milk coagulation capacity for breeds of cow, sheep and goat. De Marchi and his collaborators analyzed 506 milk samples of 5 different dairy cattle breeds from different regions of Italy, to valuate milk coagulation ability. The samples were analyzed for milk coagulation properties (MCP), milk rennet coagulation time (RTC), curd-firming time, and curd firmness (A30) as well as protein and fat percentages, somatic cell count, Soxhlet-Henkel acidity, and bacterial count. The conclusion was that breed was the most important source of variation [11]. Martins and his collaborators investigated the effect of sheep breed on milk composition and coagulation properties. The study included two successive winter/spring lactations, monitored three farms and selected different sheep breed. The samples were analyzed for acidity, pH, and non fat solids, fat, protein and casein content. The potential of cheese making yield was estimated and the milk coagulation properties were assessed using optigraph. The studies emphasized the different cheese making aptitude of the milk from the autochthons breeds and suggest the need of technology modifications according to milk characteristics [1].
Referring to our country, studies focused on milk coagulation ability measured by optigraph are in their first steps. With regard to this situation and the market demand for good quality dairy products, this study is carried out to evaluate the milk coagulation ability of some breeds grown up in Albania. The aim is to introduce a compatible method suitable for industrial application by Albanian dairy industry, taking into consideration the EU standards.

II. MATERIALS AND METHODS

1. Sampling

With regard to cows, the milk was sampled from morning milking on volume 500 ml per sample. There were selected 5 samples for each different breed, respectively xhersej, Simmental and the third race brought by European countries. The cows were from Laknas locality of Tirana region, raised in domestic conditions.

With regard to sheep, the milk was sampled from morning milking on volume 500 ml per sample. There were selected 5 samples for each different breed, respectively merino-cigan, rud and bardhok of Tropoja. The sheep were from Laknas locality, UBT locality of Tirana region and Proger locality of Devolli region, raised in domestic conditions.

Since the sheep milk samples, taken in June and July, coagulated immediately after the rennet solution of 0.08% pure chymosin (Sigma, R5876) was added, they were diluted to determine the appropriate rate of dilutions of milk samples and comparative evaluation properties of their coagulation. For these purpose samples of sheep milk was diluted as follows:

Merino-Cigan diluted at 10, 20, 30 and 40% (in volum);

Rud diluted at 20, 30, 40 and 50% ;

Bardhok of Tropoja breed diluted at 10, 20, 30, 40 and 50%.

With regard to goats, the milk was sampled from morning milking on volume 500 ml per sample. There were selected 5 samples for each different breed, respectively red Alpin, white sona and cross breeds grows on Albania. The goats were from Laknas locality, UBT locality of Tirana region, and Shyec locality of Devolli region raised in domestic conditions.

Samples were taken in June-July 2011. Milk's samples were treated with 1 ml solution of 1% sodium azide (w / v) were refrigerated at 2-4 ^{o}C and after that were sent to laboratory.[4]

2. Analyses

There were carried out analyses regarding to physical and chemical properties, acidity

(in Turner degrees), pH, density (lactodensimeter), content of casein (according to Sorensen), content of non fat solids, crude protein, fat and lactose with milk analyzer Lactoscan.[4;9] Referring to Coagulation properties of milk, the milk clotting aptitude was evaluated with the Optigraph (AMS, France), according to previous work [1;3;10]. Milk was warmed and mixed at the same time in magnetic stirrer up to 32^{0}C. The Optigraph also was programmed on the same temperature. After the temperature was reached, 10 ml of samples was transferred to optigraph. When the milk clotting temperature was stabilized at 32 ^{0}C, 1 ml of rennet solution was added to 10 ml of milk. An aqueous solution of 0.08 % pure microbus chymosin (w/v) (Sigma R5876) was used for milk coagulation trials. Analysis was performed for 60 minutes. During this period the following indicators were defined: Milk clotting time R in minutesCurd firmness A20 and A30 consistency (hardness) of milk clotting after 20 and 30 minutes of R in volt.Rate of curd firmness K20 in minute, represent the time to reach a standard curd firmness related with a firmness suitable for cutting, equivalent to a 20 mm distance between the two parabola branches of the Formagraph type output [8;11], substituted in the Optigraph by a standard consistency equivalent to 6.5 V. All analysis was performed in duplicate.

The experimental data were processed statistically by ANOVA (Statistic 99 Edition).

III. RESULTS AND DISCUSSION

1. Physical, chemical properties of milk

In the tables I, II and III are showed the mean values of physical, chemical traits of milk samples of cow breeds, sheep and goats. Fluctuation of values approximate to those of studies carried out by other authors [1;4;9], with a variability within the consistent scale with regard to chemical constituents variability of the respective breeds of cow, sheep and goat.

Properties of fat content, protein and casein resulting higher in sheep milk samples and lower in samples of milk cows and goats, respectively.

Table I Physical-Chemical Properties and Significance Effect of Milk Samples of Some Breeds of Cows Raised in Domestic Conditions, Tirana (Laknas)

Cow's breed	Acidity (o/T)	pH	Density (Lact.)	SNF (%)	Fat (%)	Protein (%)	Casein (%)	Lactose (%)
KE	0,11	7,1	1,032	9,91	5, 28	3,88	2,87	5,22
Sm	0,19	6,715	1,029	8,43	4,69	3,34	2,89	4,39
Xh	0,17	6,69	1,031	8,69	4,53	3,4	2,455	4,57
P-Value	**<0.05**	**NA**	**NA**	**NA**	**NA**	**NA**	**<0.05**	**NA**

KE - breeds brought from European Countries, Sm - Simmental breeds, Xh – Yersey breeds, P-Valeu Significance effect

Table II Physical-Chemical Properties and Significance Effect of Milk Samples of Some Breeds of Sheep Raised in

Domestic Conditions,Devoll (Proger) and Tirana (Laknas)

Sheep's breed	Acidity (o/T)	pH	Density (Lact.)	SNF (%)	Fat (%)	Protein (%)	Casein (%)	Lactose (%)
M-C	0,23	6,55	1,32	10,65	7,6	5,9	4,4	3,8
DR	0,27	6,62	1,036	10,54	10,5	6,5	5,2	3,9
BT	0,53	6,59	1,033	11,13	8,4	6,2	5	3,95
P-Value	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**<0.05**	**NA**

M-C – Merino-Cigan breed, DR – Rud sheep breed, BT – Bardhok of Tropoja breed, P-Valeu Significance effect

Table III Physical-Chemical Properties and Significance Effect of Milk Samples of Some Breeds of Goats Raised in Domestic Conditions, Devoll (Shyec) and Tirana (UBT)

Goat's breed	Acidity (o/T)	pH	Density (Lact.)	SNF(%)	Fat (%)	Protein (%)	Casein (%)	Lactose (%)
AK	0,22	6,6225	1,029	7,77	3,62	3,06	2,18	4,07
VK	0,27	6,65	1,035	8,13	4,44	3,19	2,25	4,28
SB	0,2	6,68	1,028	7,92	2,92	3,08	2,1	4,2
P-Value	**NA**	**NA**	**NA**	**NA**	<0.05	**NA**	**NA**	**NA**

AK - Red Alpina breeds, VK - cross breed grows in Albania, SB - White Sona breeds, P-Valeu Significance effect

Concerning samples of cow milk breeds was found a variability for acidity (P <0.05) and casein (P <0.05) (Table I). With regard to milk samples of sheep breeds it was found a significance effect (P <0.05) only for casein (Table II) and for milk samples of goat breeds the significance effect (P <0.05) there was only for fat (Table III). This variability comes from growth factors (race, period of lactation, nutrition on housing conditions, growth areas, etc.), noted by many studies [1;4;10].

2. Coagulation Properties

Concerning milk coagulation properties of cow and goat breeds, results of Tables IV and V showed that clotting time (R) of cow's milk resulted relatively lower than the goat's milk (respectively from 8.5 to 11.14 minutes and 12.28 to 15.17 minutes).

Curd firmness (consistency, hardness) of coagulated milk (Gel of casein) after 20 minutes (A20) and 30 minutes (A30) resulted about two times higher in cow's milk samples than in goats one.

Rate of curd firmness (K20) in cow's milk samples varied from 8.5 to 10.8 minutes, while the goat milk samples resulted in higher values (14.9 minutes), or out of range.

High values of K20 (min) showed a lower rate of curd firmness.

Data showed that samples with lower values of clotting time (R) were associated with higher rate of curd firmness (i.e. lower values of K20).

Table IV Milk Coagulation properties Properties and Significance Effect of Milk Samples for Some Cow's Breed Raised in Domestic Conditions, Tirana (Laknas)

Nr	Caw's breed	R (min)	A_{20} (Volt)	A_{30} (Volt)	K20 (min)
1	KE	11,14	14,11	18,46	8,5
2	Sm	8,5	11,51	14	10,8
3	Xh	10,32	14,3	17,39	9,48
P-Value		**<0.05**	**NA**	**NA**	**NA**

KE - breeds brought from European Countries, Sm - Simmental breeds, Xh - Stockinet breeds

Table V Milk Coagulation Properties and Significance Effect of Milk Samples for Some Goat's Breed Raised in Domestic Conditions, Devoll (Shyec) and Tirana (Laknas)

Nr	Goat's breed	R (min)	A_{20} (Volt)	A_{30} (Volt)	K20 (min)
1	AK	12,28	5,38	5,77	14,9
2	VK	15,17	5,65	6,05	NA
3	SB	12,42	1,27	2,6	NA
P-Value		**NA**	**<0.05**	**NA**	**NA**

AK - Red Alpina breeds, VK - cross breed grows in Albania, SB - White Sona breeds

Data of tables IV and V showed that mean values of coagulation indicators R, A20, A30 and K20 of the samples of cow's milk and goat's milk, fluctuated approximately in values with those of studies carried out by other authors [2;3;10]. The fluctuation was found within a consistent scale with regard to variability of indicators of coagulation for breeds of cow's milk and goat's milk.
For cow's breed were found a significant effect only for clotting time (R), while for goat's breeds only curd firmness at 20 minutes A20 (P <0.05).

Sheep's milk samples showed a different consistency. The fresh milk coagulated immediately making the measurement of coagulating properties impossible.
In order to make possible the measurement of coagulation indicators A20, A30, K20 (minutes) for sheep's milk, samples were diluted with distillated water on 10%, 20%, 30%, 40% and 50% by volume. By means of dilution the curd firmness increased after 20 minutes and remained unchanged even after 30 minutes referring to different values between the samples of milk (Table 11).
Clotting time R of sheep milk samples showed the different results. In the first five samples of milk, the coagulation times varied on a rate 8:54, 8:36, 9:20, 13:00 and 11.52 minutes and were approximately equal for each dilution of the same samples. Comparing to other two samples of milk (Bardhok Tropoje 1 and 2) the clotting time resulted about 2 times higher than the first five samples, but was noted that diluting the samples of milk, coagulation time was increased.
The different samples of milk reached a better consistency at different dilution rate.
The first sample reached better consistency A20 and A30 (28: 28.5) at dilution of 10 %, increasing the dilutions rate the value of consistency decrease (Table 11).
The same phenomena was noted for the samples 2,3,4,5,6 and 7, which reached a better consistency A20 and A30 on dilution of 20%(18,18: 19,43); 20% (32: 38,2); 50%(22,71: 25,45); 30%(24,47: 29,26); 20% (29.66: 31,11) and 30% (25,97: 31,78) respectively.
The values of K20 referring to better consistency of samples varied from 4:00 to 5:10 minutes and were similar to those studies carried out by other authors [1;9;11].
Curd firmness values of sheep breeds resulted 2 times higher than those of cow's breed and 3-5 times higher than those of goat's breed.

Table VI Milk coagulation properties of some sheep's breed raised on home conditions, Devoll (Proger) and Tirana (Laknas,UBT).

Nr	Sheep's breed dilutions	R (min)	A_{20} (Volt)	A_{30} (Volt)	K20 (min)
1	M-C 10% diluted	8,54	28	28,5	4,25
	M-C 20% diluted	8,17	24,75	25,3	5,00
	M-C 30% diluted	8,17	20	21	6,15
	M-C 40% diluted	8,17	16,3	19	7,45
2	M-C 10% diluted	8,42	14,05	10,97	9,25
	M-C 20% diluted	8,36	18,18	19,43	5,10
	M-C 30% diluted	8,36	18,43	19,36	5,45
	M-C 40% diluted	8,36	16,39	19,36	8,00
3	M-C 10% diluted	9,27	35,5	35,5	3,45
	M-C 20% diluted	9,20	32	38,2	4,00
	M-C 30% diluted	9,20	25,5	29	5,00
4	DR 3-4 lambs (Laknas), 20% diluted	NA	NA	NA	NA
	DR 3-4 lambs (Laknas), 30% diluted	13,58	7,18	7,18	15,30
	DR 3-4 lambs (Laknas), 40% diluted	12,52	26,68	26,68	4,30

	DR 3-4 lambs (Laknas), 50% diluted	13,00	22,71	25,45	5,30
5	DR 1 lambs (Laknas), 20% diluted	11,48	27,5	27,5	4,35
	DR 1 lambs (Laknas), 30% diluted	11,35	24,47	29,26	5,10
	DR 1 lambs (Laknas), 40% diluted	11,48	20,19	24,05	6,15
	DR 1 lambs (Laknas), 50% diluted	11,48	16,06	19,12	7,55
6	BT 1 (UBT), 10% diluted	21,42	20,31	20,31	5,20
	BT 1 (UBT), 20% diluted	22,44	29,66	31,11	4,15
	BT 1 (UBT), 30% diluted	24,35	22,85	28,87	5,45
	BT 1 (UBT), 40% diluted	25,44	18,28	23,03	6,45
	BT 1 (UBT), 50% diluted	29,45	12,05	15,37	10,45
7	BT 2 (UBT), 10% diluted	21,22	14,73	14,73	8,30
	BT 2 (UBT), 20% diluted	21,50	25,96	25,96	4,50
	BT 2 (UBT), 30% diluted	23,07	25,97	31,78	5,10
	BT 2 (UBT), 40% diluted	25,02	19,36	24,35	6,30
	BT 2 (UBT), 50% diluted	28,00	14,24	17,04	9,00

M-C – Merino-Cigan breed, DR – Rud sheep breed, BT – Bardhok of Tropoja breed

IV. CONCLUSIONS

1. Concentration of fat, crude protein and casein of cow's milk resulted two times higher than those of goat's milk.
The milk samples of cow's breed showed significance effect ($P<0.05$) for acidity and casein, milk of sheep's breed only for casein and milk of goat's breed only for fat content.
2. Values of clotting time R for cow's milk samples resulted lower than those of goat's milk and the consistency values after 20 minutes, A20 and 30 minutes A30, resulted two times higher. Rate curd firmness values for goat's milk resulted some times higher or out of range compared to cow's milk.
3. The analyzed values taken from optigraph for parameters A20 and A30 resulted two times higher for sheep's milk comparing to those of cow's milk, while the time to reach the curd firmness (hardness) of the standard firmness suitable for cutting (K20) resulted 2-3 times lower than those of cow's milk and within the ranges regarding to milk with better coagulation ability (4-7 min) given by literature.

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