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THE EFFECT OF GENOTYPE AND LACTATION ON YIELD AND PHYSICOCHEMICAL PROPERTIES OF EWE MILK

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Abstract: Two genotype of sheep have been utilized in the conduct of the experiment composed of 60 ewes from Pirot x Virtemberg as genotype 1 and 60 ewes of Improved Pirot as genotype 2. All the ewes were reared under identical conditions and without any differences in nutrition and management during the whole period under study. The collection of Milk sampling was done in morning and evening during periods (1, 2, 3) of lactation duration. The average lactation duration and average total milk of the two genotypes were very close and has a minimal difference of 0.467 day and 1.562 kg, in favor of genotype 2. The differences between genotypes were not significant (P>0,05). Regarding physical and chemical properties of milk for both genotypes, the difference were very minimal such as follows; viscosity Pa x s - 0.006, electrical conductivity Ω – 0.018, density kg/m^3 -0,001, freezing, t ^{0}C - 0.013, LD number – 0.028 total solids, % – 0.014, fat,% - 0,026, protein,% - 0.085, lactose,% - 0.038, ash,% - 0,021, acidity, ^{0}SH – 0.209. The results indicated that the properties of milk for both genotypes were very near to each other. It can be interpreted that the breeds utilized in the experiment were comparable due to similar characteristics perhaps. The effect of genotype was very significant only for the % protein of the milk. The lactation periods were highly significant in all physical and chemical properties of milk.

Key words: sheep milk, genotype, lactation, physical, chemical properties

Introduction

Milk plays a tremendous role in building a healthy society and can be used as vehicle for rural development, employment and slowing down the migration of the rural population *(Sarwar et. al., 2002)*. The milk is the secretion of the mammary glands and the only food of the young mammal during the first period of its life. The substances in milk provide both energy and the building materials necessary for growth. It has a dietary properties that is important in human diet and children on the rise. Sheep milk contains higher levels of total solids and major nutrient than goat and cow milk *(Park et. al.,2007).* The goat and sheep milk is similar but sheep milk contain more fat, solids-non-fat, proteins, caseins, whey-proteins and total ash as compared with goat milk *(Jandal, 1996).*

Sheep milk is white but sometimes more or less yellowish depending on the milk fat contents, the size of fat globules and suspended protein, while colostrums has the normal yellow color. The taste of milk has a specific little sweet, depends mostly on the kind of food eaten by animals, and in milk may take the taste and smell of food. Colostrums milk is salty taste, depending on the food that is taken by the animal that can occur through bitter taste. Odor of milk is specific, and the milk belongs to the foods that easily take different scents due of milk fat.

The quantity of milk is characterized of the breed, feeding and the lactation period. Nutrition is a very important factor in milk production and duration of lactation period *(Petrovic et al.,2003, Ilic et al. (2007, 2010), Lalic, M. et al.,* (*1989).* Sheep milk, due to its chemical composition and physicochemical properties is an excellent raw material for the production of some types of dairy products *(Cais-Sokolińska et. al.,2008).*It has higher specific gravity, viscosity, refractive index, titratable acidity, and lower freezing point than average cow milk *(Haenleinand Wendorff, 2006).* Additionally the total solids, conductivity are important parameters in studying the physicochemical compositions and nutritional aspects of milk *(Imran et. al., 2008).* Furthermore, sheep milk composition and its production are influenced by large number of factors which most important are: breed, nutrition, health of the animals, environment and the large number and stage of lactation *(Kuchtik et.al.,2008).*

The aim of the study was to determine the influence of genotype and period of lactation on yield and the physico-chemical properties of milk.

Material and Methods

The experiment was conducted on private farm in Vrnjacka Banja. Two genotype of sheep have been utilized in the conduct of the experiment composing 60 ewes from Pirot x Virtemberg as genotype 1 and 60 ewes of Improved Pirot as genotype 2. All the ewes were reared under identical conditions and without any differences in nutrition and management during the whole period under study.

Testing of milk. The collection of milk sampling was done in morning and evening during periods (1, 2, 3) of lactation duration. The 1st and 2nd month of lactation will be period 1, the 3rd and 4th month will be period 2 and the 5th and 6th

month will be period 3. Milk is heated at a temperature of 50 º C, then for all analyzes cooled to 20 ° C and only for specific gravity (LD number) cooled to 15 ° C. Milk was kept in a refrigerator at 4 º C.

Physical properties of milk. Density of milk was determined Gerber lactodensimeter. As the temperature of milk ranged from 15 - 17 ° C, specific gravity (LD number) is calculated at 15 º C. In tube is poured 50 ml of milk and stir the mixture thoroughly with a diluted solution of $CaCl_2$ specific gravity of 1.135. The value of the refractive index of the serum obtained was read at Hilger refractometer at 20 º C.

Freezing points of milk were determined by methods cryoscope the Funke – Gerber. Viscosity was determined by measuring Hoppler viscometer at a temperature of 20 º C, so that the milk is maintained at 20 ° C. Electrical conductivity of milk was determined by conductivity meter, and for analysis were taken milk tempered at 20 ° C.

The chemical properties of milk. Milk fat content was made by Gerber method. The determination of dry matter (DM) was performed according to International Standard FIL / IDF 21-1962 by which 3 ml of milk dried at constant temperature to a constant weight.

The dried mass is the amount of dry matter (DM). The measurements were performed on an electronic scale.The dry matter without fat was obtained by calculation from the difference between total solids content and milk fat content.

Soxlet Henkel degrees (°SH): obtained by titrating 100 mL of milk with 0.25 NaOH, using phenolphthalein as the indicator. In tube is poured 50 ml of milk and stir the mixture thoroughly with a diluted solution of serum calcium chloride ($CaCl_{2)}$ specific gravity of 1.135. The content stayed 15 minutes in boiling water and then cooled. Thereafter, the refraction reading for certain percentage of milk sugar (lactose) was determined by refractometer method Ackermann.

Total proteins were determined by the Kjeldahl method, using the conversion factor 6.38 for total nitrogen in proteins. Determination of ash was carried out by incineration. Before burning vessel that is glowing and measured on an analytical balance. The container measured by pouring 5 ml of milk, and again the same extent. Thereafter, the vessel is brought into the incinerator at a temperature of 500 - 600C for a period of 3 hours. The percentage of ash is obtained from the difference of empty containers weight and pots with ashes. The resulting value is multiplied by 100 and divided by the weight of milk samples.

Statistical analysis. Results of the physical and chemical properties of milk by lactation periods have been analyzed using GLM methods, SPSS program version 20. Genotype and period of lactation were observed as fixed factors.

Results and Discussions

As presented in table 1, the average lactation duration and average total milk of the two genotypes were very close and has a minimal difference of 0.467 day and 1.562 kg, in favor of genotype 2. The differences between genotypes were not significant (P>0,05). The quantity of milk is characteristic of the breed, and less during the lactation period. The largest quantities are obtained at the beginning of the period of secretion *(Krajinović (1978)*and the least amount at the end of secretion. The quantity of milk produced affected diet *(Ilic et al. (2007), Lalic et al.,* (*1989)*, the findings of these authors was comparable with ours. Nutrition is a very important factor in milk production and duration of lactation period.

Table 1. Average lactation duration and milk yield of sheep per genotype

Dependent Variable	Genotype	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Lactation, days	1.00	168.767	.42	167.940	169.593
	2.00	169.234	.42	168.408	170.060
Total milk, kg	1.00	69.189	.75	67.708	70.670
	2.00	70.751	.75	69.270	72.233

Table 2. The physical properties of milk during lactation period

Dependent Variable	Genotype	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Viscosity,Pa x s	1	3.340	.008	3.325	3.355
	2	3.334	.008	3.319	3.350
El.conduct., Ω	1	55.636	.016	55.605	55.667
	2	55.618	.016	55.586	55.649
Density,kg/m^3 (specfic gravity)	1	1.037	.001	1.036	1.039
	2	1.036	.001	1.034	1.037
Freezing, t ^{0}C	1	-.649	.007	-.664	-.635
	2	-.662	.007	-.677	-.648
LD number	1	36.557	.030	36.499	36.615
	2	36.585	.030	36.527	36.643

In tables 2 and 3, it can be noticed that the regarding physical and chemical properties of milk for both genotypes, the difference were very minimal such as follows; viscosity Pa x s - 0.006, electrical conductivity Ω – 0.018, density kg/m^3 - 0,001, freezing, t ^{0}C - 0.013, LD number – 0.028 total solids, % – 0.014, fat,% - 0,026, protein,% - 0.085, lactose,% - 0.038, ash,% - 0,021, acidity, ^{0}SH – 0.209. The results indicated that the properties of milk for both genotypes were very near to each other. It can be interpreted that the breeds utilized in the experiment were comparable due to similar characteristics perhaps.

The viscosity is changed during lactation, at least initially was 3 x 10^3 Pa x s, and the largest cluster at the end of the period of 3.6 x 10^3 Pa x s. The average value of 3.3 x 10^3 Pa xs is nearly twice then that of cow's milk (*Djordjevic, 1982).* Based on this figures, the values we attained (Tables 2 and 4) in this study were under this ranges. The electrical conductivity is inversely proportional to the resistance of milk provides during power. Electrical conductivity depends largely on salt in milk and in most part of these salts influence of potassium and sodium chlorides. The electrical conductivity of milk, ranging from 55.586 to 55.667 **Ω**. Lowest results of electrical conductivity of milk was found by *Djordjevic, 1982).*

The result on the density of milk (specific gravity) was similar in the study of *Mahmood and Sumaira, (2010)* in sheep milk (1.032-1.037). The results in the study of *Yuksea et. al.,(2012)* relating to the lactodensimeter degree, protein content, fat and total solids on the next breeds were: Improved Sakiz breed- 30.4, Pure Sakiz -35.6, Kivircik breed- 35, whereas the protein content; fat and total solids on the said breeds ranges from: 4.3 - 8.7%; 4 - 9%; 15.5 - 24%, this means that our findings within the ranges of theirs. Other authors found the value for the milk fat content is about 7.40%, lactose 4.90 and ash 0.88% *(Memiši and the Bauman, 2002)* while *Stojanovic and Katic, (2004*) have described the average composition of sheep milk indicating the averagecomposition of sheep milk: 19.50% dry matter, 7.20% fat, fat-free dry matter 12.30, 5.70 protein, casein 4.90, lactalbumin and lactoglobulin 0.98%, lactose 4.30, ash 0.90% and the greatest amount of 80.50% is water. According to *Jovanovic (1996)* he commented that ewes receiving quality food could provide milk throughout the year (concentrate, green feed), and the feeding itself can influence milk fat of milk. This statement supported the result of this study.

Table 3. The chemical properties of milk during lactation period

Dependent Variable	Genotype	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Total Solids, %	1	19.027	.051	18.926	19.127
	2	19.041	.051	18.940	19.142
Fat, %	1	8.326	.029	7.956	8.936
	2	8.352	.029	8.005	8.806
Protein,%	1	6.405	.019	6.368	6.442
	2	6.320	.019	6.283	6.357
Lactose,%	1	4.366	.014	4.339	4.393
	2	4.404	.014	4.376	4.431
Ash,%	1	.962	.010	.942	.982
	2	.983	.010	.963	1.003
Non-fat, solids, %	1	10.701	0.49	10.605	10.797
	2	10.705	0.49	10.609	10.801
Acidity,^{o}SH	1	8.747	.076	8.598	8.896
	2	8.538	.076	8.389	8.687

^{0}SH- Soxhlet-Henkel degree

The interaction of genotype and period of lactation on the different properties of milk have shown in table 4 and 5. It can be observed that, almost all of the milk properties got the highest values in period 3 of lactation for both genotypes except for lactose that showed highest for both genotypes in period 1 of lactation while period 2 got second place in all properties for both genotypes. The differences for viscosity in genotype 1 were: 0.195 Pa x s (periods 1&2); 0.386 (periods 1&3); 0.191(periods 2&3) while for genotype 2 were: 0.202; 0.405; 0.203 Pa x s. Pertaining to electrical conductivity, the differences were: 0.35 Ω (for lactation periods 1&2); 0.807 (periods 1&3); 0.457(periods 2&3) for genotype 1 while for genotype 2 were: 0.354 Ω; 0.824; 0.47. The density for genotypes 1 and their differences in periods of laction were: 0.01 kg/m^3; 0.015; 0.005 while in genotype 2 were: 0.014; 0.018; 0.004. As for freezing point, the differences on periods 1&2; 1&3; and 2&3 for genotype 1 were: -.102^{0}C; -.187; -.085 and for genotype 2 were: -.066; -.15; and -.084^{0}C. When it comes to lactodensimeter degree (LD number) the differences for each genotype and periods were: 0.174 - 0.155 ; 0.474 - 0,461 ; 0.3 - 0.306. The differences in total solids for each genotype were: 4.23 - 3.64% (periods 1&2); 11.50 – 11.54% (periods 1&3) and 7.59- 8.2% (periods 2&3). The fat % differences for each genotype were: 4.21 – 4.21% (periods 1&2); 11.48- 11.49% (periods 1&3); 7.59 -7.60% (periods 2&3). Relating to the other properties the differences for each genotype were the next: for protein – 4.19 - 4.39% (periods 1&2); 11.48-11.63% (periods 1&3); 7.60-7.57% (periods 2&3); for lactose- 7.57 - 7,72% (periods 1&2); 11.54 - 11.50%(periods 1&3); 4.29 - 4.10% (periods 2&3); for ash - 4.42-4.33% (periods 1&2); 11.67-11.79% (periods 1&3); 7.59-7.79% (periods 2&3); for non-fat solids- 4.21-4.25% (periods 1&2); 11.49-11% (periods 1&3); 7.60-7.05% (periods 2&3). The differences in acidity,^{0}SH- (Soxhlet-Henkel degree) for each genotype for lactation periods 1&2 were - 0.315-0.226^{0}SH; 0.576-0.475^{0}SH ; 0.261-0.249^{0}SH.

Table 4. Interaction genotype x period of lactation on the physical properties of milk

Dependent variable	Genotype	Period of lactation	Mean	Std. Error	95% Confidence interval	
					Lower Bound	Upper Bound
Viscosity, Pa x s	1	1	3.146	.013	3.119	3.172
		2	3.341	.013	3.315	3.367
		3	3.532	.013	3.506	3.559
	2	1	3.132	.013	3.106	3.158
		2	3.334	.013	3.308	3.360
		3	3.537	.013	3.511	3.563
Electrical conductivity, Ω	1	1	55.250	.028	55.196	55.304
		2	55.600	.028	55.546	55.654
		3	56.057	.028	56.003	56.112
	2	1	55.225	.028	55.171	55.279
		2	55.579	.027	55.525	55.633
		3	56.049	.028	55.994	56.103
Density, kg/m^3 (specific gravity)	1	1	1.029	.001	1.026	1.031
		2	1.039	.001	1.037	1.042
		3	1.044	.001	1.042	1.047
	2	1	1.025	.001	1.022	1.041
		2	1.039	.001	1.036	1.042
		3	1.043	.001	1.041	1.046
Freezing, t ^0C	1	1	-.553	.013	-.578	-.528
		2	-.655	.013	-.680	-.630
		3	-.740	.013	-.765	-.715
	2	1	-.590	.013	-.615	-.565
		2	-.656	.013	-.681	-.631
		3	-.740	.013	-.766	-.715
LD number (Lactodensimeter Degree)	1	1	36.341	.051	36.240	36.441
		2	36.515	.051	36.414	36.616
		3	36.815	.051	36.714	36.916
	2	1	36.380	.051	36.279	36.481
		2	36.535	.051	36.435	36.635
		3	36.841	.052	36.740	36.943

Our results can be comparable with the result obtained by *Pavić et al, (2002)* for Travnik sheep in terms of total solids contained an average of 19.11% and lactose 4.55% while their results for 7.52% fat, 5.90% protein were lowered then our results but 11.45% non-fat solids they attained was higher with ours (Table 3). *Dario et. al., (1996)* who reported that a higher lactose content obtained at the beginning of lactation period (from milk of Leccese sheep) which was true with our study (Table 4). *Manfredini et al., (1993)* stated that protein content of sheep milk was significantly lower at the beginning than at the end of lactation (5.38 and 7.11%; 5.47 and 6.46%) agreed with the result we acquired in this study. According to the statement of *Storry et al., (1983)* that “high fat, protein and total solids concentration in the milk are associated with high yields in the resulting dairy products“, supported the values we attained in the later mentioned. The average % ash obtained in our study for each genotype were higher compared with the result of *Yilmaz et al., (2011)*, which was 0.91% for Red Karaman ewes. The result we gathered on the degree of acidity were lower compared with the result obtained by *Pavić et al., (2002)* which was 9.29 ^{0}SH but their result on freezing point was lower -0.566^{0}C then ours.

Table 5. Interaction genotype x period of lactation on the chemical properties of milk

Dependent variable	Genotyp e	Period of lactation	Mean	Std. Error	95% Confidence interval	
					Lower Bound	Upper Bound
Total Solids,%	1	1	17.983	.089	17.809	18.157
		2	18.777	.089	18.603	18.952
		3	20.320	.089	20.146	20.494
	2	1	18.030	.089	17.856	18.204
		2	18.711	.088	18.538	18.883
		3	20.382	.089	20.207	20.558
Fat, %	1	1	7.871	.029	7.565	8.421
		2	8.217	.030	7.857	8.862
		3	8.892	.030	8.497	9.512
	2	1	7.895	.027	7.565	8.322
		2	8.242	.029	7.901	8.693
		3	8.920	.030	8.550	9.405
Protein, %	1	1	6.055	.033	5.991	6.119
		2	6.320	.033	6.256	6.384
		3	6.840	.033	6.776	6.904
	2	1	5.967	.033	5.903	6.031
		2	6.241	.032	6.178	6.305
		3	6.752	.033	6.687	6.817
Lactose, %	1	1	4.663	.024	4.615	4.710
		2	4.310	.024	4.263	4.357
		3	4.125	.024	4.078	4.172
	2	1	4.705	.024	4.658	4.752
		2	4.342	.024	4.658	4.389
		3	4.164	.024	4.116	4.212
Ash, %	1	1	.908	.018	.873	.942
		2	.950	.018	.915	.985
		3	1.028	.018	.993	1.062
	2	1	.928	.018	.893	.963
		2	.970	.018	.936	1.005
		3	1.052	.018	1.016	1.087
Solids, non-fat, %	1	1	10.115	.085	9.949	10.281
		2	10.560	.085	10.394	10.726
		3	11.428	.085	10.394	11.594
	2	1	10.138	.085	10.394	10.304
		2	10.588	.084	10.423	10.753
		3	11.391	.085	11.223	11.558
Acidity, ^{o}SH	1	1	8.450	.132	8.191	8.709
		2	8.765	.132	8.506	9.023
		3	9.026	.132	8.767	9.284
	2	1	8.304	.132	8.046	8.563
		2	8.530	.130	8.274	8.787

Table 6. Tests of fixed effects and their interactions on quantity and quality of milk

Source	Dependent Variable	Sum of Squares	df	Mean Square	F	Sig.
Genotype	QTM	2.949	1	2.949	.184	.669
	Fat	.011	1	.011	.118	.732
	Viscosity	.002	1	.002	.226	.635
	Elec.Cond.	.030	1	.030	.660	.417
	Density	.000	1	.000	2.052	.153
	TotalMilk	219.685	1	219.685	2.152	.143
	Freezing	.015	1	.015	1.502	.221
	DM-solids	.018	1	.018	.038	.845
	Non-fat,solids	.002	1	.002	.004	.948
	Protein	.648	1	.648	10.187	.002
	lactose	.129	1	.129	3.710	.055
	Ash	.042	1	.042	2.240	.135
	Acidity	3.931	1	3.931	3.788	.052
	Lactoden.^{o}	.073	1	.073	.467	.495
Period	QTM	14232.409	2	7116.204	443.133	.000
	Fat	83.394	2	41.697	461.472	.000
	Viscosity	9.368	2	4.684	442.825	.000
	Elec.Cond.	39.992	2	19.996	438.930	.000
	Density	.019	2	.009	80.263	.000
	TotalMilk	5.112	2	2.556	.025	.975
	Freezing	1.698	2	.849	86.514	.000
	DM-solids	343.300	2	171.650	364.788	.000
	Fat	101.262	2	50.631	118.057	.000
	Protein	38.004	2	19.002	298.510	.000
	lactose	18.016	2	9.008	259.295	.000
	Ash	.912	2	.456	24.175	.000
	Acidity	16.495	2	8.247	7.947	.000
	Lactoden.^{0}	13.451	2	6.726	42.885	.000
Genotype * Period	QTM	.893	2	.446	.028	.973
	Fat	.010	2	.005	.054	.947
	Viscosity	.005	2	.002	.233	.792
	Elec.Con.	.004	2	.002	.048	.953
	Density	.000	2	.005	.664	.515
	TotalMilk	5.112	2	2.556	.025	.975
	Freezing	.026	2	.013	1.343	.262
	Solids	.300	2	.150	.318	.727
	Non-fat,solids	.077	2	.038	.090	.914
	Protein	.002	2	.001	.014	.986
	lactose	.002	2	.001	.024	.976
	Ash	.000	2	.000	.007	.993
	Acidity	.182	2	.091	.088	.916
	Lactoden.^{0}	.006	2	.003	.019	.981

As exposed in table 6, showed that there were no significant effect of genotype on the following properties such as; viscosity, electrical conductivity, density, freezing point, total solids, fat, ash, and non-fat solids (P>0.05) including lactose and the acidity^{0} SH (with a significance of .055 and .052) but there was a highly significant effect of genotype on % protein (P<0.01). The lactation periods have highly significant (P<0.01) effect on all physical and chemical properties of milk. Meanwhile, interaction between genotype and lactation period have no significant effect for all tested properties (physical and chemical).

Conclusion

Based on the results obtained can be terminated that the two genotypes tested had a very closed lactation duration and total quantity of milk. Likewise, also having a very closed mean averages relating to the physical and chemical properties of their milk during periods of lactation. In this connection, the reason might be was that the genotype 2 had a 75% gene of Virtemberg. The effect of genotype was very significant only for the % protein of the milk. The lactation periods were highly significant in all physical and chemical properties of milk.

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Uticaj genotipa i perioda laktacije na količinu, fizičke i hemijske osobine ovčijeg mleka

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Rezime

Istraživanja su obavljena kod dve rase ovaca i to 60 grla Pirotska x Virtemberg kao genotip 1 i 60 ovaca pirotske oplemenjene populacije, kao genotip 2. Sve životinje su držane u istim proizvodnim uslovima na farmi u Vrnjačkoj Banji. Prosečne vrednosti trajanja laktacije i mleka dobijenog u periodu laktacije su bile vrlo ujednačene, tako da nije utvrđen uticaj genotipa na ova svojstva. Takođe, razlike između fizičko hemijskih osobina mleka, u većini slučajeva su bile nesignifikantne. Uticaj genotipa kao fiksnog faktora je bio vrlo signifikantan samo

kod sadržaja proteina u mleku ovaca (P<0.01). Međutim utvrđeno je da period laktacije ima vrlo signifikantan uticaj na sva posmatrana fizička i hemijska svojstva mleka.

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