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RESEARCH OF THE PHYSICO-CHEMICAL COMPOSITION OF FRESH COW'S MILK IN THE REGION OF PEJA AND GJAKOVA

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Abstract

Milk and milk products are widely consumed products in Kosovo, especially cow's milk, but new milk production and processing capacities are being built day by day. Along with the increase in the production of fresh cow's milk, the need for research on the quality of fresh milk also increases. This study investigated some physicochemical properties of milk in Kosovo.

Milk samples were collected from dairy cows of several breeds such as: Holstein, Simmental and mixed breeds in 20 farms in the region of Peja and Gjakova. Studied parameters were: pH (ISO 26323:2009), density (ISO 15212), acidity (AOAC, 1990, no 947.05), fat (ISO 19662:2018), lactose (operation manual 11.04.19), proteins (AOAC 991.20), solids-not-fat (SNF- ISO 6731 and ISO 1737), water activity (aw- ISO 18787:2017), freezing point (FP- operation manual 11.04.19), conductivity (ISO 15091) total dissolved solids (TDS-ISO 26323:2009), salt (ISO 11271:2002), oxidation reduction potential (OrP- ISO 11271:2002), and ash (AOAC 942.05). Gained data were analyzed using descriptive statistics and T-test.

The results indicated that there was a significant difference ($p < 0.01$) between milk in the two regions in physicochemical properties. At the Gjakova, the proteins and water activity (a_w) were significantly higher compared to milk collected in Peja. Regarding the other parameters, the two regions share the same characteristics.

From the experimental results, we come to the conclusion that many factors influence the physico-chemical composition of fresh cow's milk, such as: type of food that the animals consume (dry food, food in the form of silage or combined), the breed of dairy cows, the conditions in which the cows stay, the season, etc.

Key words: *Milk, Dairy cows, Farms, Physico-chemical properties.*

1. Introduction

Cow's milk is a complex fluid with a high composition of nutritional values [1]. Milk and milk products are foods composed of carbohydrates, proteins, fats, vitamins, etc., which are very important for human health, especially for children, pregnant women, the elderly, etc. [2 - 4]. For this reason, milk and milk products are widely used in all countries of the world [5].

About 85% of the total production of milk in the world is produced by dairy cows. In Kosovo during 2020, 281,960 tons of cow's milk were produced, and this amount fulfills about 80% of the annual needs for consumption [6, 7]. The production and composition of cow's milk depends on many factors such as: the breed of the animal, the season of the year, the stage of lactation, and quite important is part of the dairy cows feed management. In our country, some research has been done regarding the composition of milk and milk products, but mainly the research has been performed only in certain regions of the country [8 - 12]. Traditionally, the diet of dairy cows has been pastures, but nowadays the animals are kept inside farms, and therefore the way of feeding has changed by re-modeling the diet of dairy cows to conventional foods such as silages and various concentrates [13].

The more fodder that dairy cows eat, the higher the concentration of milk with useful fatty acids, which have a rather complex content, while the more silage consumed by dairy cows, the increase in milk yield, and changes in the composition of milk is also observed as seasons are changed, etc. [14 - 17]. The consumption of grass silage and trefoil silage by dairy cows results in an increase in the level of milk production, but also an increase in the level of lactose, while the concentrations of fat and proteins are lower when cows are fed trefoil along with grass [18].

Having all this in mind, this study investigated some physicochemical properties of milk in Kosovo.

2. Materials and Methods

Milk samples were taken from 20 farms, or: 10 farms in the region of Peja with a total of 340 dairy cows from the following breeds: Simmental and Holstein-Friesian over 98%, and the indigenous Busha breed with about 2%, as well as in 10 farms in the Gjakova region with a total of 312 dairy cows of the breeds: Simmental, Holstein-Friesian - over 99% and the autochthonous Busha breed with about 1%. From each farm, 500 mL of fresh milk directly from the lactofreeze at 5 ^{0}C temperature were taken for analysis.

The analysis of physico-chemical parameters was done based on standard methods: pH (ISO 26323:2009), density (ISO 15212), acidity (AOAC, 1990, no 947.05), fat (ISO 19662:2018), lactose (operation manual 11.04.19), proteins (AOAC 991.20), solids-not-fat (SNF- ISO 6731 and ISO 1737), water activity (a_{w}- ISO 18787:2017), freezing point (FP- operation manual 11.04.19), conductivity (ISO 15091), total dissolved solids (TDS- ISO 26323:2009), salt (ISO 11271:2002), oxidation reduction potential (OrP- ISO 11271:2002), and ash (AOAC 942.05). All analyzes were completed in the laboratories of the Faculty of Agribusiness at the University of Peja and the Agricultural Institute of Kosovo in Peja based on the relevant standards [19 - 25].

2.1 Statistical analysis

Data were analyzed by using the Statistical Package for the Social Sciences (SPSS, 19); descriptive analyses were conducted for variables as well an Independent Sample t-test was used to compare the quantified variables in the samples of milk. The significance was calculated for P < 0.05.

3. Results and Discussion

In regard to the physicochemical properties of fresh milk samples (n = 20) obtained from two districts, the findings (presented in Table 1) indicated that the mean pH value was 6.89 ± 0.125. Additionally, the range of pH values detected in the samples varied between 6.66 and 7.13. The pH level of milk is an important indicator of its freshness and quality, as it can impact factors such as microbial growth and spoilage.

In terms of density, the mean value was determined to be 1.03 ± .002, with the minimum and maximum values observed in the samples being 1.02 and 1.03, respectively. Density is an important physicochemical property of milk, as it can provide information about its composition and quality.

Regarding the acidity content of the total sample, the mean value was determined to be 6.50 ± .256, with the minimum and maximum values observed being 6.10 and 7.10, respectively.

The fat content is an important compositional parameter that impacts the overall quality and nutritional value of milk. The mean fat content of the

Table 1. Descriptive analysis of physicochemical properties of fresh milk (n = 20)

Parameters	Peja District (n = 10)		Gjakova District (n = 10)		Pulled (n = 20)	
	x ± σ	x ± σ	x ± σ	Min-max	x ± σ	Min-max
pH	6.89 ± .116	6.68-7.13	6.90 ± .140	6.66-7.10	6.89 ± .125	6.66-7.13
Density (SH^0)	1.03 ± .003	1.02-1.03	1.03 ± .001	1.03-1.03	1.03 ± .002	1.02-1.03
Acidity (%)	6.59 ± .314	6.10-7.10	6.42 ± .154	6.20-6.60	6.50 ± .256	6.10-7.10
Fat	3.61 ± ..643	2.60-4.80	3.98 ± .475	3.30-4.60	3.79 ± .582	2.60-4.80
Lactose	4.36 ± .222	4.00-4.70	4.32 ± .181	4.10-4.70	4.34 ± .198	4.00-4.70
Proteins	3.31 ± .384	2.80-3.90	4.08 ± .507	3.30-4.70	3.69 ± .589	2.80-4.70
SNF	8.78 ± .383	8.13-9.50	8.67 ± .263	8.36-9.10	8.73 ± .324	8.13-9.50
a_w	.91 ± .011	.90-.94	.93 ± .026	.88-.96	.92 ± .023	.88-.96
FP	-.46 ± .048	-.55--.38	-.46 ± .0427	-.49--.43	-.46 ± .038	-.55--.38
Conductivity	4.61 ± .643	3.58-5.95	4.35 ± .570	2.86-5.95	4.48 ± .606	2.86-5.95
TDS	2.96 ± .290	2.36-3.41	2.87 ± .379	1.88-3.41	2.92 ± .332	1.88-3.41
Salt	2.26 ± .240	1.79-2.58	2.17 ± .288	1.42-2.58	2.22 ± .261	1.42-2.58
OrP	7.51 ± 2.37	5.10-12.40	6.02 ± 2.31	3.50-12.40	6.76 ± 2.40	3.50-12.40
Ash (%)	.77 ± .086	.67-.98	.79 ± .080	.67-.98	.78 ± .081	.67-.98

sample was found to be 3.79 ± .582. The fat content of the sample ranged from 2.60 to 4.80 with a minimum and maximum value observed, respectively.

Mean lactose content was found to be 4.34 ± 0.198, with a range of 4.00 - 4.70. The reported mean lactose content suggests that the sample contains a moderate amount of lactose, which is consistent with the expected range for dairy products.

The mean protein content was 3.69 ± 0.589, with a minimum value of 2.80 and a maximum value of 4.70 detected. Mean protein content indicates that the sample contains a moderate to high amount of protein, which may have implications for its nutritional value and functional properties. The observed range for minimum and maximum protein content suggests that there is some variability within the sample, which could be due to differences in preparation or natural variation within the food product.

Mean SNF content was 8.73 ± 0.324, with a range of 8.13 - 9.50 observed for minimum and maximum values in the samples. The mean SNF content suggests that the sample contains a moderate to high amount of solid components other than fat, such as protein, lactose, and minerals. Observed range for minimum and maximum SNF content provides further insight into the sample and its potential applications.

The mean a_w value was 0.92 ± 0.23, with a range of 0.88 - 0.96 observed for minimum and maximum values in the samples. The mean a_w value indicates that the sample has a relatively high water activity, which could impact its shelf life and microbial safety. Observed range for minimum and maximum a_w values suggests that there may be some variability within the sample, which could be due to differences in processing or storage conditions.

In this study, an independent sample t-test was conducted to investigate the differences in physicochemical properties between the Peja and Gjakova districts. The results presented in Table 2 indicate that there was a statistically significant difference ($P < 0.05$) in the protein content of fresh milk between the two districts. The Gjakova district had the highest protein content, whereas the Peja district had the lowest ($\bar{x}_{PD.} = 3.31$, $\bar{x}_{GJD.} = 4.08$, $t = -3.826$, $p = .001$, $d = 1.71$). This suggests that the observed difference in protein content between the two districts is unlikely to have occurred by chance. The effect size, as indicated by Cohen's d, was 1.71, which is considered a large effect. Further analysis of Figure 1 reveals that the fresh milk samples from Gjakova 5, 8, 7, and 6 had the highest protein values respectively.

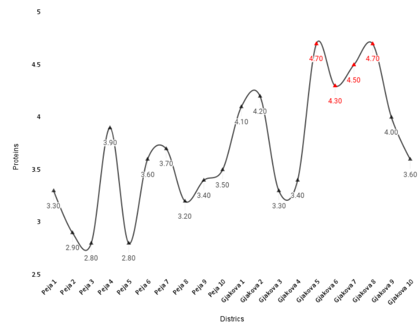

Figure 1. Protein values of the fresh milk samples

The findings of this study reveal that there were significant differences ($P < 0.05$) in a_w (water activity) content between the examined milk samples (as shown in Table 2). Specifically, the milk collected from

Table 2. Comparative analysis of the physicochemical properties between the Peja and Gjakova districts

Parameters	Peja District *Mean*	Gjakova District *Mean*	*Mean Difference*	*T-value*	*Sig.*	*d-value**
pH	6.89	6.90	-.0130	-.225	.824	-
Density (SH^0)	1.03	1.03	.001	1.130	.273	-
Acidity (%)	6.59	6.42	.1700	1.534	.142	-
Fat	3.61	3.98	-.3700	-1.462	.161	-
Lactose	4.36	4.32	.0400	.441	.664	-
Proteins	3.31	4.08	-.7700	-3.826	.001	1.71
SNF	8.87	8.67	.1060	.720	.481	-
Aw	.91	.93	-.0220	-2.378	.029	1.06
FP	-.46	-.46	-.0050	-.284	.780	-
Conductivity	4.61	4.35	.2580	.949	.355	-
TDS	2.96	2.87	.0900	.596	.559	-
Salt	2.26	2.17	.0830	.699	.493	-
OrP	7.51	6.02	1.490	1.422	.172	-
Ash (%)	.77	.79	-.0210	-.564	.580	-

Legend: *Cohen'd.

Gjakova displayed the highest a_w content (Figure 2), with a larger effect size, while the milk collected from Peja exhibited the lowest a_w content ($\bar{x}_{PD.}$ = .91, $\bar{x}_{GJD.}$ = .93, t = -2.37, p = .029, d = 1.06). The presented findings indicate that a comprehensive analysis of Figure 2 led to the discovery that certain fresh milk samples, specifically those originating from Gjakova 5 - 6 and 1, 2, 3, 7, and 8, possessed the highest a_w values, at 9.6% and 9.5%, respectively. These results imply that the aforementioned samples may have experienced a greater degree of water activity than other samples, potentially rendering them more susceptible to microbial growth and spoilage.

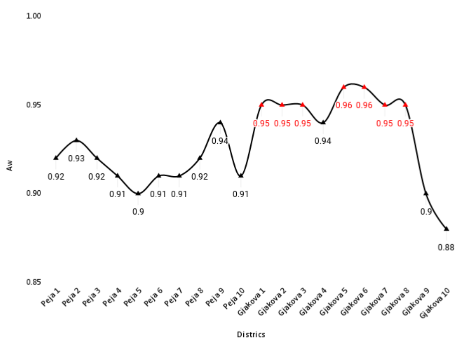

Figure 2. Aw values of the fresh milk samples

The results of this study demonstrate that there were no statistically significant differences (p > 0.05) in various physicochemical properties including: pH ($M_{PD.}$ = 6.89, $M_{GJD.}$ = 6.90, t = -.225, p = .824), density ($M_{PD.}$ = 1.03, $M_{GJD.}$ = 1.03, t = 1.130, p = .273), acidity ($M_{PD.}$ = 6.59, $M_{GJD.}$ = 6.42, t = 1.534, p = .142), fat ($M_{PD.}$ = 3.61, $M_{GJD.}$ = 3.98, t = -1.462, p = .161), lactose ($M_{PD.}$ = 4.36, $M_{GJD.}$ = 4.32, t = .441, p = .664), SNF ($M_{PD.}$ = 8.87, $M_{GJD.}$ = 8.67, t = .720, p = .481), FP ($M_{PD.}$ = -.46, $M_{GJD.}$ = -.46, t = -2.378, p = .780), conductivity ($M_{PD.}$ = 4.61, $M_{GJD.}$ = 4.35, t = .949, p = .355), TDS ($M_{PD.}$ = 2.96, $M_{GJD.}$ = 2.87, t = .596, p = .559), salt ($M_{PD.}$ = 2.26, $M_{GJD.}$ = 2.17, t = .699, p = .493), OrP ($M_{PD.}$ = 7.51, $M_{GJD.}$ = 6.02, t = 1.422, p = .172), and Ash ($M_{PD.}$ = .77, $M_{GJD.}$ = .79, t = -.564, p = .580).

4. Conclusions

- This study aimed to compare the physicochemical properties of fresh milk samples collected from the Peja and Gjakova districts in Kosovo.
- The results of the independent sample t-test revealed that there were significant differences in protein content and a_w between the two districts. The Gjakova district had the highest protein content and a_w, while the Peja district had the lowest. These findings suggest that fresh milk samples from Gjakova may be of higher quality than those from Peja in terms of protein content and water activity.
- Moreover, the effect sizes for both protein content and a_w were large, indicating a substantial difference between the two districts. In contrast, no significant differences were observed in other physicochemical properties such as: pH, density, acidity, fat, lactose, SNF, FP, conductivity, TDS, salt, OrP, and Ash. These results suggest that these properties may not be influenced by the geographical origin of the milk samples.
- Overall, this study provides valuable information on the quality of fresh milk produced in different regions of Kosovo. The findings could be used to guide decisions related to milk processing, storage, and distribution, as well as to inform future research in the field.

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