A Study of Milk Yield and Composition of Marga Ewes in Iraqi Kurdistan Region

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Abstract

This study was conducted to evaluate milk yield, milk composition, and associated genetic parameters in Marga ewes in the Kurdistan Region of Iraq. A total of 40 ewes were monitored under field conditions to assess total milk yield (TMY), daily milk yield (DMY), post-weaning milk yield (PoWMY), pre-weaning milk yield (PaWMY), lactation period (LP), and milk composition traits including fat, protein, lactose, and solid non-fat percentages. The overall means (± SD) were 558.23 ± 10.91 kg/ewe for TMY, 88.05 ± 23.15 g/ewe/day for DMY, 61.89 ± 11.49 kg/ewe for PoWMY, 26.16 ± 18.53 kg/ewe for PaWMY, and 170.99 ± 32.93 days for LP. Milk composition averaged 5.16 ± 1.12% fat, 4.33 ± 0.35% protein, 6.19 ± 0.38% lactose, and 11.25 ± 0.57% solid non-fat. The effects of non-genetic factors, including age of ewe, type of birth, month of lambing, and lactation stage, were evaluated. Results indicated that most factors significantly influenced certain milk traits, while the sex of lamb showed no significant effect. Genetic evaluation using Best Linear Unbiased Prediction (BLUP) revealed a wide range of breeding values for TMY (-73.35 to 38.70 kg/ewe), indicating substantial genetic variability within the population. Similarly, Most Probable Producing Ability (MPPA) values ranged from 50.18 to 104.90, further confirming the potential for genetic improvement. The findings suggest that Marga ewes possess considerable genetic diversity for milk production traits, and that selection based on genetic merit can effectively enhance productivity. These results provide a useful foundation for breeding programs aimed at improving milk yield and composition in this indigenous sheep breed.

Keywords: Marga ewes, milk yield, milk composition, BLUB and MPPA

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Introduction

Sheep (*Ovis aries*) are one of the oldest livestock species, they were domesticated by humans around 10,500 years before the present (YBP) in the Fertile Crescent (South-eastern Anatolia and the Iranian Zagros Mountains) [1]. Then, sheep accompanied humans in their migrations from Asia into Europe and subsequently dispersed throughout the world [2]. There are nearly 863 sheep breeds in the World (FAO, 1996). The initial reasons for raising these animals were for their meat, milk and skin [3].

Iraqi sheep breeds are a fat-tailed breed found extensively in Kurdistan and the other part of Iraq. It is a hardy well adapted breed used to produce a range of products, meat, milk and wool. Furthermore, Iraqi sheep has a good milk yield per lactation. Genetic variations for these economic traits exist within and across flocks [4]. The selections of sheep breed by farmers and breeders in general, depend on economically important traits which are quantitative in nature like meat and milk production and composition. These traits are controlled by regions of the genome that contain one or more genes and called Quantitative Trait Loci (QTL) [5].

The Marga sheep is a fat-tailed breed found in Kurdistan. It is a hardly well adapted breed used to produce a wide range of products, from meat, to milk, and wool. Furthermore, The Marga sheep is descended from the Hamdani sheep breed and closely resembles it, except that it has very small ears resulting from a genetic mutation. Breeders tend to raise it separately due to its beauty, in addition to its higher productivity compared to Hamdani sheep, especially in milk yield and quality. Therefore, this study aims to investigate milk production in these sheep, examine the non-genetic factors that affect it, and evaluate some genetic parameters of milk production to accelerate genetic improvement in milk production.

Materials and methods

Animal location and studies traits:

This study was done at 40 Marga/ Kara ewes at flock in Zrarati Village / Erbil governorate located (15 km Northwest of Erbil), during September, 2024 to May, 2025 (*Fig. 1*). All animals were apparently healthy and were fed on pasture under open field conditions. The age of the ewes ranged from 3 to 5 and more years old. The ewes were exposed to rams for mating from the beginning of April until the end of August, so the ewes lambed at beginning of September. All necessary information on ewe were recorded and all ewes were numbered. Milk yield

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was recorded, ewes were started milking 15 days after lambing and 15 days later, also after this, a measure of milk for each ewe was recorded every monthly. The day before milking, all lambs was separated at 8 pm till milking in the next day at 8 am (12 hours). This method was repeated monthly till the end of lactation (when milk yield was less than 50 g /day/ewe). Milk was measured with 5 g precision scale. Test day milk yield of individual ewe was multiplied by 2 to get the daily milk yield (g / ewe/day), which multiplied by 30 then summed to calculate the total milk yield (ICARDA and FAO, 1995). The milk composition including (fat, protein, lactose, and SNF%) were measured by using (FUNKE GERBER Lacto Star, UK). Three times through experiment at the beginning of lactation (2 weeks after lambing), at the med of lactation and at the end of lactation in the laboratory of food technology at College of Agricultural Engineering Science, Salahaddin University-Erbil.

Figure1. The Marga sheep breed.

Statistics analysis:

The PROC GLM (General Linear Model) procedure in SAS programs (2010) was used to analyze the data for milk yield and composition traits. Fixed effects studies were: Age of ewes, Sex of lamb, Type of birth, Month of lambing, and Lactation stages were fitted in the following models:

Model I for Total and Daily Milk yield:

$Y_{ijklm} = \mu + A_i + S_j + C_k + Ql + \varepsilon_{ijklm}$ **(Eq.1)**

Where:

Y_{ijklm}= Total and Daily Milk yield of ewes.

μ= Over all mean.

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A_i= effect of ewes age (k = 3,4,5 years).

S_j = effect of sex of lamb (j =1 male and j =2 female).

C_k= effect of type of birth (k =1 single and k =2 twine).

Ql = effect of month of lambing (l =9 September, l =10 October, l =11 November, l =12 December and l =1 January).

ε_{ijklm}= Random error. It was assumed to be normally and independently distributed with mean zero and variance d^2e.

Model II for Milk composition:

$Y_{ijklmn} = \mu + A_i + S_j + C_k + Ql + P_m + \varepsilon_{ijklmn}$ **(Eq.2)**

μ= Over all mean.

A_i= effect of ewes age (k =,3,4,5 years).

S_j = effect of sex of lambs (j =1 male and j =2 female).

C_k= effect of type of birth (k =1 single and k =2 twine).

Ql = effect of month of lambing (l =9 September, l =10 October, l =11 November, l =12 December and l =1 January).

P_m= effect of stages of test (n = 1, 2,3).

ε_{ijklmn}= Random error. It was assumed to be normally and independently distributed with mean zero and variance d^2e.

Tukey tests used to compare between means for all traits under study because its suitable test to comparing least square means with this program.

Model III for BLUP and MPPA of Total Milk yield

For genetics evaluation of doe for various performance traits, Best Linear Unbiased Prediction (BLUP) procedure described by [6] was applied. The model used for this purpose was the Mixed Model (fixed + random effects) of SAS (2010) software.

The MPPA was calculated by used the following equation (Thompson, 1971):

$$MPPA = [\bar{X} - (nr/(1+(n-1)r)(x-\bar{X})]$$

Where: X population mean, x individual mean, n number of records, and r is repeatability.

The repeatability of test day milk yield was estimated by used REML methods using SAS (2010) software.

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Results and Discussion

Milk yield traits of Marga ewes

The overall mean of total milk yield (TMY), daily milk yield (DMY), post weaning milk yield (PoWMY), past weaning milk yield (PaWMY), and lactation period (LP) were 558.23 ± 10.91 kg/ewe, 88.05 ± 23.15 g/ewe/day, 61.89 ± 11.49 kg/ewe, 26.16 ± 18.53 kg/ewe and 170.99 ± 32.93 day/ewe, respectively (Table 1). Similar results were reported on DMY in Hamdani (502 g/ewe/day) ewes [7] and in Awassi (620 g/ewe/day) ewes [8]. Also the TMY averaged 90 kg/ewe in Hamdani sheep breed [7].

The age of ewes had a significant (P≤0.05) effect on DMY, PoWMY, PaWMY, and LP. but no significant effect on TMY due to ewe's age was recorded (Table 1). Production increases as the ewes age advanced, the increase in production with age is due to the development and integration of the mammary gland / 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[9]. Three years old ewes yielded DMY (654.72 ± 87.65 g/ewe/day) more than young and older ewes (Table, 1). These results were in agreement with [9] in Karadi sheep.

The sex of lambs was found to have a no significant impact (p≤0.05) on all milk traits (Table 1). These findings were in agreement with those reported earlier on DMY and TMY [10,11,12,13,14,15,16,17,18].

Type of birth had a significant (P≤0.05) effect on DMY, PoWMY but not significant on TMY, PaWMY and LP. Ewes that gave twin lambs gives higher daily milk yield compared to ewes that had single lamb (Table 1). These results are similar to that reported by [19]. Also, [20] investigated factors affecting milk yield in sheep found that ewes have twin lambs generally produce more milk compared to those have single lambs.

The month of lambing was found a statistically significant impact (p≤0.05) on milk traits, Ewes lambed in December were consistently produced more TMY and higher LP in comparison with ewes lambing in other months. But ewes lambed in November showed more DMY in comparison with other ewes. In accordance with current study, [16] found the significant impact of lambing

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month on both the TMY and LP in Awassi sheep. In contrast, the studies conducted by [21] and [22] reported that the month of lambing did not demonstrate any significant impact on either daily milk yield and total milk yield.

Table 1. Least square Mean ± SD for milk production traits in Marga ewes

Traits Mean ± SD					factors	
LP (day)	PaWMY (Kg/ewe)	PoWMY (kg/ewe)	TMY (kg/ewe)	DMY (g/ewe/day)		
170.99±32.93	26.16±18.53	61.89±11.49	88.05±23.15	558.23±10.91	Overall mean	
*	*	*	N.S	*		
181.43 ± 27.62[a]	30.39 ± 9.76[a]	59.41 ± 8.94[b]	89.81 ± 16.14[a]	516.92 ± 75.85[b]	3	Age of Ewes (year)
153.33 ± 36.94[b]	17.46 ± 26.93[b]	69.79 ± 11.29[a]	87.25 ± 31.30[a]	654.72 ± 87.65[a]	4	
182.73 ± 24.94[a]	31.88 ± 15.73[a]	52.85 ± 10.80[c]	84.74 ± 24.49[a]	471.04 ± 94.59[b]	5and more	
N.S	N.S	N.S	N.S	N.S		
167.14 ± 30.85[a]	26.74 ± 14.04[a]	63.09 ± 9.23[a]	89.83 ± 19.24[a]	569.46 ± 99.86[a]	Female	Sex of lamb
174.83± 35.01[a]	25.58 ± 23.02[a]	60.70 ±13.76[a]	86.26 ± 27.05[a]	547.00 ± 121.96[a]	male	

N.S 168.00 ± 39.45[a] 174.00 ± 28.84[a]	N.S 29.02 ± 18.19[a] 24.09 ± 20.53[a]	* 65.01± 12.23[a] 59.51± 11.56[b]	N.S 94.04 ± 23.73[a] 83.59 ± 23.53[a]	* 597.47 ± 123.93[a] 529.09 ± 97.22[b]	Twin Single	Type of birth
* 120.00 ±0.00[c] 160.00 ±17.32[b] 175.71± 34.57[ab] 197.50 ± 15.44[a] 165.00 ± 16.03[b]	* 4.00 ± 2.69 [c] 17.70± 3.63 [ac] 24.69± 24.23 [ab] 40.25 ± 9.17 [a] 28.06 ± 8.03 [ab]	* 51.70 ±12.48[b] 38.45 ± 2.77[c] 66.24 ± 10.97[a] 62.52 ± 9.80[a] 64.80 ± 3.34[a]	* 55.70 ± 11.09[b] 56.15 ± 0.86[b] 90.93 ± 24.66[a] 102.77± 14.90[a] 92.86 ± 8.79[a]	* 535.00 ± 130.31[a] 359.52 ± 35.47[b] 590.43 ± 117.33[a] 538.02 ± 95.24[a] 584.73 ± 28.45[a]	9 10 11 12 1	Month of Lambing

* It means there are significant at (P≤0.05) .The same letters in same column for each factor mean non-significant difference. NS: Non-significant.

Milk Composition of Marga Ewes

means ± SD of to identify the effect of fixed effects on the observed milk composition performance recorded such as fat%, protein%, lactose % and Solid nonfat (%) are given in Table (2), the overall means were 5.16 ± 1.12 %, 4.33 ± 0.35 %, 6.19 ± 0.38 % and 11.25 ± 0.57 %, respectively. Similar results were found in Hamdani ewes milk were fat%, protein% and lactose% averaged 5.56 ± 0.45, 5.03 ± 0.25, 4.42 ±0.07 %, respectively [19]. [23] reported that overall mean of fat%, protein% and lactose% were 6.55 ± 0.16, 4.55 ± 0.98 and 3.68 ± 0.11% in Awassi ewes.

The effect of lactation stages was significant (P≤0.05) on fat and protein %. The higher fat (5.47 %) and protein (4.52 %) percentage was recorded at 3th stage of lactation, while the lowest fat (4.82 %) and protein (4.16 %)

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percentage was obtained during the 2nd stage of lactation. On the other hands, the effect of lactation stages for both lactose% and total solid% no significant (Table 2). Thesis results were agreement with [24] in Hamdani ewes found significant effect of lactations stage on fat%. [9] found significant impact of stages of lactation on the percentages of fat, protein, lactose and total solids in Karadi ewes.

Ewes' age was found to have a significant effect ($p \leq 0.05$) on Fat % of milk. However, the percentages of protein, lactose and total solid were no significantly affected in Marga ewes (Table 2). The findings of the present study are consistent with previous research conducted by [25] 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 [24] in Hamdani ewes showed non-significant effect of ewes age on fat% and [22] in Karadi ewes found no statistically significant impact of ewes' age on milk characteristics.

The sex of lambs was found to have a no significant impact on all milk compositions in Marga ewes (Table, 2). The findings of the present study agreed with what reported by [22] in Karadi sheep.

The Type of Birth exerted a statistically no significant influence on milk composition parametersin Marga ewes (Table 2). Thesis results were agreement with [25] determined that the type of birth had no significant effect on the total solid%, protein%, fat% and lactose% in Karadi sheep. On the other hands [24] found significant effect of type of birth on fat% in Hamdani ewes.

The month of lambing was found a statistically significant impact ($p \leq 0.05$) on fat, protein, lactose and total solid nonfat percentage in Marga ewes (Table 2). In accordance with current study, [9] found the significant impact month of lambing milk composition. In previous research conducted in Iraq by [26], 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 [27].

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Table 2. Least Square Mean ± SD for milk composition traits in Marga ewes.

Mean ± SD					
Solid nonfat (%)	Lactose (%)	Protein (%)	Fat (%)	Levels	Factors
11.25±0.57	6.19±0.38	4.33±0.35	5.16±1.12		Overall mean
11.35 ± 0.69[a]	6.24 ± 0.44[a]	4.31 ± 0.37[b]	5.26 ± 1.21[a]	1	Lactation stages
11.15 ± 0.56[a]	6.13 ± 0.34[a]	4.16 ± 0.27[c]	4.82 ± 0.98[b]	2	
11.26 ± 0.46[a]	6.17 ± 0.39[a]	4.51 ± 0.31[a]*	5.47 ± 1.08[a]*	3	
11.27 ± 0.60[a]	6.22 ± 0.36[a]	4.35 ± 0.35[a]	5.11 ± 1.09[b]	3	Age of Ewe (year)
11.26 ± 0.65[a]	6.16 ± 0.40[a]	4.33 ± 0.39[a]	5.60 ± 1.19[a]*	4	
11.24 ± 0.43[a]	6.14 ± 0.42[a]	4.28 ± 0.26[a]	4.65 ± 0.78[c]	5 and more	
11.18 ± 0.59[a]	6.22 ± 0.39[a]	4.34 ± 0.38[a]	5.05 ± 1.13[a]	Twin	Type of birth
11.31 ± 0.58 [a]	6.16 ± 0.37[a]	4.32 ± 0.32[a]	5.27 ± 1.11[a]	Single	
11.23 ± 0.58[a]	6.19 ± 0.37[a]	4.35 ± 0.35[a]	5.29 ± 1.22[a]	Female	Sex of Lamb
11.28 ± 0.59[a]	6.17 ± 0.40[a]	4.31 ± 0.35[a]	5.10 ± 1.04[a]	Male	
10.72 ± 0.87[b]	5.85 ± 0.49[c]	4.07 ± 0.37[b]	6.04 ± 1.58[a]*	9	Month of birth
11.53 ± 0.36[a]*	6.64 ± 0.17[a]*	4.34 ± 0.29[a]	4.26 ± 0.76[c]	10	
11.27 ± 0.54[a]	6.15 ±0.35[b]	4.31 ± 0.37[a]	5.13 ± 0.95[b]	11	
11.36 ± 0.51[a]	6.23 ± 0.37[b]	4.39 ± 0.27[a]	5.16 ± 1.15[b]	12	
11.38 ± 0.36[a]	6.26 ± 0.26[b]	4.48 ± 0.26[a]*	5.03 ± 0.83[b]	1	

* It means there are significant at (P≤0.05),.The same letters in same column for each factor mean non-significant difference. NS: Non-significant.

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Genetic merit (BLUP) for TMY

Best Linear Unbiased Prediction (BLUP) is essential for evaluating an animal's performance, allowing for an accurate assessment of its true value within the study group. By ranking animals according to their BLUP values for specific traits, this approach aids in selecting the top performers, thereby accelerating the improvement of the next generation.

The overall BLUP value for TMY in Marga ewes ranged from -73.35 to 38.70 kg/ewe, while the BLUP values of ewes in top 10% (high production group) of ewes (The ewes that take their male offspring to be the parents of the next generation) ranged from 35.40 to 38.70 kg/ewe (Table, 3). These results indicated that there are big genetic variations among ewes for milk traits. [28] reported that BLUP values for TMY in two flocks of Hamdani sheep range from -68.160 to 139.951 kg/ewe. [29] reported that BLUP values for TMY in Karadi ewes ranged from -34.20 to 7.38/ewe kg.

Table 3 BLUP values for TMY in Marga ewes.

Group	BLUP	Ewe No.	Group	BLUP	Ewe No.
	5.40	25		38.70	23
	5.10	39	10%	38.10	20
	2.85	22		36.60	30
	2.70	38		35.40	31
	1.95	8		22.50	14
	1.65	28		21.15	35
	0	40		20.40	29
	-2.40	37		19.35	9
	-4.65	26		18.15	33
	-10.20	18		18.0	15
	-15.90	19		17.25	21

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	-16.05	10	70%	16.80	16
20%	-18.75	5		16.05	27
	-21.30	3		15.71	36
	-27.0	7		13.05	24
	-27.75	2		12.30	32
	-28.50	6		10.50	12
	-40.65	4		9.30	34
	-43.50	1		7.80	11
	-73.35	13		5.40	17

Repeatability estimated for DMY

Repeatability is a measure of the tendency of animals to maintain their ranking over time. It describes the accuracy with which early records of an animal's performance in a particular trait can predict its lifetime performance. It's used to assess which animal to cull and which to keep, rather than which are the most suitable for breeding.

The repeatability estimate for DMY in this study was found to be low was arrived 0.12. This results were lower than those previously reported values in similar studies, such as those by [11] in Hamdani, [25] in Karadi and [29] in Chios sheep and [9] in Karadi. This could be attributed to inherent factors such as genetic differences among the subjects, environmental conditions or management practices that were not adequately controlled [9].

Estimated Most Probable Producing Ability (MPPA) for TMY in Marga ewes

The MPPA value of TMY in this study ranged from 50.18 to 104.90 as in Table (4). This indicated the big genetic variations among Marga ewes for TMY trait. It means that individual selection can play a major role in improving TMY trait of Marga ewes. The MPPA of dairy animal, used to predict future performance from

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past records. When the repeatability for a trait is high, selection for the trait on the basis of the first record itself would be effective in improving the over-all performance of the herd in the next year. [9] reported that The MPPA value of TMY of Karadi ewes ranged from 57.73 to 78.83 kg/ewe. Also, [30] reported that the MPPA values for TMY of Kurdi doe ranged from 80.988 to 329.749.

Table 4 Most Probable Producing Ability (MPPA) of Marga ewes for TMY.

Group	MPPA	Ewe No.	Group	MPPA	Ewe No.
	88.57	25	10%	104.90	23
	88.37	39		104.60	20
	87.39	38		102.61	30
	87.39	22		102.07	31
	87.02	8		95.66	35
	86.81	28		95.45	9
	86.30	40		95.42	14
	85.33	37		95.32	29
	83.73	26		94.43	21
	82.06	10		94.30	33
	81.55	18		94.24	15
	79.87	5		93.70	16
	78.97	19	70%	93.36	27
	78.97	3		93.21	36
	76.69	2		92.38	24

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20%	74.75	6		91.67	32
	73.991	7		90.86	12
	72.14	4		90.33	34
	71.14	1		89.46	11
	50.18	13		88.64	17

Conclusion

The study results indicate that non-genetic factors influence milk yield and composition characteristics in the Marga sheep breed. These factors should be measured and considered when developing statistical equations to achieve greater accuracy in estimating genetic parameters, such as the repeatability for DMY, the ewes' BLUP values (as breeding values) and MPPA for TMY. The wide range of BLUP and MPPA values for milk production in Marga ewes provides a solid genetic basis for selecting rams from the top 10% of the breed to be the sires of the next generation, thereby increasing production and improving breeders' income.

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