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Genetic Evaluation of Body Condition Score, Reproductive Performance and Blood Parameters in Shami Goat

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ABSTRACT
This study was conducted at the Ruminant Research Station of the Ministry of Agriculture using 50 Shami goats aged 2-3 years, aimed at studying the relationship between BCS and reproductive performance and haematological parameters in goats, as well as estimating genetic parameters. Significant differences were recorded in reproductive traits between the different BCS groups, Significant differences were recorded in reproductive traits between the groups of goats with different BCS. The study revealed highly significant differences ($P \leq 0.01$) in fertility rate, length of pregnancy, twins rate, barrenness ratio, and reproductive infections ratio. Significant differences ($P \leq 0.05$) were also found in both prolificacy and abortion rate. The best performance across these indicators was observed in goats with the highest BCS (3.5-4.5). Regarding blood traits, albumin, LDL cholesterol, and HDL cholesterol were significantly affected by the different BCS groups in the goats. Heritability estimates ranged from 0.06 to 0.28 for reproductive traits and BCS, and from 0.08 to 0.38 for blood traits. The genetic and phenotypic correlations were positive ($P \leq 0.01$) at 0.45 between BCS and prolificacy, and ranged from -0.02 to 0.52 between BCS and blood traits. The BLUP values for BCS ranged from -0.139 to 0.492. We conclude that selection based on BCS in breeding programs is feasible based on the average genetic estimates and positive genetic and phenotypic correlations with some studied traits.

التقييم الوراثي لدرجة حالة الجسم والأداء التناسلي ومعايير الدم في الماعز الشامي

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الخلاصة
أجريت الدراسة في محطة أبحاث المجترات التابعة لوزارة الزراعة باستخدام 50 معزة تتراوح أعمارها من 2-3 سنوات، بهدف دراسة علاقة BCS بالأداء التناسلي والمعايير الدموية في الماعز، فضلا عن تقدير المعالم الوراثية. تم تسجيل فروق معنوية في الصفات التناسلية بين مجاميع الماعز ذات BCS المختلفة، اذ تبين ان هنالك فروقا عالية المعنوية ($P\leq0.01$) في معدل الخصب وطول مدة الحمل ونسبة التوائم ونسبة التفويت ونسبة الإصابات التناسلية، في حين كانت الفروق معنوية ($P\leq0.05$) في كل من نسبة الخصوبة ونسبة الإجهاض، وكان افضل أداء وفق هذه المؤشرات لصالح الماعز ذات BCS الأعلى (3.5-4.5). اما فيما يخص صفات الدم فقد تأثرت معنويا كل من الألبومين والكوليسترول الضار والكوليسترول الجيد مع اختلاف مجاميع BCS للماعز. تراوحت تقديرات المكافئ الوراثي بين 0.06 و0.28 لصفات التناسل وBCS، وبين 0.08 و0.38 لصفات الدم. كانت الارتباطات الوراثية والمظهرية موجبة ($P\leq0.01$) بلغت 0.45 بين BCS والخصوبة، وتراوحت بين -0.02 و0.52 بين BCS وصفات الدم. كذلك تراوحت قيم BLUP لدرجة حالة الجسم بين -0.139 و0.492. نستنتج أن الانتخاب القائم على BCS في برامج التربية ممكن بناءً على متوسط التقديرات الوراثية والارتباطات الوراثية والمظهرية الموجبة مع بعض الصفات المدروسة.
الكلمات المفتاحية: اناث الماعز الشامي، درجة حالة الجسم، التقييم الالي، المعالم الوراثية.

INTRODUCTION

Goats have played an important role in human society, both ancient and modern, as one of the oldest domesticated livestock, ancient tribes and nations recognized their diverse benefits and selectively bred them for milk, meat, hair, and hides, their ability to live in different environments and adapt to different nutritional conditions allowed them to spread throughout the world to become essential resources in the agricultural economy (Shirke *et al*., 2024). Predicting doe reproductive success or failure in dairy goat systems is of great importance to help farmers make their decision about managing doe in a classic 10-month production system or in an extended production system (Astruc *et al*., 2021). Understanding the variability in reproductive success will help better manage the diversity of production curves in a goat herd (Gafsi *et al*., 2025). The variability in reproductive success depends on the complex dynamic interactions between milk production and body reserve management, which have been extensively studied in dairy cattle (Bedere *et al*., 2018).

Studies have shown that the Body Condition Score (BCS) of goats is a management tool for assessing the nutritional status of animals and fat cover, which is an indicator of energy reserves in the animal, and its measurement is based on the subjective assessment of the level of fat and muscle thickness in the spine behind the last rib (Sahoo *et al*., 2022; Gupta *et al*., 2023). Therefore, the BCS is one of the tools that goat farmers can use to achieve proper management of body fat reserves (Ghosh *et al*., 2019). BCS is a term used to denote the body reserves of an animal. The BCS of an animal refers to the amount of fat (lipid) and protein (muscle) stored and available for maintenance, reproduction and production. Determining the BCS of goats is a simple but useful procedure that can help farmers make management decisions regarding the quality and quantity of feed needed to improve production and reproduction, and thus can play an important role in goat marketing. The BCS scale for goats uses a range of 1.0 to 5.0, with an increment of 0.5 (Ghosh *et al*., 2019; Gupta *et al*., 2023). A healthy goat should have a BCS of 2.5 to 4.0. Goats, where a body condition score of 1.0, 1.5, or 2.0 indicates a management or health problem, while a body condition score of 4.5 or 5 indicates an excessive amount of condition that can be detrimental to the health of the goat, and these

scores are rarely observed in goat herds under standard management (Ghosh *et al*., 2019; Sahoo *et al*., 2022; Gupta *et al*., 2023; Shirke *et al*., 2024; Gafsi *et al*., 2025). The use of easily accessible body measurements in goats and their offspring, especially body condition score, can provide a practical way to improve goat production systems, especially in rural areas, as it enables breeders to make informed decisions regarding herd selection and management practices, which ultimately leads to improved productivity and economic returns (Venkata Reshma *et al*., 2021; Venkata Reshma *et al*., 2022). These insights are crucial to guide selective breeding strategies aimed at enhancing the resilience of livestock to environmental stresses such as heat, especially in arid regions where such conditions prevail (Venkata Reshma *et al*., 2021; Venkata Reshma *et al*., 2022; Atoui *et al*., 2023; Datt *et al*., 2023; Atoui *et al*., 2024).

Although the available information in goat production systems about body condition score measurements and their relationship with body weight, productive and reproductive performance is scarce, but no work has been carried out on BCS systems in Iraq for goats, as the scarcity of feed and water and adverse climatic conditions under the country's conditions lead to low BCS, which limits goat production, so there is a need to evaluate the condition of goats using the BCS scoring system to maintain the optimal productivity of the goat herd under field conditions by relying on the traditional BCS assessment method using tactile and visual cues, and the automated evaluation method using the Mobile-NetV2 network and Transfer Learning technology, note research is still underway to develop techniques for predicting BCS in goats, technological advances allow for assessment of body weight and BCS through imaging techniques, making the process faster, more accurate, and non-invasive (Ma *et al*., 2024; Goncalves *et al*., 2025). Studies have shown the potential of using digital images, along with artificial intelligence tools (deep learning and machine learning), to obtain morphometric data from cattle, goats, and sheep (Zhang *et al*., 2018; Iqbal *et al*., 2022; Li and Teng, 2022; Atoui *et al*., 2023). Machine learning and deep learning methods and algorithms have also provided different accuracy rates for predicting BCS in goats (Temenos *et al*., 2024; An *et al*., 2025; Goncalves et al., 2025) and cows (Rodriguez Alvarez et al., 2018; Huang et al., 2019; Rodriguez Alvarez *et al*., 2019; Yukun *et al*., 2019; Cevik, 2020; Liu *et al*., 2020; Liu *et al*., 2023; Xiong *et al*., 2023; Zhao *et al*., 2023; Li *et al*., 2025). Therefore, the current study aimed to evaluate the performance of Shami goats under field conditions by studying the relationship of BCS with reproductive performance and blood parameters in Shami goats raised under field conditions in Iraq, in addition to estimating the genetic parameters (heritability, genetic and phenotypic correlation, and genetic merit) of BCS and the studied traits (reproductive performance and blood parameters) in Shami goats due to their importance in goat breeding and improvement programs as they aim to improve productivity and economic return.

MATERIALS AND METHODS

Animal Ethics Approval

The study protocol was approved by the Research Ethics Committee at the College of Agricultural Engineering Sciences, University of Baghdad (Ref. No. 28, dated 1 March 2026). All experimental procedures were conducted in strict compliance with the guidelines for sound scientific conduct and animal welfare.

Experimental design and studied traits

The study was conducted at the Ruminant Research Station of the Office for Agricultural Research/Ministry of Agriculture on 50 Shami goats aged 2-3 years during the period from 12/1/2023 to 1/1/2025. They were divided based on the BCS at birth into three groups according to the evaluation system (1-5 score) used to evaluate the BCS of goats, which was indicated by (Ghosh *et al*., 2019; Gupta *et al*., 2023; Vall *et al*., 2025). The BCS scale was used for each group within a range of 1.0 degrees according to the reality of the studied goat sample. It was consistent with the Automated evaluation of BCS using Mobile-NetV2 and Transfer Learning technology, which achieved an overall accuracy of 98%, the highest accuracy rate compared to other common Deep Learning networks used in previous studies, especially Convolutional Neural Networks (CNNs) (Temenos *et al*., 2024; An *et al*., 2025; Goncalves *et al*., 2025). The groups were as follows: the low BCS group (BCS: 1.5-2.5), the medium BCS group (BCS: 2.5-3.5), and the highest BCS group (BCS: 3.5-4.5). Reproductive traits were recorded and blood components were analyzed with the aim of studying the relationship between BCS and reproductive performance and blood parameters in Shami goats raised under field conditions in Iraq, as well as estimating the genetic parameters (heritability, genetic and phenotypic correlation, and genetic merit) of BCS and studied traits (reproductive performance and hematological parameters) in Shami goats, which are recorded and calculated according to the following law:

$$\text{Fertility rate (\%)} = \frac{\text{The number of goats gives birth}}{\text{Number of goats provided to males}} \times 100$$

$$\text{Prolificacy (birth/abdominal)} = \frac{\text{Number of kids born}}{\text{The of number of goats gives birth}}$$

$$\text{Twins rate (\%)} = \frac{\text{Number of females giving birth to twins}}{\text{The number of females gives birth}} \times 100$$

$$\text{Barrenness ratio (\%)} = \frac{\text{Number of females not give birth}}{\text{Number of goats provided to males}} \times 100$$

$$\text{Abortion rate (\%)} = \frac{\text{Number of aborted females}}{\text{The number of females gives birth}} \times 100$$

$$\text{Reproductive infections ratio (\%)} = \frac{\text{Number of aborted and nulliparous females}}{\text{The number of females gives birth}} \times 100$$

Blood parameters were analyzed after drawing blood samples from each goat using a 10 ml medical syringe, after cleaning the jugular vein area and sterilizing it with 70% ethyl alcohol. The blood was then placed in tubes containing EDTA, an anticoagulant, and refrigerated until it was transported directly to Al-Shifa Laboratory in Baghdad for blood tests on the same day. The blood tests were performed using an automated blood chemistry analyzer manufactured by Mindray (model BS-120),

equipped with reagents (kits) according to the desired tests for the serum samples, manufactured by the company Agappe Swiss. The tests included (Globulin, Albumin, Total protein, LDL, HDL, Triglyceride, Cholesterol, Glucose and WBC). The globulin concentration was calculated according to the following equation:

Globulin concentration = Total protein concentration - Albumin concentration
(g/100mL) (g/100mL) (g/100mL)

Statistical Analysis

The Statistical Analysis System - SAS (2108) program was used to analyze the data to study the effect of BCS on the studied traits according to a completely randomized design (CRD), and the significant differences between the means were compared using the Duncan (1955) multinomial test.

Mathematical model of the experiment.

$Yij = \mu + Bi + eij$

Where:

Yij: The value of the observation j that is due to the degree of body condition i.

μ: The general average of the studied trait.

Bi: The effect of the degree of body condition i.

eij: The random error that is normally distributed with a mean equal to zero and a variance of σ2e.

The variance components of the random effects in the studied traits were estimated, from which the heritability, genetic and phenotypic correlations, and genetic merit estimates (Best Linear Unbiased Prediction-BLUP) were estimated using the Restricted Maximum Likelihood (REML) method, according to the following mathematical models. The variance and covariance (VCV) matrix of the parent and the error was created for each trait for the purpose of conducting the positive definite test. This matrix must have real values (Exist), and the eigenvalue matrix associated with it must be positive and definite for the purpose of obtaining estimates of the genetic parameters that must be within the permissible limits. The test was conducted on the variance and covariance matrices of the parent and the error for each group of the studied traits by calculating the eigenvalues associated with the test matrix. It was found that some of them were negative. Therefore, the binding process had to be conducted to obtain new matrices of modified variances and covariances from which the heritability of the studied traits was estimated using the paternal half-sib method and the genetic and phenotypic correlations between them.

The second mathematical model (estimation of genetic parameters):

$Yijk = \mu + Bi + S + eijk$

where:

Sj: Father effect (sire) j (since the study included 5 fathers) to estimate the variance components.

the other symbols are as in the first mathematical model.

RESULT AND DISCUSSION

The results in Table 1 indicated that there were highly significant differences ($P \leq 0.01$) in prolificacy, twins rate, barrenness ratio, and reproductive injury ratio between the three studied groups for BCS (BCS:1.5-2.5, BCS:2.5-3.5, and BCS:3.5-4.5). The

highest BCS group (BCS:3.5-4.5) recorded the highest prolificacy of 1.53±0.17 (birth/abdominal) and twins rate of 52.94%, the lowest barrenness ratio of 10.53%, and reproductive injury ratio of 10.53% compared to the groups with medium and low in body condition score (BCS:2.5-3.5 and BCS:1.5-2.5), which recorded a prolificacy of 1.08±0.05 and 1.00±0.00 (birth/abdominal) and twins rate of 8.33. 0.00%, barrenness ratio 18.75% and 26.67%, and reproductive infections ratio 25.00% and 33.33% for both groups, respectively. Also, significant differences (P≤0.05) were observed in fertility rate and abortion rate, as the highest BCS group (BCS: 3.5-4.5) recorded the highest fertility rate 89.47% and zero abortion rate 0.00% compared to the groups with medium and low in body condition score (BCS: 2.5-3.5 and BCS: 1.5-2.5) which recorded fertility rate 81.25% and 73.33% and abortion rate 7.69% and 9.09% for both groups, respectively. While there were no significant differences in the length of gestation between the three studied groups for BCS (BCS:1.5-2.5, BCS:2.5-3.5, and BCS:3.5-4.5), the length of gestation was recorded as 153.80±2.47, 150.75±2.05, and 151.35±1.44 for the three groups, respectively. Gafsi *et al.* (2025) reported that there was no significant association between fertility and BCS scores, but a significant association was found between BCS and artificial insemination success, i.e. goats with a body condition score of less than 2.5 were less likely to succeed in artificial insemination than goats with a higher body condition score. The BCS at artificial insemination significantly affected the number of litters at birth (P≤0.01) and the number of litters weaned (P≤0.05), with the number of litters born and weaned per doe being higher in does with a body condition score of 2.0 and 2.5 than in does with a body condition score of 1.5, 3.0, or 3.5. The results indicated that the optimal body condition index ranged from 2.0 to 2.5 when mating or inseminating to achieve the highest number of litters per doe (Cividini and Simcic, 2017). Mellado *et al.* (2004) reported a significant association (P≤0.05) between BCS and fertility and birth rates in dairy goats, with goats with a body condition score of less than 1.5 having a three-fold lower probability of conception than goats with a higher body condition score, i.e., the better the body condition, the earlier the onset of estrus and ovulation compared to those with a lower body condition. Studies worldwide have shown that animals with a higher body condition score have higher reproductive efficiency than animals with a lower body condition score, as the body condition index reflects the nutritional status of the animal. Malnutrition can affect many reproductive functions such as fertilization, sex hormone production, early embryonic development, egg quality and efficiency. Malnutrition can also affect the secretion of GnRH from the pituitary gland, leading to a decrease in the pulsatile secretion of LH or an increase in preovulatory LH (Sejian *et al.*, 2010). Serin *et al.* (2010) found that body weight and BCS have an effect Significant (p<0.05) effect on goat fertility during the mating season. Therefore, goats with low BMI and body weight should be given higher energy feed before the breeding season. Accordingly, goats should be treated with hormonal treatments that stimulate ovulation. Improvement in reproductive performance in goats has been achieved by improving the level of nutrition or hormonal treatment (Alkass *et al.*, 2021; Araz *et al.*, 2023; Shirke *et al.,* 2024). Moeini *et al.* (2014) reported that BCS had a significant effect (P≤0.05) on FSH concentration in Merghoze goats, with goats with a body condition score of more than 3.0 recording higher FSH concentrations than other groups. Sitaresmi *et al.* (2020) confirmed that BCS was related to the action of steroid hormones in goats such as estrogen and cortisol, with goats with BCS 3 recording the optimal concentration

of these variables compared to goats with low and high BCS. Studies have also shown that goats with low BCS have lower levels of insulin-like growth factor I (IGF-I), which can affect follicle maturation and corpus luteum progesterone production and impair early embryonic development (Leroy *et al.*, 2008), and BCS in bucks also affects reproductive performance in natural mating (Gallego-Calvo *et al.*, 2015; Veliz-Deras *et al.*, 2023). Studies on reproductive activity have shown that BCS has a significant effect on the onset, end, and duration of the breeding season, with doe goats with a body condition score of 2.75 having longer periods of reproductive activity (Gallego-Calvo *et al.*, 2014). Widiyono *et al.* (2020) found that doe goats with a body condition score of 1 had less active ovaries than doe goats with body conditions scores of 2 and 3. Also, concentrations of glucose, calcium, and magnesium in the follicular fluid of the ovaries were lower in doe goats with a body condition score of 1 than in doe goats with body conditions scores of 2 and 3. As for disease incidence, studies have indicated that the disease incidence rate in goats with a BCS score of 3.0 or 3.5 at calving is lower in the early production period compared to goats with a BCS score higher or lower, so the condition of goats should not be higher than >3.5 or lower than <2.5 during the dry period, and therefore additional nutrition should be provided to goats with a BCS score of less than 2.5 in order to improve their condition to be in a better health condition after parturition (Serin *et al.*, 2010).

We conclude from the results of the present study that the variability in reproductive performance according to the BCS score is a useful biomarker for the purpose of identifying goats that should be inseminated, as well as monitoring goats that reach the lowest BCS level (i.e. less than 2.5) for the purpose of improving their nutritional level. The use of body condition scores and/or body weights as visual or tactile management tools is useful for evaluating goat herds for the purpose of distinguishing differences in pre-partum nutritional requirements and improving reproductive efficiency in small ruminants managed in a pasture-based production system.

Table 1: Relationship between the body condition score of Shami goat and reproductive performance, health status and disease incidence

Group	Fertility (%) rate	Prolificacy (birth/abdominal)	Length of pregnancy (day)	Twins Rate (%)	Barrenness (%) ratio	Abortion (%) rate	Reproductive infections ratio (%)
BCS:1.5-2.5 (15 animal)	73.33	b 1.00±0.00	153.80±2.47	0.00	26.67	9.09	33.33
BCS:2.5-3.5 (16 animal)	81.25	b 1.08±0.05	150.75±2.05	8.33	18.75	7.69	25.00
BCS:3.5-4.5 (19 animal)	89.47	a 1.53±0.17	151.35±1.44	52.94	10.53	0.00	10.53
Significant level	*	**	N.S.	**	**	*	**

The means with different letters within one column differ significantly from each other.
**(P≤0.01), *(P≤0.05), NS: not significant.
Means were analyzed by Duncan test (ANOVA) and percentages by chi-square test.

The results in Table 2 showed significant differences (P≤0.05) in the concentration of Albumin, LDL and HDL among the three studied groups for the BCS (BCS:1.5-2.5, BCS:2.5-3.5 and BCS:3.5-4.5). The highest BCS group (BCS:3.5-4.5) recorded the highest albumin concentration of 3.37±0.18 (g/ml) compared to the medium BCS group (BCS:2.5-3.5) which recorded 2.92±0.11 (g/ml) and did not differ significantly from the low BCS group (BCS:1.5-2.5) which recorded 3.11±0.09 (g/ml). Also, the highest low group (BCS:3.5-4.5) recorded the highest LDL concentration of 28.01±2.23 (mg/ml) compared to the low BCS group (BCS:1.5-2.5) which recorded 21.14±1.19 (mg/ml) and the medium BCS group (BCS:2.5-3.5) did not differ significantly from the high and low groups in BCS which recorded 25.55±2.18 (mg/ml). Also, the high and medium BCS groups (BCS:3.5-4.5 and BCS:2.5-3.5) recorded the highest HDL concentration of 63.69±4.73 and 64.71±4.84 (mg/ml) respectively compared to the low BCS group (BCS:1.5-2.5) which recorded 50.21±2.64 (mg/ml). While there were no significant differences in the concentrations of Globulin (3.93±0.23, 3.84±0.17, and 3.67±0.16 g/ml), Total protein (7.04±0.23, 6.75±0.18, and 7.58±0.65 g/ml), Triglyceride (30.34±5.92, 29.36±3.78, and 28.87±5.52 mg/ml), Cholesterol (57.12±3.04, 67.55±3.32, and 65.80±3.77 mg/ml), Glucose (79.56±2.06, 86.19±2.96, and 85.50±1.58 mg/ml), and WBC (29.23±2.87, 34.06±3.80 and 34.47±2.67 x103) among the three studied groups for BCS (BCS:1.5-2.5, BCS:2.5-3.5, and BCS:3.5-4.5), respectively. Moeini *et al.* (2014) reported that blood metabolites were not affected by BCS in Merghoze goats. Sitaresmi *et al.* (2020) confirmed that BCS was related to blood metabolites in Saanen goats (such as protein, glucose, and blood urea), with goats with BCS 3 recording the optimal concentration of these variables compared to goats with low and high BCS. Aba *et al.* (2020) also reported in their study to evaluate the relationship of various body condition scores of goats with the activities and levels of some biochemical markers in serum that BCS was significantly and strongly associated with serum cholesterol values, with goats with a body condition score of 2.5 to 4 recording higher values compared to lean goats with a body condition score of 1.

Table 2: Relationship between body condition score of Shami goat and blood traits

Group	Mean ± Standard error								
	Globulin (g/ml)	**Albumin (g/ml)**	**Total protein (g/ml)**	**LDL (mg/ml)**	**HDL (mg/ml)**	**Triglyceride (mg/ml)**	**Cholesterol (mg/ml)**	**Glucose (mg/ml)**	**WBC (x 10^3)**
BCS:1.5-2.5 (15 animal)	3.93±0.23	3.11±0.09 ab	7.04±0.23	21.14±1.19 b	50.21±2.64 b	30.34±5.92	57.12±3.04	79.56±2.06	29.23±2.87
BCS:2.5-3.5 (16 animal)	3.84±0.17	2.92±0.11 b	6.75±0.18	25.55±2.18 ab	64.71±4.84 a	29.36±3.78	67.55±3.32	86.19±2.96	34.06±3.80
BCS:3.5-4.5 (19 animal)	3.67±0.16	3.37±0.18 a	7.58±0.65	28.01±2.23 a	63.69±4.73 a	28.87±5.52	65.80±3.77	85.50±1.58	34.47±2.67
Significant level	N.S.	*	N.S.	*	*	N.S.	N.S.	N.S.	N.S.

The means with different letters within one column differ significantly from each other.
*(P≤0.05), NS: not significant.

The results in Table 3 indicate the estimates of the heritability of the BCS and the studied traits, as the heritability of the BCS reached 0.28, which is close to what was recorded by Figueiredo Filho *et al.* (2018) in the only study in which the heritability of the BCS in goats was estimated, as it reached 0.29. The heritability of reproductive traits was low, reaching 0.06 and 0.11 for both prolificacy and gestation length. Previous studies have indicated that the heritability of reproductive traits is always low and generally reflects the low amount of genetic variation for most reproductive traits with a few exceptions for litter size, litter weight at birth, age and weight at first kidding (Hermiz *et al.*, 2020; Desha *et al.*, 2022; Tesema *et al.*, 2023; Tesema *et al.*, 2025). As for blood traits, the heritability was low to medium, reaching 0.26, 0.19, 0.33, 0.28, 0.24, 0.24, 0.34, 0.38, and 0.08 for Globulin, Albumin, Total protein, LDL, HDL, Triglyceride, Cholesterol, Glucose, and WBC, respectively. It is worth noting that the heritability for blood traits in goats has not been previously estimated.

Table 3: Estimates of Heritability of the body condition score and studied traits of Shami goats

studied traits		Number of animals	Heritability
	BCS	50	0.28
reproductive performance	**Prolificacy**	50	0.06
	Length of pregnancy	50	0.11
	Globulin	50 (100 views)	0.26
	Albumin	50 (100 views)	0.19
	Total protein	50 (100 views)	0.33
	Low-Density Lipoprotein (LDL)	50 (100 views)	0.28
blood traits	**High-density lipoprotein (HDL)**	50 (100 views)	0.24
	Triglyceride	50 (100 views)	0.24
	Cholesterol	50 (100 views)	0.34
	Glucose	50 (100 views)	0.38
	White blood cells (WBC)	50 (100 views)	0.08

Number of animals = 50, number of sires = 5 sires.

The results in Table 4 indicated the genetic and phenotypic correlation between the BCS and the studied traits. The genetic and phenotypic correlation was positive and highly significant ($P<0.01$) for the prolificacy, which reached 0.45 for each of them, while for the length of pregnancy, it was insignificant, reaching 0.05 and 0.08 for both correlations, respectively. Also, the correlations with some blood traits were positive and highly significant ($P<0.01$), as the genetic correlation for LDL was 0.38, the phenotypic correlation for LDL was 0.56, and the correlation for glucose was 0.52. As for the genetic and phenotypic correlation for HDL and Cholesterol, it was positive and significant ($P<0.05$), as it was 0.23 and 0.27 for HDL and 0.21 and 0.34 for Cholesterol for both

correlations, respectively. Likewise, the genetic correlation for Glucose was 0.35, and the phenotypic correlation for Total protein was 0.22. While the genetic correlation was insignificant for Albumin 0.12, Total protein 0.12 and WBC 0.14, as well as the phenotypic correlation for Albumin 0.14 and WBC 0.17, the genetic and phenotypic correlation for Globulin and Triglyceride was negative and insignificant, reaching -0.08 and -0.05 for Globulin and -0.03 and -0.02 for Triglyceride for both correlations, respectively. Note that the genetic and phenotypic correlations between BCS and the studied traits have not been previously studied in goats. Studies have indicated a correlation between disease incidence and BCS, Daily estimates of genetic correlations between BCS and mastitis ranged from moderate to strong throughout the production period, increasing in strength as production progressed. The average daily genetic correlation between BCS and metabolic diseases was -0.438 (0.125) and remained stable throughout the production period. Lower BCS levels during the production period were genetically associated with an increased incidence of mastitis and metabolic diseases (Loker *et al*., 2012). Costa *et al*. (2012) also found an correlation between BCS and parasitic diseases in Caninde goats (P = 0.23). Therefore, goats with a normal BCS index are less susceptible to metabolic disorders, diseases, mastitis, and reproductive problems (Koyuncu and Altincekic, 2013). We conclude that selection based on BCS is feasible based on the average genetic estimates and positive genetic and phenotypic correlations with some studied traits, but it is necessary to take into account all genetic and environmental influences that interact in determining reproductive traits, which provides insights for enhancing reproductive performance in goats.

Table 4: Genetic (rG) and phenotypic (rP) correlations between body condition score and studied traits of Shami goat

studied traits		Genetic Correlation-rG	rP-Phenotypic correlation
reproductive performance	**Prolificacy**	0.45 **	** 0.45
	Length of pregnancy	NS0.05	NS0.08
blood traits	**Globulin**	NS-0.08	NS-0.05
	Albumin	NS0.12	NS0.14
	Total protein	NS0.12	*0.22
	Low-Density Lipoprotein (LDL)	** 0.38	** 0.56
	High-density lipoprotein (HDL)	* 0.23	* 0.27
	Triglyceride	NS-0.03	NS-0.02
	Cholesterol	* 0.21	* 0.34
	Glucose	* 0.35	** 0.52
	White blood cells (WBC)	NS0.14	NS0.17

**(P≤0.01), *(P≤0.05), NS: not significant.
Number of animals = 50, number of sires = 5 sires

Table 5 shows the estimates of genetic merit of buck goats according to BCS, where the maximum genetic merit was 0.307±0.06, 0.422±0.07, and 0.492±0.06, respectively, while the minimum genetic merit was -0.139±0.02. We conclude that the high and positive genetic correlations between BCS and blood and reproductive traits improve genetic merit in goats, in addition to the wide range in estimates of genetic merit of buck goats according to BCS may be due to a genetic variance that can be used in selection programs. Recent studies have indicated that the most effective method for estimating breeding values and enhancing genetic gains in goats is the Single-Step Genomic Best Linear Unbiased Prediction (ssGBLUP) as it provides many advantages in terms of the computational process and the accuracy of the estimated breeding values, in line with the development or reliance of many countries at present on genomic selection in the dairy goat sector, as it is possible to select animals that are candidates to be mothers and fathers for the next generation such as female goats (doe) and males (buck) without the need to refer to the pedigree and son records, and thus it is expected that the increased selection accuracy through the implementation of genomic selection will accelerate the genetic improvement of milk production traits and increase production efficiency in the dairy goat industry (Massender *et al.*, 2022; Negro *et al.*, 2024).

Table 5: Estimates of Best Linear Unbiased Prediction (BLUP) on body condition score (BCS).

No.	Sire Number	Number of offspring	Estimates of BLUP on BCS	Rank (weight)
1	23667	8	0.307±0.06	3
2	23759	11	0.492±0.06	1
3	23831	9	-0.139±0.02	4
4	351	17	0.422±0.07	2
5	755	5	-0.265±0.04	5

Total number of animals: 50 heads.

CONCLUSION

It seems necessary to consider environmental (BCS) and genetic influences that affect reproductive performance in Shami goat. The average genetic estimates and positive genetic and phenotypic correlations with some traits provide insights for enhancing reproductive performance in goats and predicting for the implementation of BCS-based selection in breeding programs. Note that enabling goat farmers to achieve sound management of body reserves according to the different stages of reproductive and productive performance by applying artificial intelligence (AI) as an accurate tool in sustainably assessing BCS and meeting the nutritional needs of animals is of paramount importance for improving management methods and increasing goat productivity by supporting reliable evidence-based decision-making processes.

CONFLICT OF INTEREST

Regarding this manuscript, the authors disclose no conflicts of interest.

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