Genetic Evaluation and BLUP Estimates for Growth – Related Traits in Native Iraqi Goats

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Abstract

A recent study was conducted on 125 records from 19 sires and 53 dams of local goat at the Ruminant Research Station in Abu-Ghraib and utilized breeding and weight records to estimate breeding values using Best Linear Unbiased Prediction (BLUP) method of dam weight , birth weight and body condition score (BCS) also evaluate heritability and repeatability for the same traits by using SAS programe furthermore, BCS was measured based on weight records also body condition status of dams . Means for dam weight , birth weight and BCS were 38.17 kg , 2.67 kg and 1.82, respectively. Heritability estimates were 0.22 , 0.36 and 0.43, respectively . Repeatability were 0.34 and 0.51 for dam weight and BCS respectively. For sires, the highest BLUP values for dam weight was 4.416 kg for sire No. 64394 while the lowest – 4.978 kg for sire 64398. Sire No. 182 had the highest BLUP value of 1.327 kg whilst the lowest value of – 0.903 kg was due to sire 64384 for birth weight . BCS BLUP values were 0.175 for sire 182 and – 0.527 for sire 64398 . The highest BLUP value for dam weight was 18.48 kg for dam No. 11384 whereas the lowest was -12.94 for dam 11361. Dam 10996 exhibited the highest breeding value for birth weight 1.972 kg and was also among the top for BCS . These results indicate that BCS is the best trait for genetic improvement because it has higher genetic value so can be considered in selection programe. Sire 182 was the best for birth weight and BCS , dam weight inheritance was low because it is influenced by feeding also pregnancy as environmental effect. so, selection upon sires and dams with highest BLUP values will be active to improve the herd because

Keywords : BLUP ; Breeding value ; Dam ; Growth ; Traits ; Sire

Introduction

Goats are wildly distributed around the world and have important economic traits including milk and meat production, twinning rate and adaptability to harsh environmental conditions which encourage breeders to raise these animals (4 , 15 , 22). Growth is a key quantitative trait in goats that is influenced by genetic and environmental factors, genetic improvement of growth through selection increases genetic gain across generations (8 11, 34 , 43). Therefore growth enhancement is one of the primary objectives for animals breeding programs as it improves performance with better feeding , reproductive efficiency, and health management consequently, genetic trends represent a good indicator of selection progress (12, 14, 23, 45). Economic traits such as body weight and lamb retention rate can be increased by direct selection based on weight and body condition score which reflect body reserves , muscles and fat content. Furthermore, animal health is closely related to body condition score which varies according to physiological stage, the optimal ranges from 2.5 -3.5 during dry or rest period and from 2.75 - 3.5 at kidding while it should be approximately 2.5 during the milk

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productive period (10 , 25 , 27 ,32 , 47) , thereby, selection improves performance by changing the frequency of favourable genes in the next generation, in addition, increasing both herd mean and genetic gain through high selection intensity (29, 31 ,33 35 , 44). On the other side , Best Linear Unbiased Prediction is a statistical procedure used to predict the genetic values and estimate breeding values by accounting for non – genetic effects. It relies on a linear mixed model to partition phenotypic variation into genetic and environmental components using sire data and pedigree relationships among offspring, sires and dams. Moreover, heritability and repeatability of the trait determine the degree to phenotypic value which reflects genetic predisposition for genotype expression (2 , 6, 17, 26) Best linear unbiased prediction is widely used to predict breeding values of offspring using various methods (13, 19 , 46). However, selection based on breeding values using genetic parameters which increases annual genetic gain but may also extend the generation interval and increase costs (9,36 40, 41). Given the importance of the genetic evaluation and to the best of our knowledge that there are no previous studies about BLUP evaluation of body condition score alongside limited literature on growth traits in local Iraqi goat . Therefore, the present study aimed to estimate genetic parameters for growth traits including dam weight, birth weight, body condition score with estimating breeding values of these traits by using BLUP method.

Materials and Methods

Herd Management

This research was conducted at the ruminant station in Abu-Graib affiliated with the Agricultural Research Office, Ministry of Agriculture from 21 December 2023 to 31 March 2024 on native goat depending on historical weight and breeding records which available for years 2021 – 2023 for 125 observations included single , twin , triplet births belong to 53 dams in different stages of production and 19 sires , mothers and their neonates weighed at birth in the same time , however , body condition score was assessed for all does by subjective evaluation method based on body condition status and body weight on a three point scale from 1= emaciated 2 = thin to 3 =Average ideal . Kids were kept with their dams in closed barns until 120 days of age, then transferred to semi – open barns under a standardized management program. Feeding regime varied by season , newborns received colostrums during the first three days and suckled until weaning at 120 days , small amounts of green forage were introduced after two weeks of age while the concentrate was fed at 55 gm / day for neonates and 3% of body weight for weaners until yearlings whilst 500 gm per day for does, meanwhile , this amount varied and increased before breeding season , during suckling also lactation periods . All animals were individually numbered. Does were mated to known pedigree bucks and data were recorded accordingly. A routine veterinary program was followed including vaccination against FMD, Brucellosis and Enterotoxaemia twice annually with deworming twice yearly against internal parasites.

Statistical Analysis

Variance components and genetic parameters were estimated using a mixed model procedure with restricted maximum likelihood (REML) in SAS (42) program. Breeding values were predicted using best linear unbiased prediction (BLUP) according to Falconer & Mackey (18).

Three statistical models were fitted to estimate genetic parameters for growth traits

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Model 1 : Paternal half – sib model for heritability

Heritability of dam weight, birth weight, and body condition score was estimated using the paternal half – sib method, birth type was included as a fixed effect as next :

$Y_{ijk}=\mu+S_i + T_j + e_{ijk}$

Where y_{ijk} : Observation of the trait μ:overall mean

S_i : Random effect of sire T_j :Fixed effect of birth type (1: single , 2: twin , 3 : tríplet)

e_{ijk} : Random residual error.

Model 2 : Repeatability model

Repeatability for dam weight and body condition score was estimated based on variance among dams as follows :

$Y_{ijk} = \mu+D_i+T_j + e_{ijk}$

Where D_i: Random effect of dam

Model 3 : Sire model for breeding values

Breeding values for sires and dams were predicted using BLUP under a sire model for dam weight, birth weight and body condition score

$Y_{ijkl} =\mu+S_i+D_j+T_k + e_{ijkl}$

Where all terms are as defined above

Results and Discussion

Overall Means of Dam Weight, Birth Weight and Body Condition Score

Present study reported overall means of 38.17kg for dam weight and 2.67 kg for birth weight while received to 1.82 for body condition score (Table 1) , the mean of dam weight was higher than that 29 .17 kg reported for Ethiopian goat (30). On the same side, birth weight in current study was heavier than 2.45 kg in Tunisian lambs (1) but lower than 3.78 and 3.27 recorded for Black Bedouin and Damascus goat in Tunisia (5) it was also less than 3.16 , 2.99 and 2.84 kg for Boer , Boerja and jawaranda goat breeds in Indonesia (37), Birth weight different among breeds ranging from 2.26 to 2.73 kg for Meriz and Black mountain goat in Iraq (4). Variation in birth weight among breeds may be attributed to differences in environmental and management conditions surrounding the dam furthermore, placental size and adequate feeding during pre and late gestation stages play a crucial role in foetal growth and embryonic weight (3) . For BCS the mean value of 1.82 in present study was lower than 2.48 reported for Pelibuey goats with a mean dam weight of 35.63 kg (28) but higher than 1 -1.5 in Indian goats (20). The low mean of BCS observed in recent study may be related to heat stress under high ambient temperature and long grazing distances which increases energy expenditure from body fat reserves (20)

Table 1. Overall means of dam weight, birth weight and body condition score in goat

Traits	No of Observation	Mean ±SE
Dam weight (kg)	125	38.17 ±0.65
Birth weight (kg)	125	2.67 ±0.08
Body condition score	125	1.82 ±0.03

125= Total of observations according to dam

Heritability and Repeatability Estimations of Dam Weight, Birth Weight and Body Condition Score

Heritability estimates were 0.22 , 0.36 and 0.43 for dam weight, birth weight and body condition score respectively. Repeatability estimates for dam weight and body

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condition score were 0.34 and 0.51, respectively (Table 2). Heritability and repeatability of dam weight in the present study were higher than those founded in previous studies 0.17 and 0.33 for Burundi goats (24) and 0.17 for heritability in jamunapari (16) repeatability of dam weight was more than 0.18 for West African Dwarf goat in Nigeria(49), birth weight heritability in the present study was higher than 0.04 for Maraz goat (38) but lower than 0.41 reported for mountain goat (21) . Heritability for body condition score were also higher than 0.37 , 0.32 and 0.41 for Eghoria , Skopelos and Damascus goats respectively (48) . The variation in heritability values among breeds may be reflects differences in genetic structure and environmental conditions, the higher heritability estimate for body condition score compared with the lower estimates for dam weight and birth weight may be attributed to differences in environmental sensitivity , BCS is less affected by environmental conditions because it reflects body fat reserves which do not change rapidly in response to short – term fluctuations in feed intake . Furthermore , genes controlling fat distribution and deposition exhibit substantial variation among individuals .In contrast, body weight is highly influenced by environmental factors such as nutrition, diseases and physiological status including pregnancy and lactation consequently, environmental variance increases while genetic variance declines resulting in lower heritability estimates for body weight (4) .

Table 2. Heritability and Repeatability estimation for dam weight, birth weight and body condition score in goat

Traits	Observations No.	Heritability# ±SE	Repeatability#
Dam weight (kg)	125	0.22 ±0.05	0.34
Birth weight (kg)	125	0.36 ±0.08	--
Body condition score	125	0.43 ±0.17	0.51

Variance components were estimated for 19 Sires (Heritability) and 53 Dam (Repeatability) using half-sib method

Best Linear Unbiased Prediction Estimation for Sires Based on Dam Weight, Birth Weight and Body Condition Score

Existence study was showed substantial variation in BLUP estimates among sires . For dam weight, the highest BLUP value was 4.416 kg for sire number 64394, while the lowest value was - 4.978 kg for sire No. 64398 there were high genetic variation among sires for dam weight however the difference between best and worst sire was 9.394 kg this mean when sire No. 64394 selected its daughters' weights will be increase above the herd mean by 4.4 kg . For birth weight sire No. 182 recorded the highest BLUP estimate of 1.327 kg whereas the lowest was 0.128 kg for sire 13846 . Negative BLUP values were observed for sire No. 64394 and 64384 ranging from - 0.145 to – 0.903 kg , sire No. 182 was the best for increasing birth weight while sire No. 64384 transmits genes to offspring that reduced birth weight by 0.9 kg . For body condition score sire No. 182 had the highest BLUP value of 0.175 which declined to 0.527 for sire 64398 (Table 3). The wide range of BLUP estimates for all studied traits reflect significant genetic variance among sires, positive BLUP values indicate superior breeding merit, suggesting that selection of these sires would increase trait means in the next generation (8). BLUP estimates for birth weight in the

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present study were higher than those reported by Shalaby et. al. (46) which ranged from 0.059 to 0.255 and higher than 0.044 was recorded for body weight in cattle and - 0.325 for Awassi rams (7). The occurrence of negative BLUP values suggests the presence of sires with poor genetic merit, such sires should not be used in selection programs and their presence may indicate inbreeding within the herd.

Table 3. BLUP ± SE estimate of Sires according to Dam weight, Birth weight and Body condition score (BCS) in Goat (Top and Lowest of 5 Sires).

	Dam Weight		Birth Weight		BCS	
Sire No.	Sire No.	BLUP Estimate ±SE	Sire No.	BLUP Estimate ±SE	Sire No.	BLUP Estimate ±SE
1	64394	4.416 ±1.06	182	1.327 ±0.92	182	0.175 ±0.06
2	11840	2.663 ±0.93	64385	0.398 ±0.23	64286	0.172 ±0.06
3	64388	1.944 ±0.85	11840	0.256 ±0.19	64377	0.158 ±0.04
4	64384	1.773 ±0.62	13840	0.170 ±0.08	64384	0.131 ±0.03
5	191	1.755 ±0.72	13846	0.128 ±0.04	64391	0.078 ±0.03
15	64386	-1.101 ±0.75	64.394	-0.145 ±0.03	64.389	-0.005 ±0.003
16	64377	-1.153 ±1.08	64390	-0.250 ±0.05	64388	-0.088 ±0.024
17	64380	-2.586 ±1.26	64390	-0.284 ±0.11	64390	-0.138 ±0.07
18	13846	-2.788 ±1.22	64391	-0.634 ±0.24	13846	-0.385 ±0.11
19	64398	-4.978 ±2.14	64384	-0.903 ±0.28	64398	-0.527 ±0.18

Best Linear Unbiased Prediction Estimations of Dams Based on Dam Weight, Birth Weight and Body Condition Score

Recent study revealed substantial variation in BLUP estimates among dams for the studied traits . For dam weight the highest BLUP values were 18.48 , 17.94 and 11.58 kg refer to dams No. 11384 , 13824 and 11398 respectively , whereas the lowest values ranged from -10.23 to -12.94 kg for dams No 11366 and 11361 respectively. According to birth weight the highest BLUP estimates were 1.972 , 1.016 for dams No. 10996 , 11398 , while the lowest values ranged from – 0.999 to – 1.003 kg for dams No. 11364 and 10991 correspondingly. For body condition score BLUP estimates were 0.182 and 0.167 for dams No.11826 and 11272 respectively, while negative values ranged from - 0 .716 to - 0.765 for dams 11397 and 11366 respectively (Table 4). The wide range of

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BLUP values based on dam reflect high genetic variability among dams . Dams with high positive BLUP values are recommended for selection , as they are expected to improve trait performance in the next generation (39). The observed BLUP values indicated high genetic variance among dams for body condition score, upon this wide range of breeding values suggests that body condition score can be effectively considered in selection programs to improve this trait within the herd.

Table 4. BLUP ± SE estimate of Dams according to Dam weight, Birth weight and Body condition score (BCS) in Goat (Top and Lowest of 5 Dames).

No.	Dam Weight		Birth weight		BCS	
	Dam No.	BLUP Estimate ±SE	Dam No.	BLUP Estimate ±SE	Dam No.	BLUP Estimate ±SE
1	11384	18.48 ±3.47	10996	1.972 ±1.04	11826	0.182 ±0.04
2	13824	17.94 ±3.05	11398	1.016 ±0.86	10996	0.182 ±0.04
3	11398	11.58 ±2.16	11361	1.011 ±0.69	10992	0.180 ±0.03
4	11911	1.03 ±7.95	17379	0.810 ±0.26	11385	0.176 ±0.04
5	11294	0.97 ±7.95	13819	0.810 ±0.31	11272	0.167 ±0.03
49	11366	-10.23 ±2.05	11364	-0.999 ±0.26	11397	-0.716 ±0.21
50	2028	-11.58 ±1.02	11289	-0.999 ±0.26	11361	-0.716 ±0.21
51	11829	-12.03 ±1.94	11288	-0.999 ±0.26	11282	-0.716 ±0.21
52	11397	-12.04 ±2.06	11285	-0.999 ±0.26	11384	-0.728 ±0.18
53	11361	-12.94 ±2.35	10991	-1.003 ±0.51	11366	-0.765 ±0.25

Conclusion

Present study observed that dam weight exhibited a moderate mean with low heritability estimate indicating that only 22% of the phenotypic variance was attributable to additive genetic effects, while the remaining 78% due to environmental factors . Birth weight showed a reasonable mean with moderate heritability, Furthermore, BCS displayed a low mean but relatively high heritability reflecting that the poor body condition was primarily attributed to environmental constraints, mainly nutritional deficiencies and heat stress. Therefore, improvement of

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the studied traits requires nutritional management prior to genetic selection . The results of BLUP estimates showed considerable genetic variation among sires for dam weight , birth weight and BCS, sire No. 182 was ranked as the top sire for both birth weight and BCS with BLUP values in contrast , sire 64398 had the lowest breeding value for dam weight and BCS, these findings suggest that selection based on BLUP values could improve the performance of the herd , however , since no single was superior for all traits , a selection index is recommended. These results indicate that selection of dams based on BLUP values could lead to significant genetic improvement in the herd , dam 10996 is recommended for inclusion in the breeding programme due to its superior breeding values for both birth weight and BCS, negative association observed between dam weight and BCS in some dams such as 11384 , suggests that a selection index should be used rather than selecting for a single trait.

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