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Evaluation of Milk Characteristics of Karadi Sheep Breed in Halabja Province, Kurdistan Region of Iraq

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

In the Kurdistan region, sheep play a pivotal role as the most significant farm animals, with lamb sales constituting a major portion of the income. In present study data was collected from commercial Karadi ewes flock located in Chawg village, Halabja province, Kurdistan Region of Iraq. A total of 163 ewes were utilized to investigate the impact of various factors on daily milk yield (DMY), total milk yield (TMY), lactation period (LP) and the percentages of total solid (TS), fat, protein and lactose. The investigation also sought to determine correlations among these parameters. The least square mean ± SE of DMY, TMY, LP and the percentages of TS, fat, protein and lactose were 613.5±90.06g/ewe/day, 67.05±11.8kg/ewe, 107.8±11.14day/ewe and 16.41±1.84%, 5.79±0.69%, 5.43±0.64% and 4.28±0.51%, respectively. It is evident that all fixed effects, with the exception of the type of birth, wield a significant influence ($P \leq 0.05$) on both milk

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production and composition. Notably, a substantial positive correlation ($p \leq 0.01$) was observed between total solid percentages and the percentages of fat, protein and lactose. The BLUP values for TMY were ranged from -60.64 kg/ewe to 1 kg/ewe, while the MPPA value for TMY were ranged from 57.73092 to 78.83427. The wide range of BLUP values and the MPPA values for TMY indicate the presence of significant genetic variation among the Karadi ewes under study, where selection can play an important role in increasing productivity and the genetic and economic gain to the breeder in next generation and increasing genetic and productive ability of Karadi sheep in the Kurdistan region of Iraq.

Keywords: Karadi ewes; milk yield; milk composition; BLUP and MPPA.

1. INTRODUCTION

Karadi sheep constitute a large portion of the sheep raised in the Kurdistan region of Iraq, and contribute to providing a large portion of the red meat through lambs in the region, along with a portion of the milk and yogurt in the local markets. Karadi sheep are considered one of the breeds of Iraqi sheep, constituting 18-20% of them [1,2], and are found in Sulaimani province of the Kurdistan region were averaged 43% of total sheep populations [3]. Numerous studies have examined factors influencing the milk yield and composition of ewes' milk. The factors were month of birth [4,5], sex of lamb [6,7], ewes' age [8,9,10], ewes' weight [11], type of birth [12,13] and lactation stage effect on milk yield and composition [14].

The current study aims to determent the effect of non-genetic factors on the milk production and its components in Karadi ewes, and to estimate some of their genetic parameters, such as the repeatability for daily milk production, and to estimate the MPPA and BLUP values of milk production for Karadi ewes to selecting the best ewes to be the parents of the next generation and increasing the productivity of the ewe's milks.

2. MATERIALS AND METHOD

This study collected data from Karadi ewes in the commercial flock located in Chawg village, Halabja province, Kurdistan Region of Iraq, during the period from 1-1 to 31-8-2022. The specific geographic coordinates of the study site are Latitude 35° 8' 52" and Longitude 45° 58' 28" W, with an elevation of 865 meters above sea level. All animals were in excellent health, fed their nourishment from the lush pasture under open field conditions. In this study, a total of 163 ewes were included. During lambing, both ewes and lambs were easily identified using a simple spray technique. The study encompassed crucial data on lambing date, lamb sex and other pertinent details. Furthermore, the lambs marketing weight were recorded.

All ewes in flock was hand-milked after two weeks of lambing. All lambs were separated at 7 am till after milking at 7 pm (12 hours). This method was repeated monthly till the end of lactation (when milk yield was less than 50 gm/day/ewe according to ICAR, [15]). Milk was measured with 50 gm precision scale. Test day milk yield of individual ewe was multiplied by 2 to get the daily milk yield (gm/ ewe/day) and multiplied by 30 to get the monthly milk yield (gm/month/ewe) [16]. Milk samples were analyzed using Milkoscan TM minor machine (P/N 6004 4208, Issue 1 GB, March 2010, FOSS Analytical, 69, Slangerupgade, DK 3400 Hillerod, Denmark) to determine the percentages of total solids, protein, fat and lactose in the milk.

The PROC GLM (General Linear Model) procedure in SAS programs [17] was employed to analyze data pertaining to milk yield traits. The study focused on fixed effects, including the month of birth, sex of lamb, ewes' age at birth, ewes' weight at birth and type of birth. These effects were incorporated into two models (***I***) and (***II***) to facilitate comprehensive analysis.

2.1 Model I for Milk Traits

$$\mathbf{Y_{ijklmno} = \mu + V_i + N_j + O_k + H_l + S_m + Z_n + E_{ijklmno}} \quad \textbf{(Eq.1)}$$

Where:

$\mathbf{Y_{ijklmno}}$ = Milk yield and composition of ewes.
$\boldsymbol{\mu}$ = Over all mean.
$\mathbf{V_i}$ = fixed effect of month of lambing (i =1 January and i =2 February).
$\mathbf{N_j}$ = fixed effect of sex of lamb (j =1 male and j =2 female).
$\mathbf{O_k}$ = fixed effect of ewes age (k =2,3,4,5,6 years)

H_l = fixed effect of ewe's weight (l = A 55 kg <, B 55-60 kg and C >60 kg).
S_m = fixed effect of type of birth (m = 1single, m=2 twine).
Z_n = fixed effect of lactation stage (n = 1, 2, 3, 4, 5 month)
$E_{ijklmno}$ = Random/error effect.

2.2 Model II for MPPA

MPPA = Flock average+(nr/1+(n-1) r) (Individual sheep average -Flock average) (Eq.2)

Where:

n = number of records and
r = repeatability of the trait.

Tukey tests employed to compare all the traits means under study, as it suitable method for comparing least square means within this program.

For the genetic evaluation of ewes concerning various traits, the Best Linear Unbiased Prediction (BLUP) procedure, as described by [17], was utilized. To achieve this, a Mixed Model of fixed and random effects was used of SAS, [17] software. Also the Mixed Procedure in SAS [17] by the REML methods was used to estimate the repeatability of daily milk yield.

3. RESULTS AND DISCUSSION

3.1 Milk Traits of Karadi Ewes

The overall means of daily milk yield (g/ewes), total solid%, fat%, protein%, lactose %, total milk yield (Kg) and lactation period (days) are averaged 613.5±90.06 g/ewes/day, 16.41±1.84%, 5.79±0.69%, 5.43±0.64%, 4.28±0.51%, 67.05±11.8 kg/ewe and 107.8±11.14 days/ewe, respectively, as summarized in Table 1.

The milk trait estimates observed in this study were consistent with findings reported by many researchers in different sheep breeds [4,7,8,18,12,13].

3.2 Month of Birth

The month of birth was found to exert a statistically significant impact ($p \leq 0.05$) on milk traits, especially daily milk yield, total solid %, protein %, fat %, lactose %, total milk yield and the lactation length (Table 1).

In accordance with current study, Al-samarai et al*.* [5] found the significant impact of lambing month both the total milk yield and lactation period in Awassi sheep. In contrast, the studies conducted by [19,14] reported that the month of lambing did not demonstrate any significant impact on either daily milk yield and total milk yield. In a previous research conducted in Iraq by [20], no statistically significant impact of the lambing month was observed on the milk protein % and fat % in Karadi, Awassi, and Hamdani ewes. This outcome may be ascribed to variations in environmental factors, specifically fluctuations in ambient temperature and the varying accessibility of feeds across different lambing months [21].

3.3 Sex of Lambs

The sex of lambs was found to have a significant impact ($p \leq 0.05$) on several milk parameters, including daily milk yield, total milk yield, total solid%, protein%, fat% and lactose%. Al-Sayegh and Al-Qass [22] attributed the reason for this to the fact that male lambs are usually larger in size, which makes them need more nutritional elements and thus seeks or leads to the emptying of the udder and then stimulates their dams to produce larger amounts of milk. However, it was observed that lamb sex did not have a statistically effect on the lactation period (days) (Table 1).

The findings of this study was agree with what reported by [9] for effect of lamb's sex on daily milk yield in Hamdani ewes. While this results were not aligning with the results reported by [6]. In their research, they observed that the sex of lambs did not have a significant impact on total milk yield, daily milk yield and lactation period in Awassi sheep. Furthermore, in a study conducted by [14], they reported non-significant effects of lambs' sex on milk parameters, including protein%, fat%, total milk yield and daily milk yield in Karadi sheep.

3.4 Ewes' Age

The results in Table 1 display the significant influence ($p \leq 0.05$) of ewes age on milk characteristics, including daily milk yield, total solid%, protein%, fat%, lactose%, total milk yield and the lactation period. Production increases as the ewes age, the increase in production with age is due to the development and integration of the lactic system responsible for producing milk, as well as the increase in the ewe's weight as a result of the increase in the size of the digestive tract and the benefit from feed materials.

The findings of the present study are consistent with previous research conducted by [11,12]. These earlier studies also noted the significant impact of ewe's age on daily milk yield, total milk yield and lactation period. Similarly, Oramari and Hermiz [10] conducted a study that highlighted the significant impact of ewes' age on milk composition parameters, including fat%, lactose%, and total solid%. On the contrary, a study conducted by [9] in Hamdani ewes showed non-significant effect of ewes age on fat% and [14] in Karadi ewes found no statistically significant impact of ewes' age on milk characteristics.

3.5 Ewes' Weight

Ewes weight was found to have a significant effect ($p \leq 0.05$) on several milk parameters, including lactation period, total solid%, protein%, fat% and lactose%. This can be attributed to the intricate interplay between body condition and physiological processes in lactating ewes. Ewes with higher body weight may experience improved energy reserves, potentially leading to more extended lactation periods and higher concentrations of milk constituents. However, it was observed that the ewes weight did not have a statistically effect on the daily milk yield and total milk yield (Table 1). This suggests that ewes' weight alone may not be the sole determinant of overall milk production. Other factors, such as genetic predisposition, nutritional management and environmental conditions, may also play significant role.

In a similar vein, Yilmaz et al. [11] reported significant effects of ewes' weight on both total milk yield and the lactation period in Norduz Sheep. Abdul-Rahman and Al-Barzinji [23] found significant effect of ewes age on daily milk yield in Hamdani ewes. In contrast, Oramari and Hermiz [10] found no significant impact of ewes' weight on the percentages of fat, protein, lactose and total solids in Karadi ewes.

3.6 Type of Birth

In the current research, the type of birth was found to have no significant impact on the percentages of total solids%, protein%, fat%, lactose% and the lactation period. However, the daily milk yield and the total milk production were significantly affected ($p \leq 0.05$). Ewes that gave twin lambs significantly gives higher daily milk yield and total milk yield compared to ewes that had single lamb (Table 1). Mammary growth during gestation is affected by the number of fetus, and this has a subsequent effect on milk production, which is independent of age, body mass and season [24].

In a study by [11], ewes reared twin lambs give higher daily milk yields compared to those had single lambs. Similarly, Oramari and Hermiz [10] determined that the type of birth had no significant effect on the total solid%, protein%, fat% and lactose% in Karadi sheep. Conversely, Abd Allah et al. and Al-samarai et al. [12,5] noted a significant impact of birth type on total milk yield and Al-Barzinji and Abdul-Rahman [9] found significant effect of type of birth on fat% in Hamdani ewes. In contrast, Al-Barzinji and Hassan and Abdul-Rahman and Al-Barzinji [8,23] found non-significant effect of type of birth on daily milk yield in Hamdani ewes. Al-Samarai and Al-Anbari [6] found that the type of birth did not have significant effect on daily milk yield and total milk yield, while have the significant effect on lactation period.

3.7 Lactation Stage

The lactation stage exerted a statistically significant influence ($P \leq 0.05$) on milk parameters, such as daily milk yield, total solid%, protein%, fat% and lactose% in Karadi ewes (Table 1). This can be attributed to the dynamic physiological changes occurring during different stages of lactation. The synthesis and secretion of milk constituents are intricately regulated by hormonal fluctuations and metabolic adaptations to meet the evolving nutritional demands of the suckling lamb.

These findings align with prior research results conducted by [10,14]. Both studies independently observed that the stage of lactation significantly impacted daily milk yield in Karadi ewes. Al-Barzinji and Hassan [8] showed significant effect of stage lactation on daily milk yield and Al-Barzinji and Abdul-Rahman [9] in Hamdani ewes found significant effect of lactations stage on daily milk yield and fat%. Furthermore, these researchers reported a diverse range of results concerning the influence of the lactation stage on fat%, protein% and total solid%. Variations in reported findings can be attributed to factors such as breed, dataset size, estimation methods, production systems, climate and ecological zones in which sheep farming is conducted.

Table 1. Least square means ± S.E of some factors affecting milk production and composition in Karadi ewes

Fixed effects	Daily milk yield (g/ewes)	TS %	Fat %	Protein %	Lactose %	Total milk yield(Kg)	Lactation period(day)
Overall mean	613.5±90.06	16.41±1.84	5.79±0.69	5.43±0.64	4.28±0.51	67.05±11.8	107.8±11.14
Month of birth	*	*	*	*	*	*	*
Jan	574.18±6.8[b]	16.97±0.12[a]	5.98±0.04[a]	5.62±0.04[a]	4.44±0.32[a]	60.43±0.72[b]	104.09±0.69[b]
Feb	652.34±7.82[a]	15.84±0.11[b]	5.58±0.04[b]	5.24±0.04[b]	4.12±0.32[b]	73.9±0.74[a]	111.63±0.72[a]
Sex of lamb	*	*	*	*	*	*	*
Male	629.12±9.26[a]	15.88±0.13[b]	5.58±0.05[b]	5.24±0.04[b]	4.14±0.04[b]	72.81±0.95[a]	113.71±0.27[a]
Female	603.26±6.54[b]	16.76±0.11[a]	5.92±0.04[a]	5.55±0.04[a]	4.37±0.03[a]	63.5±0.68[b]	104.15±0.56[b]
Ewe's age (year)	*	*	*	*	*	*	*
2	629.36±16.84[a]	16.57±0.26[ab]	5.85±0.09[ab]	5.49±0.09[ab]	4.32±0.08[a]	61.96±1.44[b]	97.22±1.13[c]
3	587.4±9.16[b]	16.90 ±0.17[a]	5.96±0.06[a]	5.59±0.06[a]	4.41±0.05[a]	63.48±1.06[b]	107.38±0.88[b]
4	623.2±12.14[a]	15.82±0.14[c]	5.56±0.05[c]	5.23±0.05[c]	4.12±0.04[b]	74.25±1.12[a]	116.22±1.28[a]
5	616.96±10.94[a]	16.35±0.19[b]	5.77±0.07[b]	5.40±0.07[b]	4.27±0.05[a]	65.42±1.16[b]	104.72±0.72[b]
6	620.94±12.82[a]	16.63±0.22[ab]	5.86±0.08[ab]	5.51±0.08[ab]	4.35±0.07[a]	66.95±1.58[b]	106.79±0.99[b]
Ewe's weight (kg)	N.S	*	*	*	*	N.S	*
A (<55)	621.34±8,56[a]	16.51±0.15[ab]	5.83±0.06[ab]	5.47±0.05[ab]	4.31±0.04[ab]	64.74±0.85[a]	102.75±0.67[c]
B (55 - 60)	603±9.32[a]	16.18±0.13[b]	5.69±0.05[b]	5.35±0.05[b]	4.22±0.04[b]	69.39±1.02[a]	112.86±0.96[a]
C (>60)	619.5±9.98[a]	16.66±0.15[a]	5.88±0.06[a]	5.51±0.05[a]	4.35±0.04[a]	66.81±1.15[a]	107.38±0.84[b]
Type of birth	*	N.S	N.S	N.S	N.S	*	N.S
Single	600.56±5.16[b]	16.42±0.88[a]	5.79±0.03[a]	5.43±0.03[a]	4.28±0.02[a]	65.8±0.58[b]	108.17±0.54[a]
Twine	770.82±24.42[a]	16.21±0.29[a]	5.72±0.11[a]	5.36±0.11[a]	4.21±0.08[a]	81.36±1.55[a]	103.46±1.96[a]
Lactation stage (Month)	*	*	*	*	*		
1	577.7±9.98[c]	17.69±0.17[a]	6.26±0.06[a]	5.86±0.06[a]	4.64±0.05[a]	…	…
2	704.18±9.18[a]	15.56±0.14[c]	5.46±0.05[c]	5.12±0.05[d]	4.06±0.04[c]	…	…
3	644.1±8.04[b]	16.28±0.15[b]	5.74±0.05[b]	5.39±0.05[bc]	4.24±0.04[bc]	…	…
4	559.3±7.84[c]	16.01±0.18[bc]	5.66±0.07[bc]	5.30±0.06[cd]	4.16±0.05[bc]	…	…
5	268.22±9.44[d]	16.64±056[b]	5.84±0.21[b]	5.55±0.19[b]	4.34±0.16[b]	…	…

**Means within each trait column denoted by different letters significantly different (p≤0.05)*
N.S: non-significant

3.8 Sample Correlation among Milk Trait

The correlation coefficient is a widely used and valuable statistic that quantifies the strength of the relationship between two variables. Table 2 highlights the noteworthy statistical significance ($p \leq 0.01$) in the correlation coefficients among milk traits in Karadi ewes' milk. Specifically, the correlation between daily milk yield and its components such as total solid%, fat%, protein% and lactose% displayed negative associations. On the other hand, the correlation among milk composition traits exhibited positively significant relationships.

The study by [10] revealed consistent findings, highlighting the significant positive correlations between total solid% and both protein% and lactose% in Karadi sheep. Furthermore, they observed a positive significant correlation between fat and protein percentages. Similarly, Ilyas and Karakus 2020 [25] in their research on Awassi ewes reported a significant positive correlation between protein% and lactose%, further supporting the observed trends in sheep milk composition. In a separate investigation, Yilmaz et al. [11] observed notable correlations in Norduz sheep. They found a negative significant correlation between milk yield and various components such as total solid%, fat% and protein%. Conversely, a positive significant correlation was established between total solid%, fat%, and protein%. In summary, these studies collectively contribute to current study result of the correlations between different milk components in various sheep breeds, shedding light on the intricate relationships within milk composition.

3.9 Genetic Evaluation of Karadi Ewes for Milk Yield

3.9.1 Best Linear Unbiased Prediction (BLUP)

Table 3 displays the BLUP values for ewes' milk yield. These values range from -60.64 kg/ewe (lowest) to 1 kg/ewe (highest). Among the ewes considered as potential dams for ram lambs, the top 10% had BLUP values ranging from 1 to -7.38 kg/ewe. Conversely, the bottom 20% earmarked for culling had BLUP values in the range of -41.51 to -60.64 kg/ewe. The substantial variation in BLUP values among ewes for milk yield suggests that selecting elite ewes from the current sample can lead to improvements in milk yield.

In contrast, the present study's results revealed a broader range of milk yield compared to the findings in Hama Khan et al.'s [14] study. Their research displayed a spectrum of BLUP values, spanning from -34.20 kg/ewe to 7.38/ewe kg. BLUP values spanned from -28.29 kg/ewe to 82.61 kg/ewe in Awassi sheep, while in Hamdani sheep from -68.160 kg/ewe to 139.951 kg/ewe [26,7]. Furthermore, in Awassi sheep, the BLUP values associated with selecting varying percentages of ewes were as follows: 1.98 kg/ewe for 90%, 3.64 kg/ewe for 80%, 5.07 kg/ewe for 70%, 6.62 kg/ewe for 60% and 8.15 kg/ewe for 50% [27]. These findings underscore the significance of BLUP values in guiding the selection of ewes for improved milk yield. The findings indicate that by carefully choosing breeding pairs, one can significantly expedite the enhancement of milk yield within this sheep population under investigation. Specifically, pairing the top 10% of males based on their BLUP values with the top 70% of females has proven to be an effective strategy for achieving this goal.

3.10 Repeatability

It means the correlation coefficient between two different records or measurements on the same animal. Many economic traits are repeated throughout the life of the animal; such as milk production and wool production in sheep. The repeatability also represents the upper limit of the heritability because it includes environmental variation and the effects of the action of dominance and superiority genes, as well as the collective genetic variation relative to the total variation. The repeatability, when its estimate is high, is useful in predicting the animal's behavior or performance in the future if one of its records is known at the beginning of its productive life.

The repeatability estimate for daily milk yield in this study was found to be low at 0.12. This lower than those previously reported values in similar studies, such as those by [4] in Hamdani, [10] in Karadi and [28] in Chios sheep. This could be attributed to inherent factors such as genetic differences among the subjects, environmental conditions or management practices that were not adequately controlled during the study.

Table 2. Correlation coefficient between milk traits in Karadi ewes milk

Traits/Traits	Daily milk yield (g/ ewes)	TS %	Fat %	Protein %	Lactose %
Daily milk yield (g/ewes)	1.0	-0.69**	-0.68**	-0.69**	-0.69**
TS %		1.0	0.99**	0.99**	0.99**
Fat %			1.0	0.98**	0.97**
Protein %				1.0	0.98**
Lactose %					1.0

*** Means within each trait column denoted by different letters significantly different (p≤0.01)*

Table 3. BLUP values for total milk yield in Karadi ewes

Ewe No.	Milk yield	Ewe No.	Milk yield	Ewe No.	Milk yield	Ewe No.	Milk yield	Ewe No.	Milk yield
162	1	108	-16.32	70	-25.64	92	-31.68	53	-42.22
137	0.52	158	-16.82	159	-25.88	47	-32.1	37	-42.71
163	0	99	-17.12	69	-26.12	34	-32.63	74	-43.38
72	-0.1	113	-17.36	141	-26.64	14	-32.82	42	-43.8
86	-1.72	95	-17.44	30	-26.72	26	-32.82	82	-44.33
129	-2.14	105	-17.72	139	-26.88	56	-34.03	77	-44.58
144	-2.59	126	-17.73	117	-27.06	24	-34.25	33	-45.32
146	-3.18	124	-17.94	39	-27.35	152	-34.46	1	-45.52
59	-3.42	71	-17.98	154	-27.44	109	-34.72	41	-45.64
127	-3.95	140	-18	76	-27.66	107	-34.82	29	-47.6
104	-4.02	123	-18.07	81	-27.72	114	-35.34	51	-48.02
156	-4.05	157	-18.86	12	-27.79	31	-35.56	52	-48.02
147	-5.75	151	-18.92	63	-27.82	40	-35.74	15	-48.56
132	-6.51	133	-20.16	91	-27.94	44	-36.84	21	-49.1
122	-6.63	128	-20.71	87	-27.96	93	-37.26	27	-50.54
150	-7.38	32	-20.78	17	-27.98	49	-37.7	148	-50.78
161	-7.48	135	-20.88	80	-28.23	7	-38.08	16	-51.45
112	-8.05	75	-21.02	20	-28.6	119	-38.15	6	-51.74
118	-8.38	89	-21.08	125	-29.28	100	-38.22	38	-51.81
160	-9.06	67	-21.5	46	-29.36	18	-38.34	79	-51.92
155	-9.2	143	-22.04	94	-29.52	13	-38.42	10	-52.14
66	-9.24	134	-22.08	57	-29.57	98	-38.42	73	-52.19
90	-9.36	54	-22.23	145	-29.8	4	-38.6	115	-52.7
84	-10.68	102	-22.25	64	-29.86	48	-39.1	43	-52.94
36	-12.47	131	-22.27	45	-30.26	88	-39.2	8	-53.48
153	-13.98	50	-23.31	142	-30.32	9	-39.65	28	-53.88
111	-14.64	23	-23.42	62	-30.83	103	-40.26	2	-54.32
121	-14.74	85	-23.52	106	-30.84	5	-40.44	68	-54.46
116	-15.29	136	-23.94	61	-31.1	25	-40.94	60	-55.36
149	-15.48	110	-24.04	11	-31.19	19	-40.97	78	-56.24
130	-15.49	97	-24.15	83	-31.34	22	-40.98	120	-60.64
96	-15.68	58	-25.12	138	-31.58	55	-41.51		
65	-16.19	101	-25.12	35	-31.6	3	-41.94		

3.11 Most Probable Producing Ability (MPPA)

MPPA predicts future performance and aids in ranking animals, particularly dams within a herd, for targeted selection purposes. The estimated MPPA values for the total milk yield of each individual are presented in Table 4. Notably, ewe number 137 achieved the highest calculated MPPA value (78.83427 kg/ewe) for total milk yield among the 163 individuals under consideration. Within the experimental group, ewes with the following numbers demonstrated the highest MPPA values, comprising the top 10%: 137, 72, 86, 129, 144, 162, 163, 127, 147, 146, 59, 104, 156, 150, 66 and 132. These

Table 4. Most probable producing ability (MPPA) for total milk yield

Top group 10%		**Culling group 20%**	
Ewe No.	**MPPA**	**Ewe No.**	**MPPA**
137	78.83427	22	62.66055
72	78.58134	42	62.61995
86	77.92434	77	62.3935
129	77.75521	3	62.32172
144	77.57026	53	62.2229
162	77.47702	37	62.04996
163	77.12408	74	61.81349
127	77.02211	82	61.47819
147	76.29056	51	61.39479
146	76.00172	52	61.39479
59	75.91702	33	61.12878
104	75.70525	21	61.08125
156	75.69466	1	61.05819
150	75.6295	41	61.01584
66	74.87521	27	60.66318
132	74.82643	148	60.5935
Replacement group 70%		16	60.39899
Ewe No.	MPPA	29	60.32408
…..	……..	6	60.31479
		38	60.29447
		10	60.19866
		73	60.18415
		115	60.03608
		15	59.98525
		43	59.96641
		28	59.6935
		2	59.56576
		68	59.52512
		60	59.26383
		78	59.00834
		79	58.79937
		8	58.24878
		120	57.73092

individuals exhibited superior MPPA performance. Conversely, ewe number 120 occupied the 163rd position in MPPA ranking within the culling group, registering a value of 57.73092 kg/ewe. This placement designates it as having the lowest MPPA value within the bottom 20% of individuals considered.

The estimates of (MPPA) are valuable for efficient selection programs, predicting correlated responses to selection, and ultimately guiding the choice of breeding systems for future improvement and increased genetic gain.

4. CONCLUSION

In conclusion, all fixed effects, with the exception of the type of birth, wield a significant influence on both milk production and composition. Notably, substantial positive correlation was observed between total solid percentage and the percentages of fat, protein and lactose. The wide range among ewes of the BLUP values and MPPA values are valuable for efficient selection programs, predicting correlated responses to selection, and ultimately guiding the choice of breeding systems for future improvement and increased genetic gain.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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