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Publishing Date: July 2020

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LIVESTOCK STUDIES

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LIVESTOCK STUDIES
Volume 60 Issue 1 July 2020

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Livestock Studies, 2020; 60 (1): 1-4
http://doi.org/10.46897/lahaed.779712

RESEARCH PAPER

LIVESTOCK STUDIES

Comparison of fattening performance of Angus, Charolais, Limousine and Simmental cattle imported to Turkey

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Article History
Received: 04 July 2019
Accepted: 05 December 2019

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Key words
Angus, Charolais, Limousine, Simmental, dressing percentage, fattening performance

Abstract

The purpose of this study was to compare the fattening performance of some cattle breeds under same care and feeding condition, which were imported to a private farm in Turkey. Approximately eight months old male Angus (AN) (n=12), Charolais (CH) (n=33), Limousine (LM) (n=40) and Simmental (SM) (n=9) breeds were imported from Ireland to a private farm in Çorum. Least squares means for AN, CH, LM and SM, respectively, for the elapsed time (ET) of the breeds from the beginning of feeding until slaughter were 181.42±8.07, 181.30±4.87, 186.15±4.42, and 194.78±9.32 days; for the initial live weights (IW) at the beginning of fattening period were 404.42±11.26, 418.70±6.79, 389.00±6.17 and 430.56±13.00 kg; for the live weights (LWS) at the time of slaughter were 616.78±14.29, 625.64±8.80, 636.00±8.13 ve 631.97±16.84 kg; for the average daily live weight gains (ADLWG) were 1.17±0.06, 1.23±0.04, 1.23±0.03 and 1.16±0.07 kg; for the hot carcass weights (HCW) were 355.45±10.20, 362.76±6.28, 385.15±5.80 and 368.98±12.02 kg; for the dressing percentages (DP) of the breeds were 57.47±0.95, 58.09±0.58, 60.64±0.54 ve 58.48±1.12 %. Mean consumption of DM, OM, NDF, ADF and CP were 11.43, 11.18, 5.03, 2.63 and 1.55 kg. ET (p=0.643), LWS (p=0.653), ADLWG (p=0.600), FE (p=0.871) and HCW (p=0.389) were not statistically different whereas IW (p=0.003) and DP (p=0.005) were statistically different for the breeds. The IW of Limousine was lower than Charolais (p=0.009) and Simmental (p=0.025) whereas Limousine had better performance for the DP than did Angus (p=0.027) and Charolais (p=0.014).

Introduction

Depending on the increasing population of the world, food demands also increase. Animal protein is one of the most important nutrients among the foods consumed. Therefore, in order to meet the increasing demand, both the number of animals and the yield should be increased.

Population of Turkey is increasing in parallel with the World population. Therefore, the need for animal protein is also increasing in Turkey. Since the amount of meat produced in Turkey does not meet the demand, beef cattle or carcass meat is imported from time to time [15]. Failure to meet the demand is due to the insufficient number of animals as well as the lack of beef breeds in Turkey. The animals raised for slaughter in Turkey are generally dual purpose breeds like Simmental, Brown Swiss, also male offspring of dairy breeds [2].

According to TSI [24] the cattle number of European breeds, cross breeds and local breeds, respectively, are 8,419,204, 7.030.297, and 1.593.005. In 2018, a total of 3.426.180 cattle were slaughtered and 1.003.859 tons of meat were produced. This resulted a mean carcass weight of 293 kg per animal, while this figure is 291 kg across European countries, and 362.8 kg in the United States [12].

Animals imported from abroad were brought from Australia, Uruguay, Brazil and the European Union under the control of the Ministry of Agriculture and Forestry

[4]. The number of imported animals was 132.844 cattle for slaughter and 1.211.719 cattle for fattening in 2018 [4]. Limousine, Charolais, Angus, Hereford and Simmental were the most preferred among imported beef breeds [11, 16]. In the world and in Turkey, the Simmental breed, which is a dual purpose breed, is commonly used in fattening performance studies along with other beef cattle breeds, since it has high fertility and milk yield as well as good resistance to diseases [17].

In Turkey, crossbreeding studies with the imported beef breeds from abroad [1, 6, 7, 9, 22] have been made for many years. Studies on slaughter and fattening performance of beef cattle imported from abroad have also been conducted [11, 16, 21]. These studies revealed that more studies on imported cattle were needed.

The aim of this study was to compare the fattening performance of different beef cattle breeds imported to a private farm in Turkey under the same management and feeding conditions.

Material and Method

The animal material of the study consisted of male Angus (AN) (n = 12), Charolais (CH) (n = 33), Limousine (LM) (n = 40) and Simental (SM) (n = 9) cattle, which were imported from Ireland at the average age of approximately 8 months. The study took place in a private farm of Çorum province in 2017. One week after the animals came into the farm, internal and external parasite treatments and necessary vaccinations were done and they were included in the intensive feeding program after the adaptation process was completed.

Live body weights were taken and recorded on a monthly basis starting from the second month in the morning with an empty stomach at the end of the fattening program, the animals were slaughtered in a private slaughterhouse and hot carcass weights were recorded.

The animals were fed in a free stall-semi-open farm. The animals consumed corn silage, alfalfa hay, straw, wet beet pulp as roughage, while they consumed feed mixtures commercially available as concentrate feed and barley. The average feed amounts (on a wet basis) given to the animals are given in Table 1. Nutritional needs were gradually increased according to NRC [19] based on live body weight gain. All consumed feeds are provided commercially. Dry matter, crude ash, and crude protein analyzes of the consumed feeds were made according to AOAC [5], NDF analysis according to Van Soest and Robertson [25] and ADF analysis according to Goering and Van Soest [14] and are given in Table 2. Daily body weight gains were calculated from monthly weighings. The general linear model (GLM) was used if there is a difference between the groups (breeds) in terms of the characteristics examined. The initial live weights (IW) at the beginning of fattening period was put into the statistical model as a covariate and covariance analysis was performed for the final body live weight, carcass weight and dressing percentage. The assumptions of whether the relationship between covariate and dependent variables is linear and whether the regression slopes are the same for each breed group were checked before conducting the covariance analysis. There was a linear relationship between post-fattening body weight, carcass weight and dressing percentage with the covariate and the regression slopes were same for each breed group. Pairwise comparisons between breed groups were made with the Bonferroni test in the covariance analysis and with the Tukey test if the covariance analysis was not performed. The least squares means and standard errors are given in the tables. P≤0.05 level was accepted as a significant difference. SPSS v15 package program [13] was used for statistical analysis.

Table 1. Daily feed consumption, kg/day.

Feeds	Consumption kg/day
Concentrated feed	6
Barley	1
Straw	1.8
Alfalfa hay	0.9
Wet Beet Pulp	1
Corn silage	1.8

Table 2. Nutrient contents of feed used in ration.

	DM %	OM %	HP %	NDF %	ADF %
Concentrated feed	90.06	90.94	14.52	26.71	9.27
Barley	91.66	96.91	10.58	18.95	5.57
Straw	95.34	90.91	4.11	77.65	48.34
Alfalfa hay	95.01	92.34	14.2	53.09	41.64
Wet Beet pulp	15.2	94.39	10.01	45.37	23.97
Corn silage	26.33	94.89	7.4	49.77	27.18

Table 3. Fattening performance and carcass parameters of cattle used in the experiment.

	Angus	Charolais	Limousine	Simmental	p
n	12	33	40	9	
Elapsed time, day	181.42±8.07	181.30±4.87	186.15±4.42	194.78±9.32	0.643
Initial live body weight, kg	404.42±11.26^{ab}	418.70±6.79^{a}	389.00±6.17^{b}	430.56±13.00^{a}	0.003
Final live body weight, kg	616.78±14.29	625.64±8.80	636.00±8.13	631.97±16.84	0.653
Hot Carcass weight, kg	355.45±10.20	362.76±6.28	385.15±5.80	368.98±12.02	0.389
Dressing percentage %	57.47±0.95^{b}	58.09±0.58^{b}	60.64±0.54^{a}	58.48±1.12^{ab}	0.005
Daily live weight gain, kg	1.17±0.06	1.23±0.04	1.23±0.03	1.16±0.07	0.600

^{a,b} The difference between averages carrying different letters in the same line is statistically important (P<0.05).

Results

The data regarding the fattening performance and carcass parameters of cattle used in the experiment are given in Table 3. Daily amounts of nutrients consumed by animals are shown in Table 4.

Table 4. Daily amounts of nutrient consumed by animals, kg.

	CDM	COM	CCP	CNDF	CADF
All breeds	11.43	11.18	1.55	5.03	2.63

DM: Dry matter; OM: Organic matter; CP: Crude protein; NDF: Neutral detergent fiber; ADF: Acid detergent fiber.

Discussion and Conclusion

The elapsed times of fattening period in this study changed from 181.30±4.87 days in Charolais to 194.78±9.32 days in Simental. Different fattening period times were reported by various studies. Such as 236.0±9.8 days for Brown [8], 132.4±3.61 days for Holstein [18], 138 days for Simmental [23], 206.7±5.4, 238.1±4.4, 261.4±4.4, 227.0±5.3 and 283.6±5.2 days for imported Simental, Aberden Angus, Hereford, Limousine and Charolais, respectively [11], 180 days for all imported Limousine, Charolais, Angus and Hereford [16], 389.2 days for LimousinexHolstein F_1 hybrids [20]. The elapsed times in fattening period of this study were either lower, higher or similar to the studies mentioned above. This time may vary depending on many factors such as the age of the animal, initial live weight, daily live weight gain, animal breed and market conditions [3]. The reasons for the differences between the studies may be attributed to one or more of these factors.

The initial live body weight in this study was lowest in the Limousine (389.00±6.17 kg) and the highest in the Simmental (430.56±13.00 kg) (p= 0.003). Barton et al. [10] reported this as 391.3, 297.5, 320.7 and 285.0 for Angus, Charolais, Simmental and Hereford. Duru and Sak [11] reported this as 261.6±1.4, 267.3±1.1, 276.7±1.1, 264.1±1.3 and 276.7±1.3 kg for the imported Simental, Aberden Angus, Hereford, Limousine and Charolais, respectively. Kayar and Inal [16] reported this as 349.4±5.5, 329.2±2.9, 340.3±4.3 and 341.5±3.7 for Limousine, Charolais, Angus and Hereford, respectively. The initial live body weights in the study were higher than the ones reported by Duru and Sak [11] and Kayar and Inal [16], were similar to the ones for Angus and were higher than the ones for other breeds reported by Barton et al. [10].

The live weights before the slaughter for Angus, Charolais, Limousine and Simmental in this study, respectively, were 616.78±14.29, 625.64±8.80, 636.00±8.13 and 631.97±16.84 kg. There was no statistical difference between the breeds in terms of live weight before the slaughter (p=0.653). Various studies reported this weight as 405.2±3.7 kg for Brown Swiss [8], 529.3±15.25 kg for Holstein [18], 673.7 kg for Simmental [23], 562.3, 620.7, 632.4 and 540.1 kg for Angus, Charolais, Simmental and Hereford, respectively [10], 523.4±5.2, 543.3±4.8, 563.1±4.8, 545.5±4.9 and 589.7±4,1 kg for Simmental, Aberdeen Angus, Hereford, Limousine and Charolais, respectively [11], 561.5±5.1, 590.7 ± 5.3, 570.5 ± 5.0 and 588.2 ± 5.1 kg for Limousine, Charolais, Angus and Hereford, respectively [16], 501.9 kg for LimousinexHolstein F_1 hybrids [20]. The live weights before the slaughter in this study were similar to the ones reported by Barton et al. [10], were higher than the ones reported by Arpacık et al. [8], Oğan et al. [20], Koç and Akman [18], Duru and Sak [11], Kayar and Inal [16] and were lower than the ones reported by Sami et al. [23]. Live weights before the slaughter varies according to factors such as initial live weight, elapsed time and daily live weight gain before and during the fattening period. It is evaluated that the differences arising here depend on these factors.

The hot carcass weights for Angus, Charolais, Limousine and Simmental in this study, respectively, were 355.45±10.20, 362.76±6.28, 385.15±5.80 and 368.98±12.02 kg (p=0.389). Various studies reported this weight as 234.9 ± 3.3 kg for Brown Swiss [8], 315.30±10.70 kg for Holstein [18], 350.9 kg for Simmental [23], 326.5, 361.5, 364.3 and 302.3 kg for Angus, Charolais, Simmental and Hereford, respectively [10], 303.4, 317.7, 332.1, 319.3 and 351.2 kg for Simmental, Aberdeen Angus, Hereford, Limousine and Charolais, respectively [11] 296.41 kg for LimousinexHolstein F_1 hybrids [20]. The hot carcass weights in this study were higher than the ones reported by Arpacık et al. [8], Oğan et al. [20], Koç and Akman [18] and Duru and Sak [11], were similar to the ones reported by Sami et al. [23] and Barton et al. [10]. It was evaluated that the high carcass weights in the study were related to the initial live weight and the elapsed time before and during fattening period.

The dressing percentages in this study, respectively, were 57.47±0.9, 58.09±0.58, 60.64±0.54 and 58.48±1.12% for Angus, Charolais, Limousine and Simmental (p=0.005), [(Limouine-Angus; p=0.027), (Limousine-Charolais; p=0.014)]. Various studies reported this values as 58.0±0.5% for Brown Swiss [8], 57.97±0.81% for Holstein [18], 57.3% for Simmental [23], 58.0, 58.3, 57.5, and 56.0%, for Angus, Charolais, Simmental and Hereford, respectively [10], 58.1, 58.5, 58.9, 58.6 and 59.5% for Simmental, Aberdeen Angus, Hereford, Limousine and Charolais, respectively [11], 59.06% for LimousinexHolstein F_1 hybrids [20]. The dressing percentages in this study were similar to the ones reported by Arpacık et al. [8], Oğan et al. [20], Koç and Akman [18], Sami et al. [23], Barton et al. [10] and Duru and Sak [11]. The dressing percentage basically varies according to the animal's breed and diet. In this study, feeding different breeds in the same way was found important to reveal the genetic differences between the breeds.

The amount of feed given to the animals was kept equal for all groups. The daily live weight gains in this study, respectively, were 1.17±0.06, 1.23±0.04, 1.23±0.03 and 1.16±0.07 kg for Angus, Charolais, Limousine and Simmental. There was no difference between breeds in terms of daily live weight increases (p= 0.600). Various studies reported this values as 1114.9 g for Brown Swiss [8], 1083.87±93.81 g for Holstein [18], 1371 g for Simmental [23], 1170, 1428, 1419 and 1315 g for Angus, Charolais, Simmental and Hereford, respectively [10], 1362.9, 1275.9, 1214.2, 1266.9 and 1101.1 g for Simmental, Aberdeen Angus, Hereford, Limousine and Charolais, respectively [11], 1.318, 1.492, 1.371 and 1.477 g Limousine, Charolais, Angus and Hereford, respectively [16], 1140 g for LimousinexHolstein F_1 hybrids [20]. The daily live weight gain in this study were similar to the ones reported by Arpacık et al. [8], Oğan et al. [20], Koç and Akman [18], Duru and Sak [11], and were lower than the ones reported by Sami et al. [23], Barton et al. [10], Kayar and Inal [16]. This is primarily due to genetic capacity and, in part, to conditions of care and feeding.

It has been observed that Angus, Charolais, Limousine and Simmental animals imported for fattening purposes have significant differences in terms of dressing percentage under the same breeding conditions and Limousine, therefore, may be more advantageous for dressing percentage.

Credit

This study was presented in the 4th International Anatolian Agriculture, Food, Environment and Biology Conference, 20-22 April 2019, Afyonkarahisar, Turkey.

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Livestock Studies, 2020; 60 (1): 5-8
http://doi.org/10.46897/lahaed.661067

RESEARCH PAPER

LIVESTOCK STUDIES

Recommended sheep husbandry model and body weights of Morkaraman lambs in Muş province*

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Article History
Received: 18 December 2019
Accepted: 20 July 2020

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Key words
Birth weight, husbandry model, Morkaraman, Muş province, sheep husbandry

Abstract

This research was carried out in order to determine some reproductive traits, the birth and the weaning weight and daily live weight gain of Morkaraman sheep in different farms of Muş province. The data used in this study was one year data of 2019 year obtained from a total of 28 sheep farms in Muş province. The mean for birth weight and 90th day weaning weight were calculated as 3.79±0.01 and 29.30±0.10 kg. The average daily live weight gain of lambs was found 272.8±0.01 g between birth and 90th day. Means for some reproductive traits as lambing rate, infertility rate, survival rate at 90th day weaaning, fecundity, and litter size were found as 92.2%, 7.8%, 97%, 1.11, and 1.21, respectively. Effect of birth type and dam age on birth and weaning weight and daily live weight gain was found to be statistically significant ($p<0.001$). Effect of gender on birth ($p<0.001$) and weaning weight ($p<0.05$) was found to be statistically significant. The results of this research have shown that source of variation observed for birth and weaning weight in Morkaraman sheep may be the genetic and the environmental. As a result, it has been recommended to perform the improvement studies in mutton production from Morkaraman sheep and growth features can be used as a breeding criterion to improve meat yield.

Introduction

Sheep husbandry is an industrial sector that they transforms the natural vegetation cover pasture not used in the agriculture into the products such as meat, milk and, wool. There are breeds such as Akkaraman, Morkaraman, Awassi, Dağlıç, Kıvırcık, and Karayaka among local sheep breeds of Turkey [12]. During recent years, sheep breeding has gained increasing popularity in Turkey.

The majority of sheep production in Turkey are carried out in extensive or semi-intensive systems. Muş city in located at East Anatolia region of Turkey is important for sheep production. The most of sheep breeds reared in Turkey are characterized as rough-mixed wool genotypes and their wools are usually used to carpet, blanket, quilt and weaving socks. There are the stock breeding systems, the trashumance husbandry, and the nomadic small ruminant husbandry in Muş province. Morkaraman sheep breed represents 21.5% of sheep breeds in Turkey. This breed is widely raised in the east of the country. Traits of Morkaraman sheep breed such as the herd and the maternal instinct are good. They are resistant to cold. They have also the ability to adapt to living conditions and poor environmental conditions. Their tails are fatty. The fat tail is used as an energy source during the long and insufficient winter feeding period [9]. This breed is bred for the production of wool as well as for meat production [6]. Lifetime weight-age relationship has become subjects of major interest of animal scientists and producers, due to the economic importance of mature weight, rate of maturing and related characteristics. Early estimation of these parameters can be of importance for selection purposes given their association with other traits and the economy of production [5]. Arslan et al. [1] reported that Morkaraman and Corriedale x Morkaraman F_1 lambs had birth weights of 3.41 and 3.85 kg respectively; weaning weights 21.99 and 21.65 kg (at the age of 90 days); found daily body weight increases from birth to breastfeeding as 206 and 198 g.

In the highland sheep husbandry, sheep flocks are removed to the highlands with cool and plenty of grassy plains by pressing hot and dry towards the end of spring. For a period of 3-5 months, sheep remain in control by shepherds in the highland. After the weather cools down, sheep go back to the villages or the farms in the plain. Sheep herds usually consist of 300 to 500 heads. Sheep herds are taken away the summer ranges by grazing or by road transport [3]. The husbandry of small ruminats in this region has been adapted to regional differences, and has been characterized by the prominence of different applications. In the highland sheep husbandry, sheep flocks are removed to the highlands with cool and plenty of grassy plains by pressing hot and dry towards the end of spring.

This research was carried out in order to determine some reproductive traits, the birth and the weaning weight and daily live weight gain of Morkaraman sheep in different farms of Muş province. In addition, the importance of Morkaraman sheep breed, a significant genetic resource in Muş province has been emphasized in this paper.

Materials and Methods

Research area

Muş province is located on the Eastern Anatolia region of Turkey. Its surface area is 8196 km^2. Its sea level height (altitude) is 1.350 meters. Average annual minimum and maximum temperatures of the region ranges from -29 ºC to +37 ºC, respectively. It snows too much in the winter months in Muş province. Sheep are on the pasture for 5-6 months of the year in Muş province of Eastern Anatolia in Turkey.

Animal material

The data used in this study was one year data of 2019 year obtained from a total of 28 sheep farms in Muş province. The animal material consisted of a total of 5610 head of Morkaraman lambs including in different farms. Birth weights of lambs were taken within the first 24 hours after birth. Lambs were weighed by using electronic bascule at birth and weaning period (Figure 1 and 2).

Statistical analysis

Birth and weaning weight and daily live weight gain were analyzed using covariance analysis design. The statistical model based can be written as follows:

$$Y_{ijkl} = \mu + a_i + b_j + c_k + e_{ijkl}$$

Where;

Y_{ijkl} = Birth and weaning weight and daily live weight gain associated to l. lamb with i. birth type j. sex and k. dam age,

μ = Expected mean value,

a_i = the effect of i. birth type (i=1, 2; single, twin),

b_j = the effect of j. sex (j = 1, 2; male, female),

c_k = the effect of k. dam age (2, 3, 4, 5$\leq$)

e_{ijkl} = the random residual error.

Statistical analyses were performed by using SAS statistical package program [13].

Figure 1. A herd of Morkaraman sheep.

Figure 2. Morkaraman rams.

Results and Discussion

Averages for the birth weight, weaning weight and daily live weight gain of Morkaraman sheep

Averages for the birth weight, the weaning weight, and daily live weight gain of Morkaraman sheep are presented in the Table 1.

The means for birth and weaning weight of 90^{th} day were calculated as 3.79±0.01 kg and 29.30±0.10 kg. The average of daily live weight gain of lambs was found 272.8±0.01 g between birth and 90^{th} day. Means for some reproductive traits as lambing rate, infertility rate, survival rate at 90^{th} day weaaning, fecundity, and litter size were found as 92.2%, 7.8%, 97%, 1.11, and 1.21, respectively.

Effect of birth type and dam age on birth and weaning weight and daily live weight gain was found to be statistically significant ($p<0.001$). Effect of gender on birth ($p<0.001$) and weaning weight ($p<0.05$) was found to be statistically significant. These findings on dam age were in agreement with those reported by Aygun and Bingol [2] and Kucuk [11].

The results of this research have shown that source of variation observed for birth and weaning weight in Morkaraman sheep may be the genetic and the environmental. As a result, it has been recommended to perform the improvement studies in mutton production from these sheep and these features can be used as a criterion to improve meat yield. The results of this research have been the basis for the scientific studies taking into account birth weight, weaning weight, and some reproductive traits of Morkaraman sheep. In particular, the source of observed variation in birth and weaning weight in Morkaraman sheep may be the genetic and the environmental.

Table 1. Means of birth and weaning weight, and daily live weight gain in Morkaraman lambs.

		Birth Weight (kg)	Weaning Weight (kg)	Daily Live Weight Gain (0-90th day, kg)
Factors	n	Mean	Mean	Mean
Birth type		***	**	***
Single	3776	4.00±0.01	28.60±0.10	0.280±0.01
Twin	1834	3.40±0.01	29.61±0.16	0.290±0.01
Sex		***	*	
Male	2787	3.87±0.01	29.02±0.12	0.285±0.01
Female	2823	3.73±0.01	28.60±0.13	0.282±0.01
Dam age		***	***	***
2	1817	3.80±0.01^{a}	29.62±0.14^{b}	0.290±0.01^{b}
3	1222	3.79±0.01^{a}	29.60±0.20^{b}	0.288±0.01^{b}
4	477	3.90±0.02^{ab}	29.40±0.33^{b}	0.288±0.01^{b}
5≤	2094	3.80±0.01^{a}	28.11±0.13^{b}	0.280±0.01^{b}
Overall	5610	3.79±0.01	29.30±0.10	0.273±0.01

*: p<0.05; **: p<0.01; ***: p<0.001; a, b: Values in same column not having a common superscript differ significantly (p<0.05).

It has been suggested that the ram effect used in villages can be significant. In particular, the selection of ram must be considered for breeding in Morkaraman sheep. In order to obtain a more definite conclusion is required to detailed works in native sheep populations in Eastern Anatolia region of Turkey.

Detailed descriptions regarding the overall performances of Turkey's native breeds in local conditions are not sufficient. However, the improvement programs should be efficiently developed in livestock at direct breeders. Investigations should be conducted to identify the morphological and the physiological characteristics of native breeds under normal breeder conditions. By obtaining the more synthesis of this information, the more sensitive animal breeding programs and the policies can be developed [4, 7, 10].

As a method, selection should be used for improvement of Morkaraman breed because of their high milk yield, and the growth and development properties of lambs. To increase the yield of indigenous breeds, a selection which will take into account the structure and yields must be applied. In selection, lamb yield and live weight gain should be emphasized.

Sheep husbandry is an industrial sector that they transforms the natural vegetation cover pasture and the pasture not used in the agriculture into the products such as meat, milk, and wool. There are breeds such as White Karaman, Morkaraman, Awassi, Dağlıç, Kıvırcık, and Karayaka among local sheep breeds of Turkey [8]. The results of this study will contribute to the scientific studies taking into account the greasy wool yield, the live weight after shearing, and the clean fleece percentage of Morkaraman ewes and the wool problems in the region. Even so, in order to obtain a more definite conclusion is required to detailed works in native sheep populations in Eastern Anatolia region of Turkey. The findings of this study have suggested that the ram effect used in villages can be significant. In particular, the source of the observed variation in the greasy wool weight may be the genetic and the environmental in Morkaraman sheep.

Conclusion

Studies about Morkaraman sheep breed have been mostly performed in the Eeastern Anatolia of Turkey. In order to obtain a more definite conclusion is required to detailed works in native sheep populations in Eastern Anatolia region of Turkey.

Small ruminant husbandry is indispensable and an important source of income for farmers in Muş province. Muş province is suitable for small ruminant breeding in terms of large pasture areas, water resources, and climate characteristics. It can be said that the province is rich in terms of underground and surface irrigation sources as well as a suitable land structure for the production of forage crops. Small ruminant husbandry is a major industrial sector in the Eastern Anatolia of Turkey and relies heavily on migrant and nomadic farm life. It has been suggested that the ram factor used in villages can be significant. In particular, the selection of ram must be considered for breeding in Morkaraman sheep.

The results of this research have shown that source of variation observed for birth and weaning weight in Morkaraman sheep may be the genetic and the environmental. As a result, it has been recommended to perform the improvement studies in mutton production from these sheep and these features can be used as a breeding criterion to improve meat yield.

Acknowledgment

This research has financially been supported by Republic of Turkey Ministry of Agriculture and Forestry, General Directorate of Agricultural Research and Policies as Morkaraman Sheep Breeding Sub-Project code: 49MOR2017-01. We thank for survey all breeders working in the sheep husbandry. We would like to emphasize my deep appreciation to the organizing committees of 1st International Livestock Science Congress.

Credit

This study was presented in the 1st International Livestock Science Congress, 31 Oct.-01Nov. 2019, Antalya, Turkey.

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Livestock Studies, 2020; 60 (1): 9-14
http://doi.org/10.46897/lahaed.701388

RESEARCH PAPER

LIVESTOCK STUDIES

The number of false mounting affects the quality of semen in bulls

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Article History
Received: 07 March 2020
Accepted: 20 July 2020

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Key words
Cryopreservation, false mounting, freezability, libido, bull, sexual preparation

Abstract

Bulls in Artificial Insemination (AI) Centres are generally trained with false mounting (FM) activity in order to improve the quality of semen. 360 ejaculates were collected via artificial vagina from twelve bulls. The bulls were subjected to each group according to the number of FM activity (FM- 0, FM- 1, and FM- 2). After the initial examination, samples were diluted and were frozen using a digital freezing machine. Post-thaw quality of sperm was assessed by using a computer assisted sperm analyzer and a photometer. Significant differences were obtained among the FM groups regarding the volume and concentration ($P< 0.001$). The highest concentration was obtained in FM- 2 group as $1326.7 \pm 365.07 \times 10^6$ sperm/mL ($P< 0.001$) and the number of straws produced per ejaculate was highest in FM-2 group ($P< 0.05$). Individual responses of the bulls to FM activity have revealed that, in general, double FM resulted in improved post-thaw motility and therefore the freezability ($P< 0.001$). In conclusion, in this study aimed to evaluate the relationship between the number of FM and sperm quality, double FM is a practical method for increasing the sperm output and post-thaw motility of the insemination doses produced in AI Centres.

Introduction

Duct of epididymis, ductus deferens and ampulla are the extragonadal sites of sperm reservoirs in the male genital tract, although, during the ejaculation, only a part of sperm reserved in the tail can be expulsed. In order to maximize the output of spermatozoa per ejaculate, sexual preparation plays a key role and can be achieved by extending the period of sexual stimulation beyond what is needed for mounting and ejaculation [5, 31]. Sexual preparation starts with the sensory stimulation via optic, olfactory, tactile and auditory stimulus, followed by the stimulation of the nerves in the supraoptic and paraventricular nuclei, which leads to the release of oxytocin from posterior pituitary that can cause the contractions of smooth muscle in the distal tail of epididymis and ductus deferens, thereby the transport of spermatozoa into an ejaculatory position. Steroids, especially testosterone is the main hormone that is responsible for the regulation of sexual behaviors. While the sexual behavior was reduced in orchiectomized males, exogenous testosterone or E_2 resulted with the restored sexual behavior [31].

The relationship between sexual behavior and semen quality mirrors the reproductive efficiency of stud bulls and has a significant importance in the breeding program, particularly in the selection criteria of bulls and the decisions of the suitable management interventions in order to optimize the production performance individually. Besides, initial semen quality has an important effect on the post-thaw spermatological parameters as well. Even with the most suitable protocol of cryopreservation, approximately half of the sperm population may lose their ability of motion due to freezing and thawing process. Thus, the initial concentration of sperm and their tolerance against the detrimental effects of cryopreservation process are essential for a profitable management in Artificial Insemination (AI) Centres. In order to achieve the highest sperm output during the routine semen collections, males are sexually prepared by three approaches, which can be listed as false mounting (FM), restraint, and the combination of these two methods [15]. For the efficiency of the restraint method, it is important to distinguish between the actual stimulation of the bull and simply its standing position close to the stimulus animal. However, this assessment can be subjective. On the contrary, FM is always recommended since it is evident to the observer [8]. In general, bulls are initially trained with FM (allowing the bull to mount, but not to ejaculate) on a teaser animal and are afterwards restrained on the teaser for several minutes to maximize their sexual stimulation and sperm quality. FM consists of manually deviating the penis during a mount so that intromission and ejaculation cannot occur. Restraint prevents the male from mounting even though he wishes to do so. Generally, restraint is for two to three minutes within half to one meter of the stimulus animal. In dairy bulls, the recommended procedures for sexual preparation are: one false mount followed by two minutes of restraint, followed by two additional false mounts before each ejaculation [9, 18, 31]. Although some researches have tested the effect of three FM and collecting the semen on the fourth attempt, this approach was found highly risky due to concerns of animal welfare since animals were more prone to get injured during the increased numbers of mounting attempts and dismounting [5, 13, 30]. It has been suggested that with the method of sexual stimulation and/or preparation, increased motility, sperm survival and conception rates could be obtained [3, 9]. It has been noted that sexual preparation is more effective in dairy than beef bulls [3, 9]. However, the studies are mainly conducted in the 1950s. Thus, it would be useful to determine whether these findings are applicable for use in current technology for semen collection and examination [24]. Therefore, in the present study, evaluation of the relationship between the number of FM and sperm quality of fresh and cryopreserved bull semen was aimed.

Materials and methods

Animals

Semen samples were collected from twelve fertility proven bulls (2 - 4 years of age) of three different breeds (6 Simmental, 5 Brown Swiss and 1 Holstein) which are kept under a uniform diet program and housing conditions in the Lalahan International Livestock Research Institute (Ankara, Turkey). These bulls are on a regular collection schedule for semen production and had fulfilled a standard breeding soundness evaluation as well as requirements of routine disease-control.

Experimental design

On each collection date, bulls were assigned to three groups (FM- 0, FM- 1, FM- 2) regarding the number of FM, and all the animals were subjected to manipulations of each group with five repetitions. FM- 0; semen collection was completed on the first mount attempt of the bull, without false mounting. FM- 1; semen was collected on the second attempt of mounting, following the first false mounting. FM- 2; semen was collected on the third attempt of mounting, after the bulls were false mounted twice. Sexual preparation of the bulls was achieved by keeping the animal restrained for 3 to 5 minutes between the mounting activities. The semen was collected during a maximum of third attempt in order to reduce the risk of injuries of the bulls.

Collection, cryopreservation and evaluation of semen

Ejaculates (n= 360) were collected on two days weekly by using an artificial vagina with the presence of a teaser animal. On each collection date, ejaculates were collected twice, consecutively, from the same bull, 5 minutes apart and the same FM procedure was applied prior to each collection. Consecutive ejaculates collected on the same day, that belonged to same animals were pooled and examined initially taking into account the volume, concentration using a photometer (Accucell, IMV, France) and motility using a phase contrast microscope [12].

A commercial semen extender (Andromed, Minitüb, Germany) was used to dilute the semen. After three hours of an equilibration period at a temperature of 4 °C, cooled aliquots were loaded into 0.25 mL French straws with a final ratio of 20×10^6 spermatozoa / straw. Straws were frozen using a digital freezing machine (Digitcool 5300 ZB 250, IMV, France) program and maintained in liquid nitrogen at least for one month until further analysis.

The straws were thawed in a 37 °C water bath for 30 s. Total motility and progressivity were assessed by using IVOS I CASA individual software (Hamilton Thorne Inc., Beverly, USA) with the existing species-specific evaluation parameters for bulls. In the analysis settings, spermatozoa with VSL 70% and VAP 50 µm / s were evaluated as a progressive motil, and spermatozoa with VAP 50 µm / s were classified as rapid. The motility parameters were expressed in percentage units. Freezability values (Δ) were defined as the loss of motility due to the cryopreservation and it was calculated as the difference of percentage between the initial fresh motility and post-thaw motility.

Statistical Analysis

The differences among the groups regarding Motility and Post-thaw motility were compared by using parametric ANOVA test. P-values, less than 0.05 were considered significant. Data comparison pertaining to the rest of the parameters were analyzed by non-parametrical Kruskal-Wallis test.

Before performing the statistical analysis, data were examined with Shapiro-Wilk test for normality and with Levene test for homogeneity of variances as parametric test assumptions. Descriptive statistics for each variable were calculated and presented as standard deviation. All data were analyzed using MIXED procedure of SPSS (V22.0; SPSS Inc., Chicago, IL, USA). The effect of group, bulls and their interaction on freezing, straw, post-thaw motility, ejaculate, concentration, total motility %, Concentration/ejaculate and freezing/CASA motility were analyzed using following model with repeated measures:

$$Y_{ijk} = \mu + G_i + B_j + (G \times B)_{ij} + e_{ijk}$$

Where, Y_{ijk}, dependent variable; μ, overall mean; G_i, effect of the group (i= FM- 0, FM- 1 and FM- 2); B_j, effect of bulls ($_j$ = -10, 3 and 10 d); $(G \times B)_{ij}$, interaction between group i and bulls j; and e_{ijk}, residual error.

Group, bulls and their interaction were assessed as a fixed effect. P< 0.001 was considered as significant in all analyses. When a significant difference was revealed, any significant terms were compared by Simple effect analysis with Bonferroni adjustment.

Results

The initial sperm motility was similar among the three groups of FM (P> 0.05) and although there were no significant differences, the post-thaw motility tended to improve with the increased number of FM. Besides, statistically significant differences were detected in volume and concentration (P< 0.001). With the increase of sexual stimulation through the FM, there was an elevated answer at the collection time and the highest concentration was obtained in FM- 2 group as 1326.7 ± 365.07 × 10^6 sperm/mL (P< 0.001). Despite the increased concentration, reduced volumes were observed in false mounted bulls (FM- 1 and FM- 2) regardless of the number of the FM activity (Table 1). Similarly, total sperm output in the pooled ejaculates was statistically higher in double FM group (8826.3 ± 4242.48 × 10^6 sperm) than in single FM group (7236.6 ± 3204.76 × 10^6 sperm) (P< 0.05). In accord with the concentration, the highest number of straws per pooled ejaculates were obtained in FM- 2 group (396.0 ± 183.63) (P< 0.05). The increase in both the concentration and the number of produced straws was more evident in the samples, which initially had the lower values with the lack of FM.

Additionally, with the lack of FM activity, the volume of semen was lower in the consecutive second ejaculates than the first ones (Table 2). However, in FM groups, the volume was either equal between the ejaculates (FM- 2), or higher volumes were obtained in the second ejaculation (FM- 1). Contrary to these findings, overall, the mean volume tended to decrease by 0.2 mL in the second ejaculates, as it was observed similarly in each breed.

Table 1. The relationship between the number of false mounting and semen parameters.

	Number of False Mounting			
Semen Parameters	0 (n=60)	1 (n=60)	2 (n=60)	P-value
Mean ejaculate volume (ml)	4.10 ± 1.13 [a]	3.29 ± 1.24 [b]	3.38 ± 1.27 [b]	< 0.001
Concentration (x 10^6 sperm/ml)	1013.68 ± 329.26 [a]	1124.73 ± 382.01 [a]	1326.70 ± 365.07 [b]	< 0.001
Total sperm output of pooled ejaculates (x 10^6 sperm)	8026.30 ± 2685.53 [ab]	7236.57 ± 3204.76 [a]	8826.32 ± 4242.48 [b]	0.043
Fresh motility (%)	83.00 ± 3.59	82.75 ± 2.83	83.92 ± 3.58	0.136
Post-thaw motility (%)	59.75 ± 10.80	61.08 ± 8.86	63.97 ± 10.56	0.068
Freezability (Δ)	23.25 ± 11.10	21.67 ± 8.74	19.95 ± 10.67	0.212
Total number of straws / pooled ejaculates	318.00 ± 108.34 [b]	302.00 ± 131.00 [b]	396.00 ± 183.63 [a]	0.004

[a,b] Mean values ± standard deviations within a row with different superscripts differ significantly at P< 0.05.

Table 2. Volumes of consecutive ejaculates regarding the different breeds and the number of false mounting

Total and Mean Volumes of Consecutive Ejaculates (ml)		Breed of the Bulls			Number of False Mounting			Total (n= 360)
		Simmental (n=180)	Brown Swiss (n=150)	Holstein (n=30)	FM 0 (n=120)	FM 1 (n=120)	FM 2 (n=120)	
1st Ejaculate	Mean ± SD	3.8 ± 1.72	3.5 ± 1.43	4.0 ± 1.96	4.5 ± 2.26	3.1 ± 1.40	3.4 ± 1.53	3.7 ± 1.63
	Minimum	1.0	1.0	1.0	2.0	1.0	1.0	1.0
	Maximum	8.5	9.0	8.0	9.0	8.0	8.0	9.0
	Total	343.3	260.0	60.0	271.8	187.5	204.0	663.3
2nd Ejaculate	Mean ± SD	3.6 ± 1.59	3.3 ± 1.08	3.8 ± 1.15	3.7 ± 1.13	3.5 ± 1.47	3.4 ± 1.48	3.5 ± 1.37
	Minimum	0.0	2.0	2.0	2.0	1.0	0.0	0.0
	Maximum	8.0	7.0	6.0	7.0	8.0	8.0	8.0
	Total	326.0	245.0	57.3	219.8	207.5	201.0	628.3

Apart from that, the effect of the number of FM on sperm characteristics was analyzed individually for each of twelve bulls and in general, double FM resulted in improved post-thaw motility and thereby the freezability (P< 0.001), although, in one bull, a single FM was adequate to increase these values, while in another one, double FM led to a decrease in both of these parameters (Table 3). When the effect of individualism was neglected, the increase of post-thaw motility in FM groups were statistically insignificant (P> 0.05).

Table 3. The interaction between the individual bulls and the number of false mounting on post-thaw motility and freezability of sperm

Parameters	Number of FM	Bull												SEM	Estimated Marginal Means	P-value		
		1	2	3	4	5	6	7	8	9	10	11	12			Number of FM	Bull	FM * Bull
Post-thaw motility (%)	FM-0	68.00^{a}	44.60^{d}	43.00$^{d.B}$	54.20$^{bcd.B}$	57.40$^{abc.B}$	63.20$^{abc.A}$	65.80^{ab}	62.40^{abc}	67.20$^{ab.AB}$	71.00^{a}	50.60$^{cd.B}$	69.60^{a}		59.75±0.82	0.001	<0.001	<0.001
	FM-1	68.60^{a}	52.60^{b}	57.60$^{ab.A}$	53.80$^{b.B}$	61.20$^{ab.AB}$	57.60$^{ab.AB}$	61.00^{ab}	59.40^{ab}	61.20$^{ab.B}$	64.60^{ab}	70.60$^{a.A}$	64.80^{ab}	2.83	61.08±0.82			
	FM-2	74.20^{a}	52.40^{bc}	49.60$^{b.AB}$	73.00$^{a.A}$	70.80$^{a.A}$	51.40$^{bc.B}$	63.80^{ac}	68.00^{a}	71.00$^{a.A}$	65.20^{ac}	67.60$^{a.A}$	60.60^{ab}		63.97±0.82			
Estimated Marginal Means		70.27	49.87	50.07	60.33	63.13	57.40	63.53	63.27	66.47	66.93	62.93	65.00	1.63				
Freezability (*Δ*)	FM-0	14.00^{c}	37.40^{a}	37.00$^{a.A}$	29.80$^{ab.A}$	24.60$^{abc.A}$	19.80$^{bc.B}$	19.20^{bc}	19.60^{bc}	18.80$^{bc.AB}$	10.00^{c}	35.40$^{a.A}$	13.40$^{c.B}$		23.25±0.89	0.034	<0.001	<0.001
	FM-1	15.40^{ab}	28.40^{a}	24.40$^{ab.B}$	28.20$^{a.A}$	21.80$^{ab.A}$	23.40$^{ab.AB}$	25.00^{ab}	23.60^{ab}	21.80$^{ab.A}$	18.40^{ab}	13.40$^{ab.B}$	16.20$^{ab.AB}$	3.08	21.67±0.89			
	FM-2	12.80^{b}	29.60^{a}	31.40$^{a.AB}$	10.00$^{b.B}$	13.20$^{b.B}$	32.60$^{a.A}$	22.20^{ab}	14.00^{b}	11.00$^{b.B}$	17.80^{ab}	20.40$^{ab.B}$	24.40$^{ab.A}$		19.95±0.89			
Estimated Marginal Means		14.07	31.80	30.93	22.67	19.87	25.27	22.13	19.07	17.20	15.40	23.07	18.00	1.78				

^{a,b,c,d} Mean values within a row with different superscripts differ significantly at P< 0.001
$^{A,\ B}$ Mean values within a column with different superscripts differ significantly at P< 0.001

Discussion

The false mounting is a process that allows the bull to mount on another bull for a limited period, before the actual ejaculation occurs. In the present study, the effect of the number of FM on spermatological parameters were evaluated by allowing the bulls to false mount once, twice or none at all, prior to the semen collection and as a result, sperm quality was enhanced significantly in double FM group, especially with respect to the concentration and post-thaw motility of spermatozoa.

False mounting is determined as the most efficient method for sexual preparation [2, 30], particularly since it indicates the sexual arousal clearly. In dairy bulls, the recommended procedure for sexual preparation is one false mount followed by two minutes of restraint, which is followed by two additional false mounts before each ejaculation. On the other hand, the response of beef bulls to FM and/or active restraint was either indifferent [11] or resulted with a minimal increase (3 FM) when repeated before the second collection [2]. Although some researches have tested the effect of higher numbers of FM activity, in the present study, this approach was not preferred due to the increased risk of bulls to get injured with the increased numbers of mounting attempts and dismounting [5, 13, 30]. Usually, bull-to-bull (teaser) or bull-to-phantom stimulations are used for sperm collection in AI Centres. In the present study, teaser stimulation was preferred for sperm collection.

In the current study, highest concentration was obtained in FM- 2 group. In spite of the increased concentration, reduced volumes were observed in false mounted animal groups (FM- 1 and FM- 2). In earlier researches, "the booster" effect of FM on sperm output of bulls has been studied by several researchers [2, 4, 14]. However, these studies were conducted mainly on 1960s and updated results using the current available technology is needed. In lieu of subjective evaluation methods, in the present study, the results were obtained using objective analysers such as the CASA and spectrophotometer. The effect of FM on sperm output was investigated in other farm animals as well. In boars, the number of spermatozoa in the sperm rich fraction was greater (P< 0.05) when males were collected after a false mount [20]. On the contrary, in stallion, an increase in the number of mounts resulted in increased volume and total sperm count together with reduced sperm concentration of the ejaculate [33]. Along with other hormones, these procedures can cause the release of oxytocin, which may result in the enhancement of sperm transport or emission from the extragonadal reserves [6, 32]. In an early study in dairy bulls, total sperm number of the ejaculate increased with the number of false mounts from 7.1 billion (with the lack of FM), up to 14.2 (with double FM) while with three FM, a decrease to 13.5 billion sperm was observed. Furthermore, total sperm number has reached to 15.1 billion owing to the addition of 5 min active restraint into this procedure [13]. Divergent from the present study, the increase in sperm output was mainly associated with the increase of semen volume than the increase of sperm concentration. In the present study, the reduced volumes of ejaculates in FM groups may link to the dripping of the excess secretion of the glands during the FM activity, since these secretions are physiologically aimed to clean the urethral duct prior to ejaculation. Generally, as a part of sexual preparation, partial erection, protrusion of the penis with dribbling of accessory fluid and repeated and persistent attempts of mounting are observed in bulls [16]. Apart from the number of FM, the duration of sexual preparation has also been associated with the semen quality. In bulls, shorter preparation periods that are less than 15 minutes, led to greater volumes of ejaculates (P< 0.05) [17], while in men, a significant positive correlation between the duration and sperm concentration (t= 2.13, P< 0.05) was obtained [25]. It is known that following the sexual stimulation, the rate of sperm transported into the excurrent ducts increases and thus it can be concluded as the underlying reason of the increased sperm concentration due the FM activity [9, 27]. Furthermore, Hafez and Bouissou [18] stated that, bulls which have the lowest sperm output show the greatest improvements with pre-stimulation. The present study agrees with the statement since the increase in both the concentration and the number of produced straws with the FM effect were more evident in the samples, which initially have/had the lower values than higher ones, in the collections with the lack of FM.

It is important to note that sexual preparation does not affect the sperm production. However, with the increase in the efficiency of ejaculation, it allows collecting the maximal daily sperm output via minimum number of ejaculations, thus, eliminates the requirement of higher frequency of ejaculations [5]. It is beneficial for the AI industry, because it reduces the total time required to collect and process the maximal quantity of semen for a given male. Ideally, AI centres follow the double collection technique in order to maximise the number of the straws produced, and thereby the profitability [28]. A maximum number of collections per bull would depend on the individual capacity of the bull. In the present study, the volume of an ejaculate ranged from 1.5 to 8 mL with double collection technique. Generally, the volume of first ejaculate is higher than the following consecutive ones [21, 29]. Similarly, in the current study, a decrease was observed in the volume of second ejaculate in overall and each breed group, especially in FM-0 group. However, in FM groups, the volume of second ejaculate was able to reach and exceed the first ones. The overall reduction in semen volume seems to be largely related to the short collection interval between consecutive ejaculates [12, 21]. In the present study, this interval is prolonged due to FM activity and bulls could have adequate time for sexual preparation. Furthermore it has been stated that, the collection of multiple ejaculates on the same day did not affect the post-thaw motility, but the pre-freeze motility was reduced ($P < 0.01$) in Holstein bulls [21], whereas no significant difference was observed in Shorthorn-Zebu breed [23]. Although in general, second ejaculates are of less volume and sperm concentration, the collection of sequential ejaculates increases productivity per unit time, as more insemination doses can be obtained on a given day.

Even though the initial sperm motility was similar among the three groups of FM, on the individual bases, generally, double FM resulted in improved post-thaw motility and thereby the freezability ($P < 0.001$), although, in one bull, a single FM was adequate to increase these values, while in another one, double FM has led to a decrease in both these parameters. Contrary to the positive influence of sexual preparation on sperm output, there is less evidence for its influence on sperm characteristics. However, few researchers have reported that the pre-coital stimulation and/or 'preparation' of bulls by false mounts and restraint, beyond that adequate for mounting and ejaculation have improved the motility and survival rate of the sperm as well as the conception rate [3, 9]. The mechanism behind the improvement of post-thaw motility due to FM is unclear and still needs detailed research but it can be assumed that the increase of initial sperm concentration and the reduction in the volume led to the use of higher dilution rates during the sperm processing and in return, this could favour the post-thaw motility enhancement. Various researches have investigated the effect of concentration on post-thaw semen quality in ram [1, 19], buck [4] and stallion [22] and their result revealed that higher dilution and/or lower sperm concentration has led to enhancement of motility as well as intact plasma membrane and acrosome integrity. This effect may be linked with the release of reactive oxygen species from sperm cells into their surrounding medium due to the stress during the freeze-thaw process, can be alleviated owing to the use of higher dilution rates by lowering the concentration of these factors. Similarly, a study conducted on Norwegian Cattle bulls has revealed that sexual preparation beyond 15 minutes resulted with higher post-thaw motility without any significant differences in 60-day non-return rates [17]. It can be concluded that various conditions such as frequency of collection, duration of sexual preparation and type of semen collection and the rate of dilution of the semen may have an influence on the harvested semen quality [35]. Besides, it has been stated that certain semen characteristics are more variable than others [7, 10, 26, 34, 36].

According to our results, double FM activity before the semen collection increased the post-thaw motility and concentration of spermatozoa and therefore the number of straws produced. In conclusion, double FM is recommended as a method to increase the libido and sperm quality of bulls and Artificial Insemination centres could benefit from the double FM activity prior to semen collection. However, differences in the response of individuals should be kept in mind, and in order to obtain the maximum yield from each bull, it would be wise to initially test the individual responses of each bull and optimise the number of FM treatment accordingly.

Acknowledgments

The authors are thankful to, General Directorate of Agricultural Research and Policies (GDARP) and International Center for Livestock Research and Training, to provide the necessary animal material to carry out the research programme.

Credit

The pre-elaminary results were published in 8th National Reproduction and Artificial Insemination Congress at 5-9 September, 2016, Antalya, Turkey

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Livestock Studies, 2020; 60 (1): 15-23
http://doi.org/10.46897/lahaed.674261

RESEARCH PAPER

LIVESTOCK STUDIES

Effect of diet protein and energy levels on serum biochemical profile of fatty tailed sheep

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Article History
Received: 13 January 2020
Accepted: 17 July 2020

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Key words
Metabolic profile test, Akkaraman, serum biochemical parameters.

Abstract

The aim of this study is to determine relationships between metabolic profile with diet in fat tailed sheep. With this aim, one hundred twenty Akkaraman sheep coming twenty out of six flocks, which gave birth a year ago, clinically healthy, were chosen. The sheep chosen were bled from jugular vein and serums obtained were analyzed for; glucose, total protein, albumin, BUN, cholesterol, AST and GGT, as biochemical parameters. During the physiological states of late pregnancy 115th and 125thdays, and postpartum, 10 days after partition-early lactation, same procedures were followed and data collected was compared by using Z test and for concerned metabolite, unlike statistically averages values of different flocks were determined. While different flocks were coded as DA (different from average), the similar ones were coded as IA (inside in average). The relationships between diet composition and metabolic profile were determined through regression analysis. According to the adjusted determined coefficients (R-Sqadj) which was obtained from regression analysis and interactions between diet compounds in DA group and serum biochemical profile were detected more meaningful than the group IA which was created as a different group. While cholesterol has strongest relationship with diet energy, BUN was the best reflector of diet crude protein level.

Introduction

Livestock are involved in an effort to balance their feed consumption and physiological nutritional requirements. Therefore, they try to consume nutrients to meet the maintenance and yield needs. The establishment of this balance depends on the feed characteristics and the needs of the animal. The level of metabolite concentrations in the critical periods of the animal's lifetime affects yield temporarily or permanently. Obtaining data amongst the relationship between the diet nutrients and blood metabolites could enable to meet the needs of every physiological state of sheep with balanced diet. In studies conducted on this target, while a large number of consensuses were provided for diet-component relationships with some of the metabolites, while some are meaningless.

In studies on the effect of diet energy level on glucose, Lee et al. [12] reported that diet energy value was generally effective on blood glucose concentration in cattle, while Kida [11] reported that it was effective only in the middle and late lactation periods. In studies conducted in sheep, flushing has been reported to have an important effect on serum glucose concentration [15, 24]. Furthermore, in a study on non-pregnant sheep, it is stated that an increase in serum glucose value is observed in parallel with increasing diet energy value [5]. Most of the energy need in ruminants is met by the volatile fatty acids produced in the rumen. The increase in the production of ketone bodies in ruminants is a result of increased lipolysis as a result of decreased serum glucose level due to the inability of the diet to meet the energy needs. Therefore, it could be said that the relationship between BHBA (Beta Hydroxy Butyric Acid), another metabolite associated with energy metabolism, and the diet energy value is indirectly dependent on glucose. However, this relationship between two parameter is not always linear and unidirectional.Bani Ismail et al. [3] state that a significant negative relationship between BHBA and glucose is observed only in goats with a BHBA level greater than 0.86 mmol / l. Cholesterol is another metabolite which reflects diet energy level [11].

Published by International Center for Livestock Research and Training

It is stated that the effect of diet protein content on serum BUN (Blood Urea Nitrogen) concentration is at significant levels within studies on both cattle [4, 8, 17] and sheep [5, 14, 23]. It has been shown in several studies that there is a direct relationship between serum albumin concentration and diet protein level, which is reported to include nutritional conditions [16], among the factors affecting its synthesis, in both sheep and cows [9,12, 21, 26]. However, it is argued that serum albumin level is significantly affected by dehydration, and therefore BUN values should be considered rather than albumin as a means of estimating diet protein level [11]. Dietary energy and insulin levels also have an effect on albumin synthesis, and the rate of decrease in energy deficiency could only be eliminated by glucose feeding [5, 13, 19].

In ruminants; activity of AST (Aspartate-Aminotransferase) and GGT (Gamma Glutamyl-transferase) is often contact with FCS (Fat Cow Syndrome), depression of feed intake and ketosis [17]. According to Meyer and Harwey [17], increasing serum AST activity is sensitive marker for liver damage even in subclinical case. It is reported that fatty liver syndrome is seen because of large amount of body fat mobilization resulting the hypoglycemia in pregnancy toxemia [22], and one of the reason of increasing AST activitiy is the reduction of the diet energy [1]. The increase of serum activities of aminotransferases, which is used for determining the size of the change of hepatocelluler membran permeability (e.g. death of cell), it is also described as increased synthesis rate [18]. While Şahinduran et al.[20] described that increasing GGT activity is resulted in cholestasis and subsequent hepatobiliar circulation defect, it is reported that GGT, which is stated to have an antioxidant effect outside the cell and an antioxidant effect inside the cell [6], could be used as an oxidative stress indicator also [10].

The studies about morphological features of Akkaraman ewes which is the experimental breed of this study, live weight is as 57.6 kg [2] and as 66.4 kg [25] reported. The metabolic energy (ME) and crude protein (CP) needs of sheep with 60 kg live weight, and over 1.5 years old ages are suggested as 3.11 Mcal, 137.00 g and 3.37 Mcal, 200 g, respectively during the late pregnancy and postpartum early lactation period [7].

Various studies have previously been conducted on the relationship between the diet components and the biochemical profile and relationships at different levels have been identified. The group design in the studies conducted in this direction generally takes the form of groups that consume different diet components and changes in biochemical parameter/parameters are monitored through these groups. Our investigation was carried out in field conditions and the feeding patterns of the animals were not interfered. For this reason, the groups were formed not according to the diet components they consume, but according to the degree of deviation of the biochemical parameters they have, and the numerical data about the role of the diet in differentiation of a biochemical parameter from the average was tried to be obtained. For this purpose, a third group to cover all animals, as well as two groups created by determining the flocks with positive or negative deviations from the averages for each of the measured biochemical parameters was created and the biochemical profile-diet relationship was examined for each group separately.

Although as far as we know, there is no direct study on the effects of diet components on the biochemical profile in the Akkaraman breed, which is a fat-tailed sheep race, similar studies have been conducted in other sheep breeds and cattles.The data obtained in these studies were discussed and evaluated on the basis of metabolite groups.

Materials and Methods

Animals and Nutrition

This study was carried out on the sheep herds involved in the National Countryside Small Ruminant Animal Project of Minisitry of Food Agriculture and Forestry, TAGEM on Sivas Kangal Akkaraman sheep. A sum of 120 prompt randomly selected sheep from 6 different flocks, clinically healthy and fertile animals that had given birth in the previous year, were used for this experimental research. The investigated animals were kept in their own flock that were monitored by giving numbers, identified by organic dyeing paint visually to be captured easily for monitoring and sampling. Due to the investigation periods took place within the indoor conditions as late pregnancy and post partum-early lactation, there was no pasture affect on flocks. The daily diet and nutritional values of the research material consumed during the sampling periods were performed as shown in Table 1.

Sampling and Analyses

From selected 20 animals, 7-10 ml of blood was taken into containing plain vacuum glass tubes with serum gel via *V. Jugularis* during the late pregnancy (between the 115^{th} and 125^{th}days of pregnancy) and postpartum (in the first 10 days after delivery-early lactation) period. The sampling process was carried out before the morning or evening feeding. Following standing at room temperature for 20-30 min, the tubes were centrifuged at 3,000 rpm for 10 min and the serum samples stored at -20°C until biochemical analyses. Glucose, cholesterol, AST, GGT, BUN, total protein, albumin were determined within 1 month following sampling for each period with the use of commercial kits *(Shenzhen Mindray Bio-Medical Electronics Co. Ltd, Shenzhen, Chine)* at auto analyzer *(BS 200 chemistry analyzer, Shenzhen Mindray Bio-Medical Electronics Co. Ltd, Shenzhen, Chine)* which was located at University of Cumhuriyet, Veterinary Faculty, Departmant of Internal Diseases. BHBA was measured with a device *(Optium Xceed, Abbott Diabetes Care Ltd.)* which is run with strip *(Freestyle Optium, Abbott Diabetes Care Ltd.).*

Table 1. Nutritive value of feeds and diet fed to ewes during the study.

Flock number	Physiological Period	Diet fed (g)		Nutritive value		
				DM, kg	ME, Mcal	CP, g
1	LP	Barley	600	1,31	2,76	87,29
		Straw	850			
	PP	Barley	600	1,31	2,76	87,29
		Straw	850			
2	LP	Barley	350	1,30	3,08	116,64
		Wheat	350			
		Alfa alfa hay	125			
		Grass hay	125			
		Straw	500			
	PP	Barley	200	1,30	1,63	68,24
		Wheat	200			
		Alfa alfa hay	100			
		Straw	250			
3	LP	Concentrate feed*	500	1,34	3,12	158,56
		Milk concentrate**	200			
		Alfa alfa hay	300			
		Straw	300			
	PP	Concentrate feed *	500	1,38	3,21	166,12
		Concentrate feed (milk)**	200			
		Alfa alfa hay	450			
		Straw	400			
4	LP	Barley	200	1,30	2,81	114,52
		Wheat	200			
		Oat	100			
		Alfa alfa hay	150			
		Grass hay	200			
		Straw	600			
	PP	Barley	200	1,30	2,81	114,52
		Wheat	200			
		Oat	100			
		Alfa alfa hay	150			
		Grass hay	200			
		Straw	600			
5	LP	Barley	700	1,01	3,02	124,58
		Milk concentrate**	250			
		Grass hay	150			
		Wet sugar beet pulp	400			
	PP	Barley	700	0,97	2,79	109,68
		Grass hay	350			
		Wet sugar beet pulp	400			
6	LP	Rye	600	1,16	2,70	101,40
		Grass hay	300			
		Straw	400			
	PP	Concentrate feed (milk)**	600	1,16	2,77	122,45
		Grass hay	300			
		Straw	400			

LP: The late pregnancy period. **PP**: The postpartum period. **DM**: Dry matter. **ME**: Metabolic Energy. **CP**: Crude protein. * Concentrate feed %88 DM, 2750 Mca/kgl ME, %14g CP. ** Concentrate feed (milk)** %88 DM, 2481 Mca/kg ME, % 16 CP.

Groups and Statistical Analysis

The average value of the data from all 6 flocks was determined for each metabolite in both physiological periods (general average value). The average value of each flock in both physiological periods for each metabolite was compared with the general average value determined using the Z test. Thus, flocks that were statistically different from the general mean value for the relevant metabolite were determined. The direction of these flocks that differ from the general mean value was determined by the Z value getting a positive or negative sign. The symbol Z+ refers to flocks that have higher than average mean for the relevant metabolite, while Z- refers to flocks having lower mean than general mean. As a result of the comparison, all flocks of both periods different from the averages were considered different from the general averages and coded as **DA** (Different from Average), and those outside the **DA** group were accepted as inside the general averages and coded as **IA** (Inside the Average). The total of **DA** and **IA** were called total group **(TOT)**. Thus, there were 3 groups with different n counts for each metabolite. For example, for glucose metabolite, as stated in table 3, the **DA** group formed 4 flocks and the count of n of this group was (20x4) 80 (each flock consists of 20 sheep). These four flocks formed the following flocks; -*In the late pregnancy period*; **1-)** 1 flock as Z+ (number 5 flock), **2-)**1 flock as Z- (number 6 flock), - *in the postpartum period;* **3-)**1 flock as Z+ (number 3 flock), **4-)** 1 flock as Z- (number 2 flock) (Table 3). The count of TOT group n for the same metabolite was 240, (6x20) 120 in the late pregnancy period and (6x20) 120 in the postpartum period. Since the **TOT** group ncount was 240 and the **DA** group n count was 80 for the glucose metabolite, the difference gave the number of **IA** group n (160). Groups of other metabolites were also determined by this method.

The relationship between diet components and metabolite levels was determined on the basis of groups created. The relationship between the diet energy content and blood glucose level for the **DA** group, the blood glucose level of 80 animals performed as **DA** group. Same method was applied in diet nutrients and metabolite relationships in other metabolites. While the relationship between diet energy level and glucose, BHBA, cholesterol, AST and GGT concentrations were determined in the groups, the relationship between diet protein level and BUN, total protein and albumin were determined. Due to the role of insulin on albumin synthesis, the relationship between total protein and albumin with diet protein level, as well as their relationship with diet energy level were examined. The live weights of the sheep within in the flocks were around 60 kg during this period.

The ratio of nutrients of the diet to meet the needs in late pregnancy and postpartum periods was determined with the formulas *"Diet Energy Amount x 100 / Energy Requirement"* for diet energy and *"Diet Crude Protein Amount x 100 / Crude Protein Requirement"* for the diet crude protein. In the formulas, the energy and crude protein requirement of the sheep were accepted as 3.11 Mcal, 137.00 g and 3.37 Mcal, 200 g, respectively, in late pregnancy and postpartum period [7].

Relationship between diet components and serum biochemical parameters were determined by correlation and regression analysis. Adjusted determination coefficients (R-Sqadj) were determined by regression analysis of interactions that showed statistically significant ($p<0.05$) correlations. The significant of the determination coefficient was tested with variance analysis (ANOVA). The differences between the nutritional requirements of the diet nutrients were determined by chi-square (Chi-Sq) test. All statistical analysis was performed with the computer program (Minitab 17) for Windows, version 8.0.

Results

The diet energy and crude protein values of the herds to meet the specified needs of sheep during late pregnancy and postpartum periods are presented in Table 2. The rates of the crude protein and energy amounts of the diets given to the experimental flocks and sufficiencylevels to meet the daily needs of the animals were statistically important except for the energy content of the late pregnancy period Table 2. When compared with the diet energy values according to the obtained chi-square values, it was seen that the variation between crude protein ratios was wider.

The flock/flocks which statistically different from the general average value obtained by comparing the average values of each flock with the general mean value in both physiological periods for each metabolite occurred are shown in Table 3. Flock numbers differentiating from the values higher than the general average value performed are shown in column 'Z+' and, lower values as shown in the 'Z-' column. The number of flocks that differ from the general averages for both physiological periods as a result of the comparison was specified in the column "The count of flocks the DA group".

Adjusted determination coefficients (R-Sqadj) of regression analysis for interactions that show statistically significant correlations between diet components and metabolites concentrations were shown in Table 4. According to the value of determination coefficients, the relationships between diet components and metabolites were stronger in the **DA** group than other groups (Table 4).

Table 2. Diet nutritional factor and the rate of requirements.

	Metabolic energy				Crude protein			
	LP		PP		LP		PP	
Requirement*	3.11 Mcal		3.37 Mcal		137.00 gr		200.00 gr	
Flocks	diet	rr%	diet	rr%	diet	rr%	diet	rr%
1	2.76	89	2.76	82	87.29	64	87.29	44
2	3.08	99	1.63	48	116.64	91	68.24	34
3	3.12	103	3.21	95	158.56	121	166.12	83
4	2.81	90	2.81	83	114.53	84	114.53	57
5	3.02	97	2.79	83	124.58	91	109.68	55
6	2.7	87	2.77	75	101.4	74	122.45	58
p		0.824		0.06		0.001		0.000
Chi-Sq		2.18		16.27		21.64		24.63

LP: The late pregnancy period. **PP**: The postpartum period. **rr**: The rate of requirements.*According to diet program [7].

Table 3. The flocks, different from general average value and differences direction.

	Late pregnancy			Postpartum			
		Flock numbers			Flock numbers		Count of the DA group flocks
Metabolites	mean	Z+	Z-	mean	Z+	Z-	
Glucose(mg/dl)	64.92±9,40	5th	6th	55.16±10,75	3th	2nd	4
BHBA(mmol/l)	0,35±0,16	3th	-	0,42±0,26	4th	2nd	3
Cholesterol(mg/dl)	60,62±13,48	2nd;3th	4th;6th	62,23±13,29	3th	-	5
AST(IU/l)	10,24±5,16	-	1st	14,72±5,67	3th	1st	3
GGT(IU/l)	6,28±0,70	6th	3th	6,04±0,64	-	6th	3
BUN(mg/dl)	3,21±0,36	3th	1st;4th;6th	3,07±0,36	3th	1st;2nd;6th	8
T.Protein(mg/dl)	74,95±18,03	3th;5th	1st;6th	104,71±29,82	3th;5th	1st;6th	8
Albumin(mg/dl)	43,02±12,57	3th	1st	46,77±16,22	3th	2nd	4

Z+;The flocks, different from average with positive direction, **Z-**: The flocks, different from average with negative direction. **BHBA**: Beta Hydroxy Butyric Acid. **AST**:Aspartate-aminotransferase,**GGT**: Gamma glutamyl-transferase, **BUN**: Blood urea nitrogen, **T.protein**: Total protein.

Table 4. The relatiosnhip of diet compounds and metabolites.

	Determination coefficient of variable(R-Sqadj)					
Groups	**DA**		**IA**		**TOT**	
DC	**Energy**	**Protein**	**Energy**	**Protein**	**Energy**	**Protein**
Metabolite						
Glucose	13,55 *** (n=80)		ns (n=160)		4,13 ** (n=240)	
BHBA	14,27 ** (n=60)		ns (n=180)		4,58 *** (n=240)	
Cholesterol	34,33 *** (n=100)		ns (n=140)		2,84 ** (n=240)	
AST	27,8 *** (n=60)		8,42 (-) *** (n=180)		1,40 (-) * (n=240)	
GGT	24,78 *** (n=60)		ns (n=180)		ns (n=240)	
BUN		58,7 *** (n=160)		21,71 *** (n=80)		37,9 *** (n=240)
T.Protein	31,63 *** (n=160)	27,11 *** (n=160)	ns (n=80)	ns (n=80)	8,05 *** (n=240)	15,83 *** (n=240)
Alb	43,2 *** (n=80)	52,91 *** (n=80)	ns (n=160)	2,13 * (n=160)	17,89 *** (n=240)	32,6 *** (n=240)

DC: diet compound. **DA**: flocks, different from the average. **IA**: flocks, inside the average. **TOT**: Total group. **ns**: not significiant. **(-):** negative correlation. **BHB:** Beta Hydroxy Butyric Acid. **AST**: aspartate-aminotransferase .**GGT**: gamma glutamyl-transferase. **T.protein**: total protein. *p<0.05 **p<0.005 ***p=0.000 (according to variance analyze).

Discussion

According to determination coefficients, the relationships between diet components and metabolites were generally stronger in the DA group compared to other groups. In other words, the flocks that differed in terms of a metabolite from the general averages, either positive or negative, were in a more significant relationship with the diet component than the flocks that did not differ. This difference could be interpreted that diet may also be a factor in the differentiation of the metabolite from the averages. It is also seen in the diagrams that this difference in meaning in the relationship degrees could be caused by diet (Figure 1-8). Because these diagrams were developed by using the flocks included in the DA group with differentiation directions as in Table 3 and the ratio of the diet used in these flocks to meet the requirement (Table 2). The diet components and the metabolite levels related are shown together in the flocks forming the DA group, the relationship between the two variables has become more visible in these diagrams (Figure 1-8),

According to the values of the determination coefficient, the relationship between protein metabolism metabolites and the diet component was stronger than energy metabolism metabolites. This difference in relationship levels may have occurred due to the relatively wide spectrum observed in diet protein levels according to chi-square values (Table 3).In other words, it seems possible that the depth of variation between the diet protein ratios of the flocks may increase the significance of the relationship by causing high variation in the metabolites associated with the diet protein.This form of relationship could be seen as another proof of the relationship between diet and biochemical profile.

Figure 1

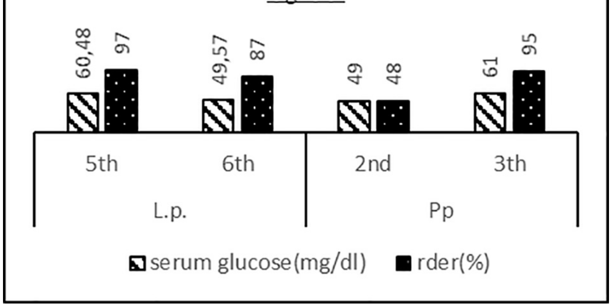


Figure 2

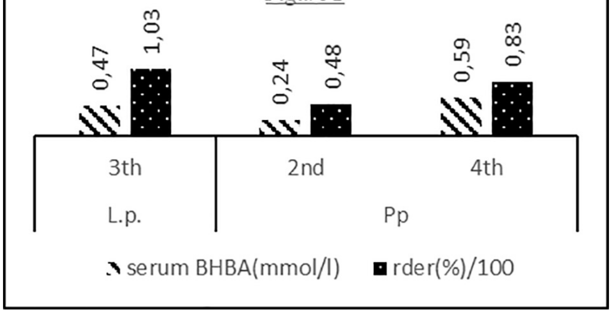


Figure 3

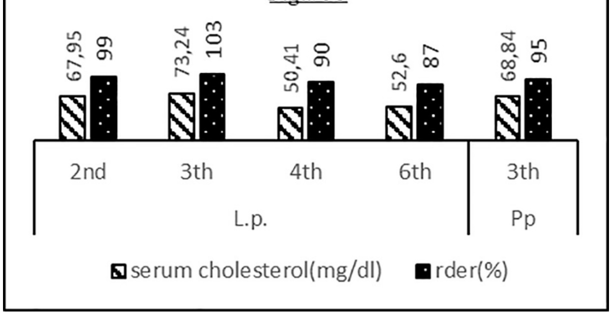


Figure 4

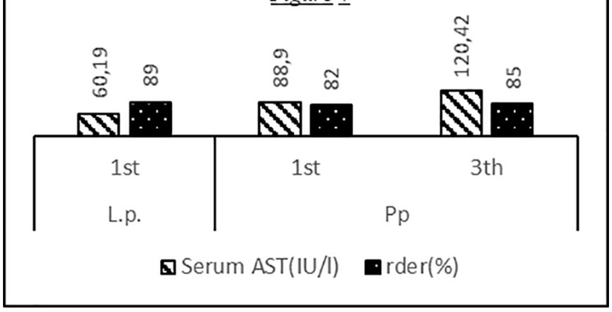


Figure 5

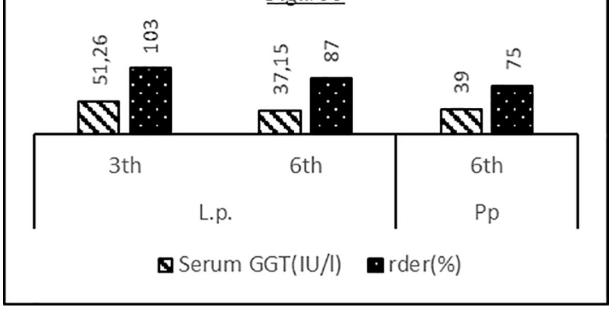
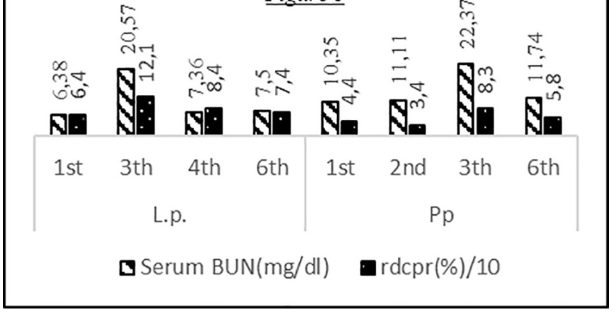
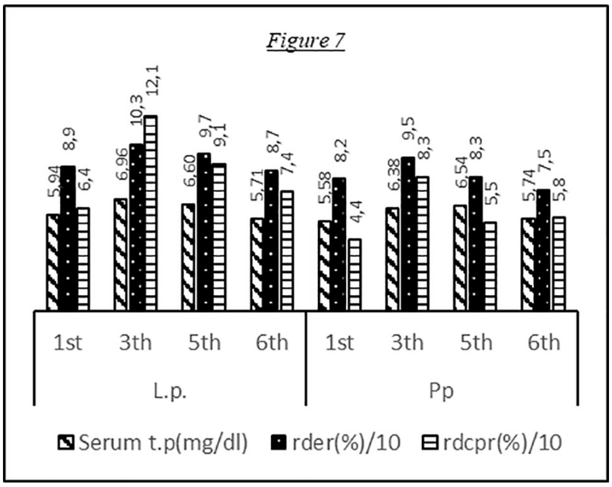


Figure 6





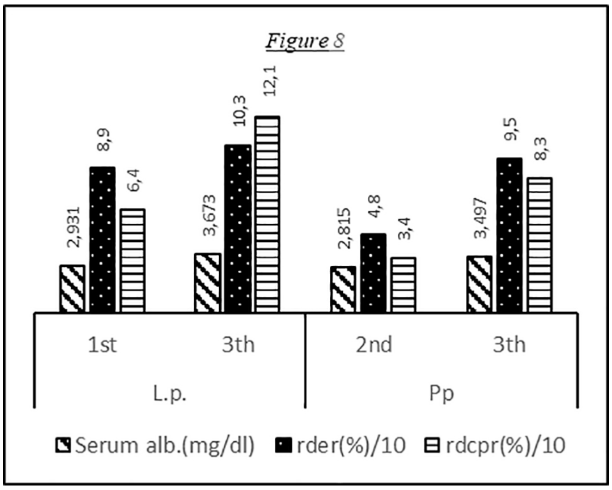


Figure 1-8. Serum mean metabolite concentrations and the ratios of the diet to meet the energy and protein requirements of the herds in the establishments that consist the **DA** group.

L.p.: Late pregnancy. **Pp:** Postpartum. **rder%:**The rate of diet energy requirement. **rdpcr%**:The rate of diet crude protein requirement. **BHBA:** Beta hydroxybutyric acid. **AST:** Aspartate amino transferase. **GGT:** Gama glutamyl transferase. **BUN:** Blood urea nitrogen. **t.p:** Total protein. **Alb**: Albumin. The y-axis shows physiological periods and flock numbers.
In order for the variables to form similar columns in the same diagram, some transformations were made in the (rder%) and (rdcpr%) ratios. These transformations: **1-**1% of (rder%) was used in figure 2 **2-** 1 in 10 of (rdpcr%) was used in Figure 6. **3-** In Figures 7 and 8, 1 of 10 (rder%) and (rdpcr%) was used

Energy Metabolism and Diet

It was observed that glucose, BHBA and cholesterol do not have a statistically significant relationship with diet energy value in the IA group. While the relationships between glucose and BHBA concentrations and diet energy level occur approximately in the TOT and DA groups, in the case of cholesterol, DA group interactions appear to be significantly stronger than the total group (Table 4).

In studies focusing on the effect of diet energy level on glucose, Lee et al. [12] reported that diet energy value was effective on glucose concentration in cattle, while Kida [11] reported that it was effective only in the middle and late lactation periods. In determining the energy balance and the amount of energy taken by diet, especially in early lactation, the blood glucose level [11] is significantly changed by flushing applications in sheep [15, 24]. On this study the relationship of glucose concantdiet and diet energy, which was found not significant on IA groups was found significant on DA group (Table 4). This difference in meaning shows the effect of diet energy level on blood glucose value deviating from the mean. This finding is supported with the result of Caldeira et al. [5] study on sheep for meeting energy needs of sheep at certain rates, reported that the serum glucose levels of sheep fed with a low energy content are low compared to other groups.

The increase in the production of ketone bodies in ruminants is a result of increased lipolysis due to the inability of the diet to meet its energy needs [22]. Ketone bodies occurred and raised in numbers from fats catabolism when glucose does not meet the body energy requirements. In this case, unlike glucose, which positively correlates with diet energy, the BHBA-diet energy relationship was expected to occur negatively. However the correlation between diet energy and BHBA levels were found to be positive (Table 4). The positive relationship in this study may be due to the levels of BHBA obtained in the studymay be explained as; Bani Ismail et al. [3] suggested that the relationship between glucose and BHBA is occurs when concentration of BHBA is greater than 0.86 mmol/l. The mean BHBA concentration obtained in the study presented was 0.35 and 0.42 mmol / l during late pregnancy and postpartum periods, respectively.

While cholesterol, which is the one of the major indicator of body energy index [11] has been least affected metabolite from diet energy level compared with other energy metabolism metabolite in total group, but has been most affected in DA group (Table 4). Because of these deep differencies, which have reexisted among the experimental groups, cholesterol may be the one of the most useful instrument for assessing energy level of diet.

Liver Enzymes and Diet

According to the determination coefficients in the presented study, it is seen that the effect of diet energy value on AST is more visible than the GGT, even if it is moderate (Table 4). In the study conducted by Abdalla et al. [1], which was providing 50% and 100% of energy requirements of sheep, mean AST concantdiet respectively 55.11 u/l and 82.34 u/l, GGT concentration 32.57

u/l and 38.23 u/l was found [1]. In this study, the negative relationship between the diet energy value and serum AST level in the IA group was compatible with the data of the study conducted by Abdalla et al. [1]. However, in the case of the DA group, there was a positive relationship between diet energy value and serum AST and GGT levels (Table 4). This incompatibility between the groups may be occurred by the participation of liver enzymes into the circulation not only due to hepatocellular damage but also from leakage from over production [18]. Because the diet energy is relatively high, the liver is one of the first organs to be affected in the accelerated metabolism and probably more transamination reactions. The increased production of transaminases into the circulation in the form of leakage will increase blood concentrations. When evaluated in terms of metabolic rate and increased enzyme synthesis, the positive correlation between diet energy and GGT activity could also be associated with oxidative stress. Because it is reported that GGT, which is stated to have an antioxidant effect outside the cell, and an antioxidant effect inside the cell [6], could be used as an oxidative stress indicator as well as evaluating liver functions [10].

Protein Metabolism and Diet

While the effect of diet protein level on BUN, total protein and albumin metabolites, which are reflecting protein metabolism [11], was significant on almost all group, this effect was more meaningful within the DA group then the other (Table 4).

The relationship between the diet protein level and BUN concentration found important in all of the groups in our study, supported by the data obtained by Torell et al. [23] and Lobley et al. [14] in their studies on sheep. It is reported that there is a linear relationship between NH_3, which is transferred from portal visceral organs, to the liver, and dietary nitrogen intake, and this correlation is up to $r^2 = 0.96$. [14]. Also a strong correlation between BUN and nitrogen intake was reported in the study conducted by Torell et al. [23] by giving pelleted alfa alfa hay under pasture conditions ($r^2 = 0.99$) as well. Similar results were taken from the researches which were realised on cattle about this matter and BUN is describe as the good indicator, which reflects of rumen ammonium concentration [11, 12].

Several previous studies have shown that there is a direct relationship between serum albumin concentration and nutritional status, particularly protein intake, in both sheep and cows [9, 12, 26]. Albumin, which was reported to be affected by nutritional conditions [16], had a relatively strong relationship with diet protein in our study (Table 4). Mazzaferro et al. [16] suggested that one of the synthesis factors of albumin is the diet and %6 of daily nitrogen intake is used for synthesis of albumin. Furthermore, it is stated that when diet and protein deficiency takes a long time, albumin synthesis decreases by 50-60% and diet with 0-4% protein does not slow down this decrease [21]. Furthermore, increasing serum albumin and total protein levels are parallel with increases of diet energy level on nonpregnant ewes [5]. It is stated that the relationship between albumin and diet protein could be explained by the fact that the amino acid requirement for the synthesis of the molecule can not be taken in the diet, but also plays a role as an amino acid provider due to an inadequate diet [5].

It is suggested that dietary energy also has an effect on albumin synthesis, and in energy deficiency, the reduced synthesis rate of albumin could only be eliminated by feeding with glucose [19]. Also, the insulin level must be sufficient to synthesize the appropriate amounts of albumin [13]. In our presented study, it was determined that albumin and total protein concentrations are related to the diet energy level as well as the relationship between the diet protein level (Table 4). This data support the data that described, increasing serum albumin and total protein levels are parallel with increases of diet level on nonpregnant ewes, by Caldeira et al. [5]. However, in the emergence of this relationship, the high dry matter of energy-intensive feeds and thus the formation of dehydration may also contribute. Because dehydration is reported to increase the albumin level proportionally [11].

Conclusion

In our study, it was determined that there are varying degrees of relationship between the diet components and the serum biochemical profile. It is very difficult to set up with a mathematical formula that provides certainty for these relationships. Because it is a known fact that the biochemical profile is affected by countless agents and metabolic pathways besides the diet factor. However, considering the difference in diet-biochemical relationships between the groups formed in our study, it seems possible to modify the serum biochemical profile with diet arrangements. Because the interactions between the diet components and serum biochemical profile in the DA group were found to be more significant than the other group, the IA group.In other words, the diet-biochemical profile relationship of the flocks that differed upwards or downwards in terms of a metabolite was stronger than those that did not differ. This difference in the degree of relationship of the groups could be interpreted that diet may also be a factor in metabolite deviations.

It is thought that serum cholesterol level is a good indicator for evaluating the diet energy level, but caution should be taken in use of transferases because the direction of interaction changes between groups to determine the diet energy level. The relationship between glucose and BHBA and diet energy level was not as strong as cholesterol.

It is one of the common outcomes of both this study and previous studies that there are very strong relationship between the diet protein level and BUN. Therefore, it can be said that the BUN level is an indicator that can be used in diet protein arrangements. It is thought that total protein and especially albumin concent of diets can be used to evaluate both protein and energy levels of the diet considering the level of the diet.

This article is the part of 'Investigiation of Metabolic Profile Test Applicability in Sheep Herds' Project which was supported by General Directorate of Agricultural Research and Policy with the project number TAGEM/ HAYSÜD/14/A07/P01/003.

Credit

This study was presented in the 1st International Livestock Science Congress, 31 Oct.-01 Nov. 2019, Antalya, Turkey.

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Livestock Studies, 2020; 60 (1): 24-31
http://doi.org/10.46897/lahaed.719095

RESEARCH PAPER

LIVESTOCK STUDIES

A comparative forecasting approach to forecast animal production: A case of Turkey

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Article History
Received: 13 April 2020
Accepted: 17 July 2020

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Key words
Red meat, forecasting, animal production, comparative method

Abstract

A number of reasons such as the increase in the world population, changes in the climate due to global warming and pandemic diseases affecting many regions have brought the importance of vegetative and animal production to the agenda, which is necessary for the healthy and balanced nutrition of the societies. Due to the global changes occurring for many years, researchers and policy makers have carried out studies on sustainable agriculture and livestock policies at the national and international level of food supply. In the literature, a limited number of forecasting studies on animal production have been carried out. The aim of our study is to develop a comparative forecasting approach and determine the best forecasting methods and models for each type of red meat (i.e. goat, seep, buffalo carcass, and cattle and calf carcass). Accordingly, we used ARIMA, exponential smoothing and STLF forecasting methods. Quarterly data between 2010 and 2018 published by Turkish Statistical Institute were used. As a result, ARIMA method was successful in forecasting amount of red meat production of cattle and calf carcass, and goat; exponential smoothing method was the best for other red meat resources. On the other hand, STLF method performed better than ARIMA and exponential smoothing methods in the training process of all forecasting models. The results of the study showed that comparing more than one forecasting method rather than using a single method in estimating the amount of red meat production will produce more reliable and accurate results.

Introduction

Livestock is one of sub-branches of agriculture sector and provides raw materials for different industrial sectors. It is also crucial for societies due to supplying essential nutrients [1]. The livestock sector is an indispensable production branch in terms of adequate and balanced nutrition for people. Basic animal products (i.e. egg, milk and meat) constitute the main protein sources that people have to intake for a balanced and healthy life. Moreover, the existing studies in the literature proved that the amino acids contained in animal products have a very high positive effects on human brain development [2]. In addition, animal products have been used to produce different industrial products for people to benefit from. For example, the hide is used in the manufacture of shoes, bags and belts; the wool in the weaving industry; the feather in bedding industry; the bowl in the production of the suture.

According to the statistical data of the United Nations Food and Agriculture Organization, 35% of gross revenue in the total agricultural sector is covered by the livestock sector [3]. This rate changes in parallel with the level of development of countries. For example, this rate is 49% for EU countries, 43% for USA and 33% for the developing countries. Although Turkey is a rich country for the livestock industry in terms of geographical location, climate and agricultural diversity, Turkey has around 36% of gross revenue in the agricultural sector by their livestock activities. It means that Turkey has a great potential to use its existing resources in producing both plant and animal products and access the desired or targeted level of production (i.e. encouraging sheep and goats meat consumption in the red meat sector and increasing its market share as mentioned in the final declaration of the 3rd Agricultural Forest Council in Turkey [4]). Turkey has been conducting a number of projects for this purpose over the country. With the “Project of Ovine Animal Breeding in the Hands of the People” project carried out by the Ministry of Agriculture and Forestry, General Directorate of Agricultural Research and Policies (TAGEM), which is the best example of this purpose, the desired yields per unit have been increased with the breeding studies of the animals within the scope of the project. In addition, the producers in the Turkish agricultural sector aim to reduce raw material costs and increase profits by making crop production to meet roughage needs required by animal production. The vast majority of agricultural companies in Turkey (62.3%) are interested in both plant and animal production. On the other hand, 37.2% of these companies focuses on only plant production whereas the remaining (0.5%) makes animal production [5].

In addition, population has been on the rise in Turkey as well as over the world. The increasing population will increase the demand for basic food resources and livestock-based industrial products. On the other hand, the effects of some factors increase on animal production. For example, it is assumed that global warming will affect livestock system directly and indirectly. Direct effects (i.e. temperature-based disease and death) are assumed to be occurred whereas indirect effects (i.e. feed and water shortage, and the effects of climate changes on microbial population) are considered to be emerged in the livestock systems and animal production [6]. The governments should give importance to the development of the livestock sector in order to meet the basic food needs of population, to ensure the sustainability of economic activities, and to support the farmers. In the light of all these reasons, it is of great importance to anticipate the amount of future animal production and to take necessary measures beforehand.

In this study, we aimed to develop a comparative forecasting approach to determine the best forecasting methods for each type of red meat (i.e. goat, sheep, buffalo carcass, and cattle and calf carcass) to generate more accurate forecasts for red meat production in Turkey. In this context, the data from the Turkish Statistical Institute over the period between 2010 and 2018 were used. Three different forecasting methods were applied: Autoregressive integrated moving average (ARIMA), exponential smoothing (ES) and the function of the seasonal and trend decomposition using loess (STLF). We contributed to the knowledge as follows: 1) Developing a comparative forecasting approach to better understand the future of livestock and animal production in Turkey, 2) Using the STLF method which has never been applied in agriculture and livestock industries before, and 3) Presenting a strategical framework for Turkish livestock and animal production.

Section 2 reviews the related literature and Section 3 presents the comparative forecasting approach and explains methodologies used in the study. Sections 4 discusses results and Section 5 concludes the study, respectively.

Literature Review

In literature, a number of forecasting studies has been carried out on agricultural sector. A various of studies is related to red meat production. For example, Yavuz and Zulauf [7] proposed a novel estimation method based on biological parameters (i.e. proportion of animals that give birth to twins, average carcass weight and so on). Akgül and Yıldız [8] used ARIMA technique to forecast red meat production in Turkey and discussed a number of recommendations to access the 2023 targets of Turkey. Tutkun [9] presented the overall assessment of red meat production with the last previous year in Turkey and discussed the existing problems and solutions. Alhas Eroğlu et al. [10] developed a forecasting model using ARIMA method for a 10-year projection. In addition, a number of researchers studied on forecasting of dairy products. For instance, Karkacıer [11] analysed a number of variables affecting the import of the Turkish dairy products. Lohano and Soomro [12] applied an ARIMA model including randow walk model with drift and trend-stationary for forecasting milk production in Pakistan and found an annual increase of 4.17%. Kaygısız and Sezgin [13] forecast goat milk production by comparing artificial neural network (ANN), ARMA and ARIMA methods and determined ANN was more successful forecasting technique. Doğan et al. [14] used contingent valuation method to forecast the potential demand of organic milk. Akın et al. [15] evaluated how red meat price affects the chicken meat price in Turkey and determined red meat price and chicken meat price are inversely proportional.

Table 1 shows the past and current studies on forecasting red meat production. A limited studies used multivariate time series forecasting methods which take into account explanatory variables to produce robust and accurate estimates of red meat production or consumption. They applied linear regression, Vector Error Correction Model and the estimation method based on the biology. On the other hand, univariate time series forecasting methods (i.e. ARIMA and exponential smoothing method) were used in a number of studies. In this study, our contribution to the knowledge is to develop a comparative forecasting approach to prove the using more than one forecasting method generates more accurate forecasted results rather than using a single method for different red meat resources. We then included ARIMA and ES methods since these methods have been widely used in the literature. Second contribution is to include a different forecasting method (i.e. STLF) which has never been used in forecasting studies related to agricultural sector.

Table 1. Past and current studies on forecasting red meat production. AIDS: Almost Ideal Demand System Model, AIM: Asymptotic Ideal model, DGM: Directed Graph Model, VECM: Vector Error Correction Model, MSE: Mean Square Error, MAPE: Mean Absolute Percentage Error, ES: Exponential Smoothing

References	Aims	Methods	Type of Methods	Forecast Accuracy
Yavuz and Zulauf [7]	Introducing a new approach based on the biology to estimating red meat production	Estimation method based on the biology	Multiplicative	-
Wang and Bessler [16]	Short-term forecasting US meat consumption	AIDS, Rotterdam, AIM, DGM and VECM	Univariate and Multiplicative	MSE
Yavuz et al. [17]	Forecasting red meat production in Turkey	ARIMA	Univariate	R^2
Nouman and Khan [18]	Modelling and forecasting Beef, mutton, poultry meat and total meat in Pakistan	ARIMA	Univariate	R^2
Sherafatmand and Baghestany [19]	Determining demand model for red meat and fish in Iran	AIDS, Rotterdam	Univariate	-
Akgül and Yıldız [8]	Forecasting red meat production in Turkey	ARIMA	Univariate	R^2
Aujla et al. [20]	Estimating beef meat projection in Pakistan	Linear regression, Polynomial price lag models	Univariate and Multiplicative	R^2
Özen et al. [21]	Modelling and Forecasting Meat Consumption	ARIMA, ES	Univariate	R^2, MAPE
Mgaya [22]	Forecasting egg, cattle meat, cow milk and chicken meat in Tanzania	ARIMA	Univariate	R^2, MAPE
Alhas Eroğlu et al. [10]	Forecasting Beef Production in Turkey	ARIMA	Univariate	-

Material and Method

The hypothesis of the study is various forecasting methods can produce more accurate and robust estimates of red meat production for different red meat resources (i.e. goat, sheep, buffalo carcass, cattle and calf carcass).

The limitations of our study are two ways. First is the study used univariate time series excluding some factors affecting the amount of red meat production or consumption. We will take into account this situation in our future work as mentioned in Conclusion Section. Second is the data period is between 2010 and 2018. Thus, our study assumed this time series represent the Turkish red meat sector.

1. Data

The data used in this study is extracted from Turkish Statistical Institute (TSI) which records a number of statistics under many themes (i.e. agriculture, foreign trade, inflation & price, population & demography and so on). TSI collects agricultural statistics into six categories: agricultural equipment and machinery, agricultural holding structure, agricultural prices and economic accounts, crop production, fishery and livestock. Statistics related to red meat production are presented by TSI according to types, time period (i.e. quarter, month, year) and region. We used the quarterly data over the period between 2010 and 2018. Figure 1 illustrates data patterns based on type of resources for red meat production in Turkey over the study period. The data were divided into two: training set (75%) and validation set (25%).

A total amount of goat meat over the data period in Turkey is 230262 tones with 925413 tones sheep meat, 10017 tones buffalo carcass and 7879586 tones cattle and calf carcass. A breakdown of all activity for each meat resource is presented in Table 2.

Table 2. Number of animal production in Turkey for each meat resource over the study period.

Types of Meat	Mean	Standard Deviation
Goat	25585	7662.90
Sheep	102824	14036.69
Buffalo Carcass	1113	1031.82
Cattle and Calf Carcass	875510	160957.99

2. The Proposed Comparative Forecasting Approach

In this study, a comparative forecasting approach (see Figure 2) is proposed for the purpose of enabling the truer and more reliable forecasts of animal production in Turkey. Our approach is flexible and therefore allows to include any forecasting method to compare each other. We consider two widely used forecasting techniques (i.e. ARIMA and exponential smoothing) along with the function of the seasonal and trend decomposition using loess (STLF) method. The first step is to gather data from Turkish Statistical Institute and extract the related information from the data. The second step consists of forecasting process using forecasting methods. The last step is to compare forecast accuracy value and determine the best forecasting method.

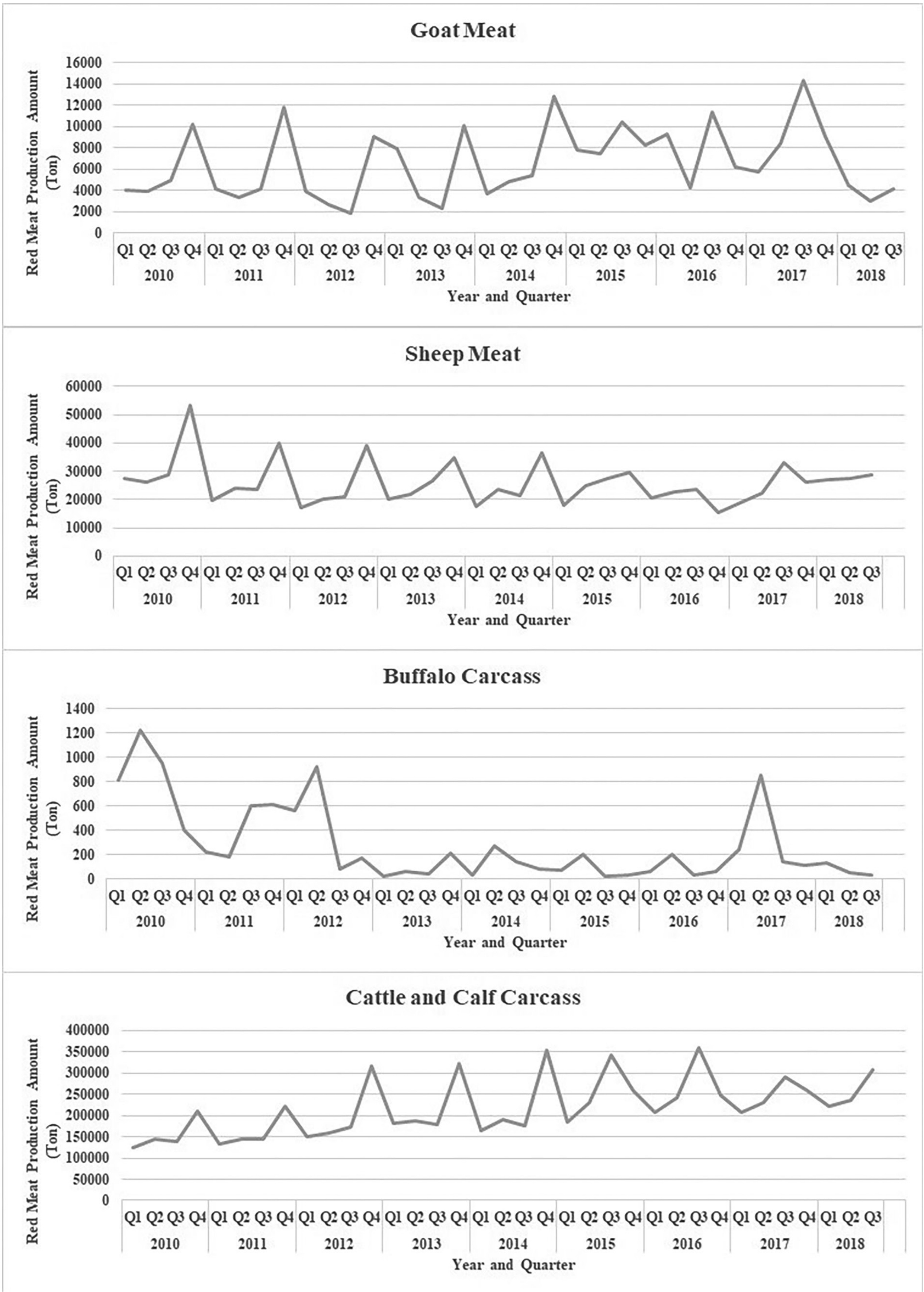

Figure 1. Data patterns based on type of resources for red meat production in Turkey over the study period (2010 - 2018)

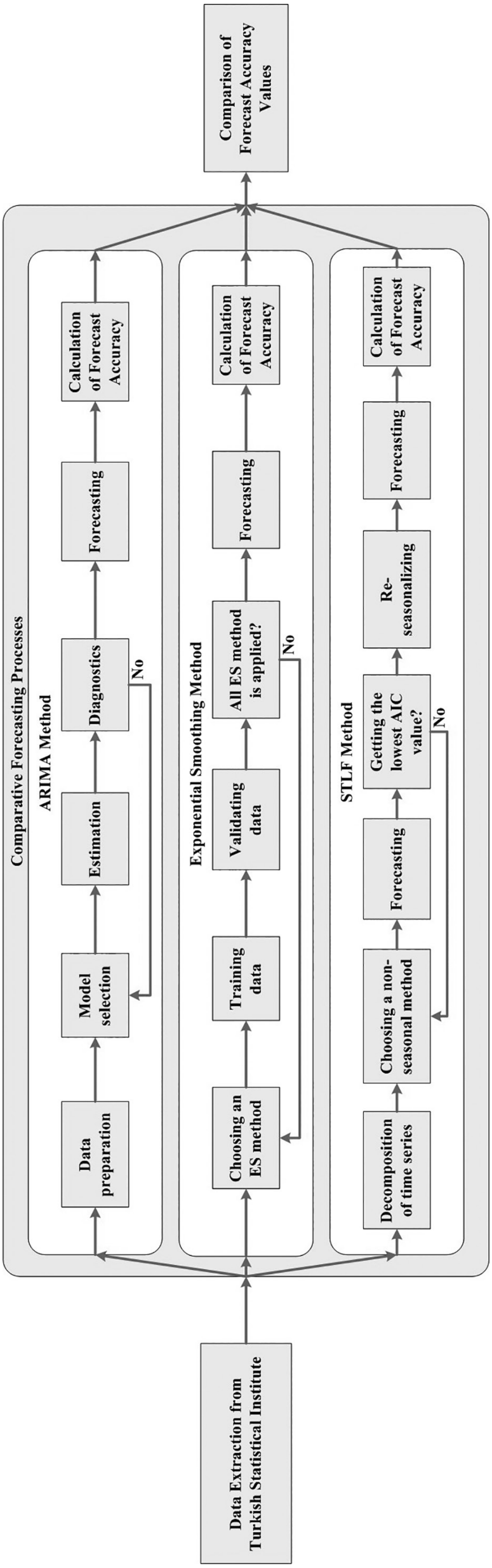

Figure 2. The proposed comparative forecasting approach

3. Methods

We used three forecasting methods: Autoregressive Integrated Moving Average (ARIMA) Method, Exponential Smoothing (ES) and The function of the seasonal and trend decomposition using loess (STLF). These are explained in greater detail below.

3.1. Autoregressive Integrated Moving Average (ARIMA) Method

The autoregressive integrated moving average (ARIMA) method has been widely used and generates forecasts by autocorrelations in the time series [23]. In the ARIMA method, three parameters (i.e. p, d and q) are taken into account and p denotes the order of autoregression, d is the order of differencing and q is the order of the moving average [24]. Firstly, a data preparation section lets to conduct a stationarity analysis. Secondly, p and q parameters are determined in model selection section. p is autoregression that dependent variable at time t depends on previous observation (i.e. at time t-1) while q is moving average that dependent variable relates to error at previous time in the data. The auto.arima package in R developed by Hyndman and Khandakar [25] automatically calculates the values of the parameters. It takes into account Akaike's Information Criteria (AIC) as a criterion to obtain the orders of p and q in ARIMA models. Least squares or maximum likelihood estimation methods are applied to specify the ARIMA models in the estimation section. The diagnostic section presents ARIMA model determined in the estimation section is an appropriate model or not by using the statistical methods (i.e. portmanteau test) [26]. Finally, the estimated values are generated by the selected ARIMA model in the forecasting section.

3.2. Exponential Smoothing (ES)

Exponential smoothing method takes into account the larger weights for the closest observation than the furthest one in forecasting [26]. A total of 15 exponential smoothing methods have been developed without the error terms. Along with the additive and multiplicative errors for each ES model, total 30 ES models are available [27]. One of ES methods is selected, and the data is divided: training data and validation data. This process is applied until all ES models are developed for all ES methods. The best ES model is determined using the ets() package developed by Hyndman and Khandakar [25].

3.3. The function of the seasonal and trend decomposition using loess (STLF)

The STLF method decomposes the time series using the loess which is known as locally estimated scatterplot smoothing [23]. The STLF method applies a non-seasonal forecasting method (i.e. Holt's method or nonseasonal ARIMA method) to estimate the time series. After getting the lowest AIC value, re-seasonalizing procedure is carried out by using "the last year of the seasonal component" [28]. The STLF method was found as successful forecasting method in some forecasting studies [29].

Results and Discussion

We developed a total of 12 forecasting models using the modelling framework shown in Figure 2. 4 forecasting models for each type of red meat resource were developed. This process is carried out by applying RStudio software to estimate red meat production. Table 3 gives all forecasting models developed, for example, each data is stationary for goat and sheep meat whereas the related data is needed to be taken first differences of time series in forecasting buffalo, and cattle and calf carcasses. In all ARIMA models excluding one for sheep meat resource, dependent variables do not relate to error at previous time in the data. In addition, the ARIMA model for cattle and calf carcass involves dependent variable depends on previous three observations whereas others are uncorrelated for other time-lags.

The best exponential smoothing method was found to be with additive error, no trend and no seasonality for goat and sheep meat production. In addition, the best ES model involved multiplicative error, no trend and no seasonality for buffalo carcass whereas the best ES model was determined to be with multiplicative error, additive trend and no seasonality for cattle and calf carcass production.

After decomposition of time series, an exponential smoothing method (with different parameters) as non-seasonal forecasting method was applied to forecast the red meat production for all types of meat. Multiplicative error as error term was determined in the applied ES model in the STLF model for goat meat. All ES models used in the STLF models for goat, sheep and buffalo meat resources included different error terms than theirs ES models.

Table 3. Forecasting models. ETS: Exponential Smoothing, STL: The seasonal and trend decomposition using loess, A: Additive, M: Multiplicative, N: No

Type of red meat	Forecasting methods		
	ARIMA	ES	STLF
Goat meat	ARIMA(0,0,0) with non-zero mean	ETS(A,N,N)	STL+ETS(M,N,N)
Sheep meat	ARIMA(0,0,1) with non-zero mean	ETS(A,N,N)	STL+ETS(M,N,N)
Buffalo carcass	ARIMA(0,1,0)	ETS(M,N,N)	STL+ETS(A,N,N)
Cattle and calf carcass	ARIMA(3,1,0) with drift	ETS(M,A,N)	STL+ETS(M,A,N)

RStudio uses AIC as goodness of fit (or forecast accuracy) to determine the best forecasting model. We also present the corrected AIC (AICc), Bayesian information criterion (BIC) and log likelihood along with Akaike's information criterion (AIC) in Table 4.

Mean absolute percentage error (MAPE) was used as goodness of fit in this study. MAPEs are calculated for both training set and validation set. MAPE values are illustrated in Table 5 for each forecasting model. According to the results, the STLF models are well trained, however, theirs MAPE results for validation sets are the worst for goat, sheep, and cattle and calf carcass. ARIMA method performs than others in forecasting goat, and cattle and calf carcass production whereas ES method provides the best results to estimate sheep meat and buffalo carcass. Figure 3 illustrates the validation graph of the amount of red meat production for cattle and calf carcass.

The livestock sector is an indispensable strategic activity for communities and states over the centuries. Fattening and red meat production are also very crucial for the states to provide a sufficient and balanced amount of food needs of their communities in each step from the production of agricultural products to consumption. This activity is associated to many sectors. Whereas animal production increases red meat production, on the one hand, it also supplies raw materials to many sectors, particularly the manufacturing sector. When we also consider the products that are produced with export focus, it is of great importance for the strategic development of countries. Therefore, countries should have plans with high efficiency and applicability in the period from production to consumption. The right approaches to support the producers will provide the consumer with products that are of good quality and reasonable prices. In order to do this, it is very important to maintain plant and animal production together. At this point, sustainability should be based on the robust planning of production models. Thus, by an efficient and effective planning, it will be possible to get rid of many negative scenarios that may occur. For example, negative reflections of disasters such as global warming, price imbalances, earthquakes, floods, fires and epidemics can be kept to a minimum with the right planning and predictive model. In conclusion, such countries can obtain a serious economic gain by exporting their surplus products to other countries that are caught unprepared in the event of a possible crisis affecting the world.

Table 4. Akaike's information criterion (AIC), the corrected AIC (AICc), Bayesian information criterion (BIC) and log likelihood

Forecasting method	Type of red meat	AIC	AICc	BIC	log likelihood
ARIMA	Goat meat	496.50	497.02	499.01	-246.25
	Sheep meat	545.87	546.96	549.65	-269.94
	Buffalo carcass	353.30	353.48	354.52	-175.65
	Cattle and calf carcass	613.95	617.11	620.04	-301.98
ES	Goat meat	507.43	507.95	509.94	-
	Sheep meat	557.43	557.95	559.95	-
	Buffalo carcass	365.22	365.74	367.74	-
	Cattle and calf carcass	657.43	659.33	662.46	-
STLF	Goat meat	480.36	480.88	482.87	-
	Sheep meat	517.92	518.44	520.43	-
	Buffalo carcass	371.55	372.08	374.07	-
	Cattle and calf carcass	631.45	633.35	636.48	-

Table 5. Mean absolute percentage errors (MAPEs). TS: Training set, VS: Validation set

Type of red meat	Forecasting methods					
	ARIMA		ES		STLF	
	TS	VS	TS	VS	TS	VS
Goat meat	59.69	**40.04**	59.70	40.05	31.32	52.44
Sheep meat	20.99	20.71	22.92	**19.71**	12.58	32.23
Buffalo carcass	169.84	202.38	237.90	**99.53**	131.86	109.28
Cattle and calf carcass	11.92	**15.01**	22.81	17.72	11.04	24.14

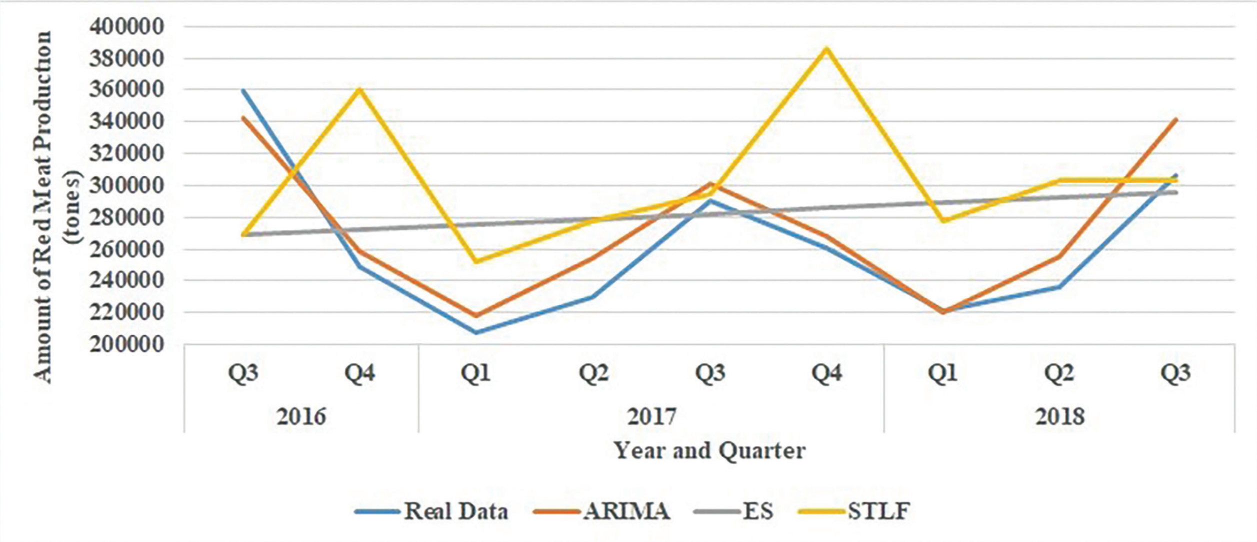

Figure 3. The validation graph of the amount of red meat production for Cattle and Calf Carcass

Conclusion

The livestock sector and the chain from production to consumption in this sector are very important for the development of countries and for the societies to provide healthy and balanced nutrition and development. For example, countries set themselves as the target of making value added productions in many fields for economic development, and for this purpose, they produce innovative and high-economic products in many fields. Undoubtedly, the livestock sector has an indispensable importance for the development of the country. This importance covers a wide range from rural development to the economic development of the country.

This study indicates that the usage of a comparative forecasting approach might produce more accurate forecasted results for animal production instead of using a single forecasting method. The results show that the best animal production estimates are generated by using ARIMA method for goat, and cattle and calf carcass. This study addresses that policy makers will need to consider different forecasting techniques to better estimate animal production.

Our study proved the various forecasting methods can be more suitable techniques for different red meat resources. Therefore, all stakeholders in forecasting processes can include the most appropriate methods to their works, for example, along with univariate forecasting techniques, multivariate time series forecasting methods such as artificial neural networks, regression analysis, data mining or deep learning. We are planning to compare univariate and multivariate forecasting methods for our future studies.

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Livestock Studies, 2020; 60 (1): 32-36
http://doi.org/10.46897/lahaed.779729

RESEARCH PAPER

LIVESTOCK STUDIES

Effects of different lambing season on some reproductive characteristics of ewes and growth performance of lambs in Awassi sheep

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Article History
Received: 05 June 2020
Accepted: 17 July 2020

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Key words
Awassi, birth season, reproductive parameters, growth characteristics

Abstract

In this study, it was aimed to determine the performance of Awassi sheep and their lambs in different season within the scope of the national breeding project carried out in Gaziantep. For this purpose, a total of 23490 heads of ewes and its lambs reared in different herds and under natural conditions were used in Gaziantep. The study covers the period between 2014 and 2017. The preliminary descriptive statistics showed that 35.24% and 25.47% of the ewes gave birth in January and December, respectively. Furthermore, the lamb survival rate at the weaning age was calculated to be 97.54% in February and 97.52% in December. The highest and the lowest birth weights were detected as 4.2 ± 0.01 kg and 2.7 ± 0.09 kg in January and May, respectively (P<0.01). On the other hand, the highest and lowest mean values for weaning weight (60th day live weight) were determined as 21.1 ± 0.11 kg and 15.4 ± 0.45 kg in lambs respectively born in October and May (P<0.01). As a result, it can be stated that the most appropriate mating period for Awassi sheep reared in Gaziantep province is between August and September considering the reproductive characteristics and lamb growing.

Introduction

Meat production is an important source of animal protein for many people in the world. The increasing human population makes the production of protein mandatory from animal origin. Sheep farming is gaining more importance every day in the production of red meat which is used as an animal-sourced protein in human nutrition and it is considered as an indicator of the development level of countries. The purpose of breeding for meat production in livestock is to produce high quality and heavy carcasses. On the other hand, reproductive performance should also be taken into account for breeding purposes to increase the total amount of meat production. The number of lambs born per ewe, which are used as fattening materials, is closely related to the reproductive performance of the dams. Therefore, it is crucially important to increase the number of lambs born and the survival rate per ewe, if sustainable production capacity is aimed for sheep sourced meat.

Reproductive performance in small ruminants varies depending on the season as well as the other factors such as genetics, age, herd and year [1, 3, 4, 9, 17, 22]. Although small ruminants usually show seasonal oestrus, it is known that animals of some breeds mate unseasonal or mating periods may take longer than the others [2, 12]. Births in sheep and goats usually take place in late winter or early spring, which is a time period that pasture conditions are better and the other environmental circumstances are at optimum rates for the growth and development of newborns [11,12].

The high proportion of native sheep breeds are known with low milk yield and litter size in the Turkish sheep population. Insufficient feeding regimes, poor pasture condition and slaughtering of lambs at an early age has led to the reduction of the annual amount of meat produced from sheep Turkey. Moreover, improperly implemented mating programs and practices such as keeping rams in the flock for all year caused significantly increased death rate of newborns [6].

Awassi sheep breeding project under farmer's condition has been in progress since 2011 in Gaziantep province, where herd management practices among farmers are approximately similar. This project, as a sub project of "National Sheep and Goat Breeding Project under Farmers Condition", is getting implemented in whole Turkey by Ministry of Agriculture and Forestry via Universities, Research Institutes, Sheep & Goat Breeder Associations, and breeders actively involved in. The breeders in the project do not apply for any mating program and the rams that are present in the flock throughout the year can mate with females showing oestrus at any time during this period. This practice causes the lambing period to be spread out throughout the year. The increase in mortality, growth retardation and labour loss problems are observed especially in spring births.

There are some studies on the effect of mating season on reproductive characteristics in Awassi sheep, which in practice can be mated in a large period of the year [5]. In this study, Awassi ewes are separated into two groups as three lambing in two years and one lambing per year. In the experiment, it has been reported that the number of lambs born in a year increases by 39.4 % with three lambing in two years. The researchers also stated that both the highest lambing rate and litter size were obtained from the mating of September whereas the mean birth weight was the lowest for this period. Yet in another study, it is shown that the lambs born in winter are higher in birth and weaning weights in Norduz sheep [24]. Gündüz [7] expressed that the average birth and weaning weights for Awassi lambs are 4.4 and 18.5 kg for those born in the autumn season and 4.0 kg and 18.5 kg for those born in the winter season, respectively.

The aim of the study was to determine the total length of mating period and, the reproductive performance of Awassi sheep raised under farm conditions. Additionally, lamb growth and survival characteristics were determined comparatively among different months.

Material and Methods

The animal material of the study was consisted of 23490 heads of Awassi ewes and their lambs, which were reared in Gaziantep province between 2014 and 2017. In the study, birth records of ewes were taken between these years. The birth and weaning (60^{th} day) weights of each lamb were measured by weighing with 50 g of precision scales. According to the raw data obtained from these records, the births were evaluated for 12 months and the effects of months and seasons on birth and weaning weights of lambs were estimated. The sheep flocks were grazed during daytime in the pasture except for rainy days and they were fed with a mixture of wheat straw, barley, cottonseed and peanut shell as 500 g/head in the evenings. On the rainy days, 1 kg/day of straw per animal was added to this mixture as a daily regime. The lambs were allowed to suck their dams twice a day (morning and evening) until being weaned at 60 days of age. These lambs were given concentrate and wheat straw for 15 days and grazed with their mothers in the pasture after 1 month of age. The rams were kept freely in the flocks during the year and allowed to mate with the ewes showing oestrus. After the lambing; birth date, birth weight, sex, birth type and later on the weaning weights of each lamb were recorded. The Chi-Square test was used to compare the effect of months of on reproductive performance. The birth weight and weaning weights of lambs born in different months were compared with one-way ANOVA. All data were processed with the SPSS package program [20].

Results and Discussion

In the region where the study was carried out, rams are kept in the flocks throughout the year, as a result of the labour routines of the breeders. This situation causes the ewes in oestrus to mate at any time of the year and thus the births to be spread out in different months.

As can be seen from Table 1, the Awassi sheep reared under natural conditions did mostly give birth in December and January (P<0.05). The birth rates in these months averaged for four years, were calculated as 25.47% and 35.23%, respectively. Considering later highest birth rates, these months were followed by November and February with respectively 15.54% and 13.04%. In addition, births occurred in the remaining periods of the year; however, these rates were remained extremely low. Additionally, there was no birth in June, July, and August except for 2016, for when only a few ewes gave birth within these months. The relevant fluctuation patterns of the birth rates were strongly similar among those four years. In other words, these findings for the lambing months of the ewes crucially indicate that Awassi ewes were able to mate from April to November under breeders' condition (Figure 1).

Table 1. Birth rates of ewes (%) per month in different years*

Months	2014	2015	2016	2017	Overall
January	25.19	44.30	28.43	43.05	35.23
February	11.46	10.90	8.74	21.09	13.04
March	0.37	0.74	1.05	0.94	0.78
April	0.17	0.46	0.43	0.16	0.31
May	0.18	0.28	0.14	0	0.15
June	0	0	0.16	0	0.04
July	0	0	0.12	0	0.03
August	0	0	0.20	0	0.05
September	0	0.62	2.34	1.11	1.02
October	7.25	7.24	17.37	1.50	8.34
November	22.15	7.87	20.99	11.13	15.54
December	33.23	27.59	20.03	21.02	25.47
P	0.003	0.005	0.024	0.003	0.005
N	6000	6000	5740	5750	23490

*Birth rates were calculated according to the ewe's number in the flocks.

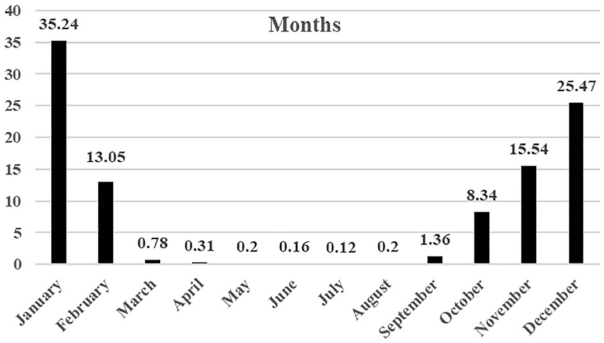

Figure 1. Average birth rate according to months (%)

The season when the sheep show oestrus behaviours is called a mating season. The length of this period and reproductive performance of sheep are influenced by different factors such as genetic background, age, breed, season, herd management and feeding [1, 3, 4, 9, 17, 22]. As shown in Table 1, the Awassi ewes usually gave birth in December and January (P<0.05). The majority of births (97.64%) occurred in the period from October to the end of February. This information states that the sheep of Awassi have started to mate from the late of April and the mating has been largely completed in October. Kaymakçı [12] reported the mating season duration for Awassi sheep as approximately 104.7 days. Our current findings showed that Awassi sheep reared in Gaziantep province have a mating period of around 180 days. Additionally, there are also several studies indicating that the duration of a mating period varies among different breeds. Notter [18] reported the birth rates for Targhee sheep in winter, spring, summer and autumn seasons as 17.18%, 81.16%, 1.58%, and 0.08%, respectively. In the same study birth rates for Suffolk sheep in the same seasonal order were reported as, 68.59%, 30.30%, 0.18%, 0.94%. Yet in another study, Köyceğiz *et al.* [13] emphasized that the active mating season is between September and October and spring and summer months are anoestrus period for Eastern Anatolia region of Turkey.

Another important concept, as well as birth rate in sheep breeding, is the survival rate. Therefore, in this study, calculated survival rates for the lambs are given in Table 2.

The effect of the birth months on survival rate was statistically significant for each year (P<0.05). It is substantially important to note that there is a problem in terms of the survival rate for the period between March and September.

On the other hand, the survival rate was identified to be in the expected range for December, January, and February, meaning that these months can be accepted as the ideal birth time for Awassi sheep under regional conditions.

As for the birth rate, the effect of birth months on survival rate was also significant for each year (P<0.05).

In the present study, it is noteworthy that there is an interesting problem in terms of survival rate in births between March and September (Table 2). As repeatedly reported by different researchers, sheep can also give birth in off-season. However, survival rate and fertility characteristics are adversely affected in off-season births [5, 10, 8, 19, 16, 21]. In the current study, it is realized that there is a problem in herds in terms of survival rate from March to October, which is a period that is accepted as out of birth season in the region. Susic *et al.* [21] informed that season had a significant effect on perinatal lamb mortality with an obtained set of values of 1.0 % and 2.0 % for lambs born in autumn and spring, while 11.0 % and 20.0 % during winter and summer, respectively. Variation in the birth weights depending on the season that was identified in the current study may have an effect on the survival status of the lambs. There are also other studies supporting the deduction made by our study [15, 21]. As well as low birth weight, causes of early lamb losses could be the various number of different factors such as stress, injuries, and starvations. Additionally, some of the reasons may be related to the season, because at different times of the year the ewes and lambs are exposed to different environmental conditions in terms of humidity and temperature. Therefore, the birth season should be taken into account to reduce perinatal lamb deaths [21].

Table 2. Survival rates according to months of birth (%)

Months	2014	2015	2016	2017
January	96.57	95.96	94.23	99.27
February	96.63	98.07	97.96	97.48
March	70.00	71.43	81.36	80.00
April	55.56	80.77	66.67	60.00
May	60.00	37.50	50.00	---
June	---	---	55.56	---
July	---	---	57.14	---
August	---	---	63.64	---
September	---	80.00	85.50	80.56
October	97.72	95.16	93.94	95.83
November	97.76	94.65	98.39	85.53
December	94.46	98.03	98.04	99.55
P	0.003	0.005	0.024	0.003

Birth weights of lambs born in different months are given in Table 3. As shown in Table 3, the highest birth weights were obtained in January and February for 2016 and 2017, and in October for 2014 and 2015. As the average of all years, the highest and the lowest values for birth weights were 4.2 ± 0.01 kg and 2.7 ± 0.09 kg in January and May births, respectively (P<0.01).

The results for weights of the lambs on the 60th day are presented in Table 4. Regarding the Table 4, the highest mean live weights of 60th days were found to be for the lambs born in January and February for 2016 and 2017 and for the lambs born in October for 2014 and 2015.

Table 3. Birth weights of lambs born in different months

Months	n	2014	n	2015	n	2016	n	2017	Overall
January	1369	4.2±0.02^{cd}	2527	4.2±0.02^{de}	1502	4.3±0.02^{d}	2755	4.0±0.02^{d}	4.2±0.01^{c}
February	623	4.1±0.03^{cd}	623	4.0±0.04^{de}	490	4.1±0.04^{d}	1350	4.2±0.03^{d}	4.1±0.02^{c}
March	20	3.7±0.15^{bc}	42	3.4±0.05^{b}	59	3.4±0.07^{abc}	60	3.6±0.11^{c}	3.5±0.05^{b}
April	9	3.5±0.19^{b}	26	3.4±0.07^{b}	24	3.3±0.17^{ab}	10	2.1±0.20^{a}	3.2±0.09^{ab}
May	10	2.8±0.14^{a}	16	2.6±0.13^{a}	8	3.0±0.02^{a}	---	---	2.7±0.09^{a}
June	---	---	---	---	9	3.3±0.19^{ab}	---	---	3.3±0.19^{b}
July	---	---	---	---	7	3.4±0.16^{abc}	---	---	3.4±0.16^{b}
August	---	---	---	---	11	3.4±0.08^{ab}	---	---	3.4±0.08^{b}
September	---	---	35	3.7±0.13b^{c}	131	3.9±0.08^{bcd}	71	3.3±0.04^{b}	3.7±0.05^{bc}
October	394	4.4±0.06^{d}	413	4.3±0.05^{e}	974	4.0±0.03^{cd}	96	4.0±0.08^{d}	4.1±0.02^{c}
November	1204	4.1±0.03^{cd}	448	3.9±0.04^{cd}	1177	4.0±0.02^{cd}	712	3.9±0.03^{cd}	4.0±0.01^{c}
December	1806	4.1±0.02^{cd}	1574	4.1±0.02^{de}	1122	4.2±0.03^{d}	1345	3.9±0.02^{cd}	4.1±0.01^{c}
P		0.001		0.001		0.001		0.001	0.001
Total	**5435**	**4.1±0.01**	**5704**	**4.0±0.01**	**5514**	**4.1±0.01**	**6399**	**4.0±0.01**	**4.1±0.01**

*Letters in the same column show differences; ($\bar{x} \pm S_{\bar{x}}$, kg)

When all four years were averaged for this trait, the highest and the lowest values were obtained in October with 21.1 ± 0.11 kg and in May with 15.4 ± 0.45 kg (P<0.01), respectively.

In this study, it was identified that birth and weaning weights were affected by the month of birth for each of the three years (Table 3 and Table 4). Lambs born between March and September had lower values for both birth weight and weaning weight than those born in the other months. We know that both birth weight and reproductive performance are also affected by environmental factors and breed differences due to their quantitative nature [8, 9, 13, 14, 22, 24]. It can be said that the reason for the birth weight decrease from February to May in lambs is due to the recent malnutrition of the mothers. Because, in the last third of the pregnancy which is the best time for the development of offspring, the pastures may be inadequate for grazing. Yılmaz *et al*. [24] reported that Norduz lambs born in the winter season were heavier than those born in the spring period. On the other hand, Boujenane [1] stated that the birth and weaning weights in D'man sheep were affected by season and that the lambs born in spring had lower live weight than lambs born in the summer period. In the same study, weaning weights were reported as 25.1 kg for the February-March periods, 21.8 kg for the June-July and 22.1 kg in October-November periods. Freaking *et al*. [4] found that birth weights in lambs born in October and December were higher than those born in August. The mean birth weight was reported as 4.2 kg by Üstüner and Oğan [23], 60th day weight was reported as 17.34 kg following the same study and found as 11.53 kg by [14] for Awassi lambs. It can be said that the birth and weaning weights found by our present study are quite similar to the results of these studies mentioned above, also considering the differences in climate and management-feeding between regions. Since sheep breeding is usually carried out under semi-intensive conditions, nutritional problems especially arising from roughage supplying occur in the summer period. The negative effect of this situation on milk yield and high environmental temperature rates adversely affects the development of lambs during the late spring and summer season.

Table 4. Weaning weights of lambs according to the month of birth

Months	n	2014	n	2015	n	2016	n	2017	Overall
January	1322	18.9±0.09^{abc}	2422	18.0±0.08^{cd}	1494	21.8±0.10^{f}	2736	19.1±0.07^{b}	19.2±0.04^{bc}
February	601	19.3±0.16^{bc}	595	18.0±0.16^{cd}	488	21.6±0.15^{ef}	1316	20.2±0.10^{b}	19.8±0.07^{bc}
March	14	16.9±0.44^{ab}	29	17.0±0.61b^{c}	48	16.5±0.33^{ab}	48	18.6±0.39^{b}	17.4±0.23^{ab}
April	5	16.8±0.32^{ab}	21	15.8±0.34^{b}	16	14.8±0.52^{a}	6	16.2±0.91^{a}	15.6±0.27^{a}
May	6	16.5±0.34^{a}	6	13.8±0.47^{a}	4	16.7±0.74^{ab}	---	---	15.4±0.45^{a}
June	---	---	---	---	5	17.0±1.02^{abc}	---	---	17.0±1.02^{ab}
July	---	---	---	---	4	17.6±0.35^{abcd}	---	---	17.6±0.35^{ab}
August	---	---	---	---	7	18.4±0.27^{bcde}	---	---	18.4±0.27^{abc}
September	---	---	28	15.9±0.28^{b}	112	20.1±0.46^{cdef}	57	15.4±0.21^{a}	18.2±0.32^{abc}
October	385	21.1±0.16^{b}	396	22.2±0.22^{e}	915	20.6±0.15^{def}	91	20.5±0.63^{b}	21.1±0.11^{c}
November	1176	19.4±0.12^{bc}	424	19.3±0.19^{d}	1158	20.5±0.11^{def}	69	19.5±0.17^{b}	19.8±0.07^{bc}
December	1705	18.8±0.09^{abc}	1544	18.0±0.08^{cd}	1101	22.3±0.12^{f}	1339	19.1±0.10^{b}	19.3±0.05^{bc}
P		0.000		0.000		0.000		0.000	0.000
Total	**5214**	**19.2±0.05**	**5465**	**18.4±0.05**	**5352**	**21.3±0.05**	**6292**	**19.3±0.05**	**19.5±0.03**

*Letters in the same column show differences; ($\bar{x} \pm S_{\bar{x}}$, kg)

Conclusion

The main purpose of livestock production is to increase the profitability of each animal as much as possible. Therefore, to provide the desired level of profitability, lamb losses should be minimized and environmental factors should be optimized. The results have shown that season significantly influenced the birth weight, weaning weight and litter size. The mentioned factors can be influenced by pasture (as a food source) feeding regime, mating time and climate characteristics. With good herd management practices, off-season lamb losses will be prevented and boost profitability will increase. This study showed that Awassi sheep could ideally mate from May to the end of October. In conclusion, it can be said that it is an advantage if being taken into account in the application of accelerated lambing systems due to these properties of the sheep. Also, milk production from the Awassi sheep may be spread over a longer period.

Declaration of competing interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Acknowledgments

In this study, the authors thank the Research Foundation of Hatay Mustafa Kemal University for its financial supports (Project No: 13981). Also, all data used in the study were from a project named “Improvement of Awassi Sheep under Farm Conditions” supported by the Ministry of Agriculture and Forestry of the Republic of Turkey.

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