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ANALYSIS OF MORPHOLOGICAL TRAITS IN BALOCHI SHEEP BREED OF BALOCHISTAN

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ABSTRACT

Balochi sheep is a popular breed of Balochistan used for meat and fleece production. This breed faces an elevated susceptibility to the annihilation of its distinctive traits due to uncontrolled and indiscriminate breeding practices. The process of phenotypic classification plays a crucial role in facilitating the sustainable utilization, conservation, and enhancement of a particular breed. The current study was conducted to evaluate the morphological attributes for conservation, rearing and breed improvement of the Balochi sheep in Balochistan. Five districts were selected for data collection included Quetta, Sibi, Mastung, Kalat, and Khuzdar. Five flocks were selected from each district, consisting of more than 250 animals. Most of the sheep population had a semi-pendulous ear direction (89.5%). In terms of ear colour, 73.5% of the sheep displayed a white tendency, while 26.5% had black. In male Balochi sheep, several typical morphological characteristics were observed, included wool fiber diameter averaging 37.47±0.06µm, body weight at 39.76±0.87 kg, height 35.20±0.13 inches, chest size of 50.16±0.74 cm, belly circumference of 55.48±0.62 cm, neck length at 7.84±0.46 cm, neck girth of 17.89±0.07 cm, testicle length 8.94±0.43 cm, and testicle diameter of 4.014±0.14 cm. Similarly, in female average values for wool fiber diameter were 37.47±0.06 µm, body weight was 34.02±0.27 kg, height 34.03±0.11 inches, chest size was 47.27±0.49 cm, belly circumference was 51.36±0.49 cm, neck length was 7.84±0.22 cm, neck girth was 17.89±0.03 cm, udder height was 7.86±0.20 cm, udder circumference was 11.83±0.3 cm, teat length was 2.99±0.00 cm, and teat diameter was 1.03±0.01 cm. The coat colour patterns of the overall phenotypes exhibited a mainly uneven distribution, with white coat colour patterns being most prevalent (95%), followed by black and brown patches. The facial head colour exhibited a predominant white pigmentation (85%) with the remaining 15% displaying a partly black shade. The distribution of nose shape among the sheep was 62% minor roman and 38% medium roman. Whereas 89.5% of sheep had an almond-shaped eye structure accompanied by black eyelashes, the remaining 10.5% displayed a brown eye colour. Our study found that 89.5% of Balochi sheep had semi-pendulous ears, 7% had pendulous ears, and 3.5% had ears that were erected upward. Moreover, coat color commonly observed predominantly white, often displaying a combination of white with black and brown patches, which was observed in around 90% of the sheep. Notably, male had horns with curved 56% and 44% straight, while females were hornless. Additionally, 86% of the sheep had legs that were predominantly white with black spots, and the neck color was mostly white, recorded in 90.5%, although some animals showed black spots on their necks. Finally, the belly color was mainly white in 90% animals, with 10% displaying black or brown spots on their bellies. The findings of the present study can be used to improve the management practices for the production and conservation of Balochi sheep breed.

Keywords: balochi sheep, phenotype, morphological attribute

INTRODUCTION

The presence of 31 varieties of thin- and fat-tailed sheep in Pakistan is evidence of the country's abundance in animal genetic resources. (Deng *et al.*, 2020). During the 2020-2021 fiscal year, 31.6 million head of sheep will be evaluated throughout the nation (Haq and Rehman, 2021). Balochistan has a significant proportion, 44%, of the national sheep population. This region is habitat of four

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indigenous sheep breeds, namely Balochi, Harnai, Bibrik, and Rakhshani.

Small ruminants play a significant part in the national economy as a supply of meat protein for the human population. Additionally, the production of leather from small ruminants serves as an added source of money in semi-dry and arid regions of the country (Kakar, 2011). Balochi (approximately 3.8 million heads) is a popular breed in Balochistan, primarily farmed for meat and fleece production (Jehan *et al.*, 2022). The Balochi sheep has a medium stature, a big tail, a white coat, heavy black markings on the legs, head, and nose, and coarse fleece for its wool. This breed faces an elevated susceptibility to the annihilation of its distinctive traits due to uncontrolled breeding practices, indiscriminate breeding and a lack of regulatory oversight or guidance from governing bodies. The main requirement to access Animal Genetic Resources (AnGR) is the morphological interpretation of any breed. (Lanari *et al.*, 2003). The process of phenotypic classification plays a crucial role in facilitating the sustainable utilization, conservation, and enhancement of a particular breed by effectively strategizing sheep breeding and rearing practices (Mogues *et al.*, 2012). Morphological attributes such as heart girth, wither height, and body weight, can be employed in the field to promptly identify sheep in large populations, facilitating the development of high-quality flocks. Lack of phenotypic characterization of the local sheep breed in Pakistan has led to insufficient attempts in their recording and protection. Indigenous and locally produced sheep breeds have substantial value because they contain unique combinations of adaptive features that have developed over time and allow them to successfully endure the environmental difficulties unique to their different environments (Khan *et al.*, 2019). According to reports, there are indigenous breeds that go by different names but have the same phenotypic traits (Vajed *et al.,* 2017). To analyse the present population structure and differences among the important sheep breeds, it is urgently necessary to genetically reevaluate these breeds. This analysis would serve as a starting point for supporting conservation projects in an effective and substantial way (Flanagan *et al.*, 2018). Thus, the goal of the current study was to evaluate the morphological characteristics of the Balochi sheep breed that is native to Balochistan. This will support breed improvement, breeding, and preservation.

MATERIALS AND METHODS

Present study was carried out in Balochistan, Pakistan at the Animal Breeding Genetics Laboratory of the Faculty of Veterinary and Animal Sciences of Lasbela University of Agriculture, Water and Marine Sciences.

Registration of farmers

Balochi sheep phenotypic information was gathered in the habitat districts of Quetta, Sibi, Mastung, Khuzdar, and Kalat. Five progressive farmers from each district were selected for data collection. Information was collected from government livestock farms, including the Multipurpose Sheep Breeding Farm in Yetabad, Loralai, Balochi Sheep Breeding Farm in Usta Mohammad, and the Karakul Sheep Breeding Farm in Maslakh Quetta. The phenotypic data was collected by using a proforma designed according to FAO guidelines from 2012. Morphological characteristics of sheep between the ages of 2-4 years were evaluated (Figure 1), including body weight (BW), heart girth (HG), belly (BL), neck length (NL), neck girth (NG), testicular length (TL), testicle diameter (TD), average age (AA), uterine height (UH), uterine circumference (UC), teat length (TL), and teat diameter (TD).

Methodology

The population and production of sheep in the selected areas (Quetta, Sibi, Mastung, Khuzdar, and Kalat) were surveyed prior to this study. Data was collected from animal owners and livestock and dairy development department. Selected districts were rich in population of small ruminant's research-based stations and agro friendly environment areas (Figure 2).

Description of study area

The study was carried out in the five selected districts of province between July 2020 and June 2021 (Figure 3). Balochistan experiences yearly precipitation ranging from 50 to 500 mm. Northeastern parts receive the more, with an average annual rainfall of 200 to 500 mm. The summer season lasts from late May to early September, with temperatures ranging between 24°C (75°F) and 50°C (79°F). Late September marks the start of fall, which lasts until mid-November with temperatures averaging 12°C (54°F) to 30°C (64°F). Agricultural sector of Balochistan has massive financial potential. Many areas in the region are suitable for the development of lucrative yields like pistachios, almonds, walnuts, and apricots. Consequently,

this region agricultural practice is based on a crop-livestock domesticated animal production framework, in which animals play a significant role in crop production and the farmers' ability to support themselves (Kerga, 2021). In terms of crop practices and agro-environmental subzones, Balochistan is split into seven groups based on rising and climatic factors (Lobb *et al.,* 2007; Rodrigues *et al.*, 2006).

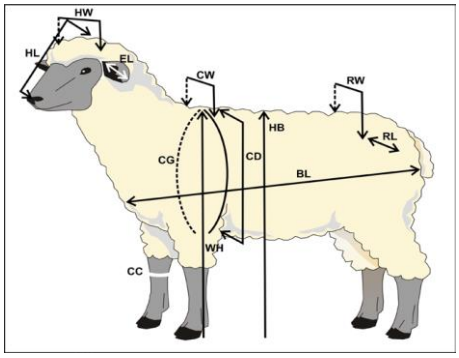

Figure 1. Measures zoometric. Head length (HL), head width (HW), ear length (EL), chest depth (CD), chest width (CW), chest circumference (CG), wrist height (WH), and height at the centre of the back (HB), BL: length of body: Root length (RL), root width (RW), and cannon circumference (CC) (Popoola. 2015).

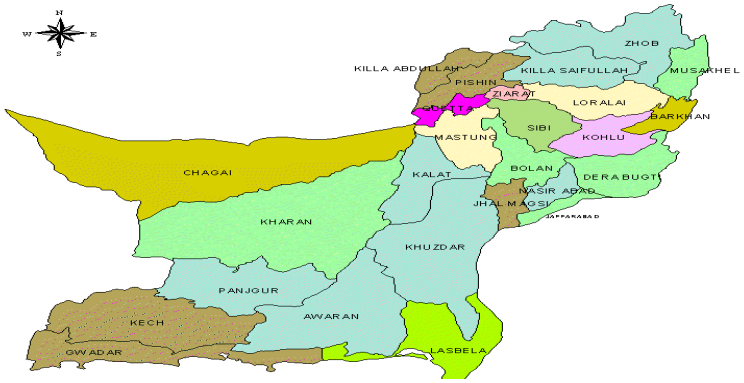

Figure 2. Map shows selected areas for study in Balochistan province (Rahim Bakhsh and Sarfraz Khan 2014)

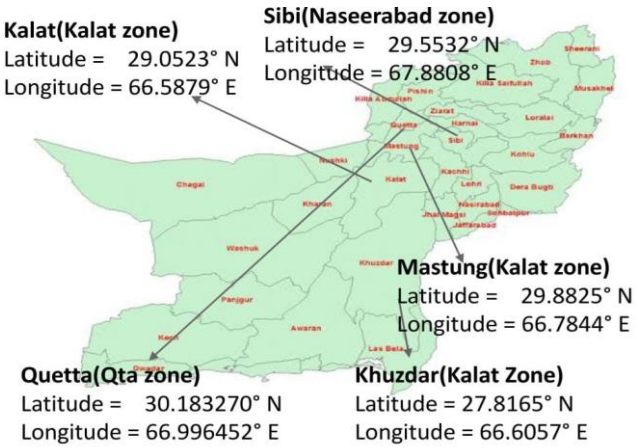

Figure 3. Districts wise position of Balochistan province (Ghalib *et al.* 2019)

Sampling method

Five districts, Quetta, Sibi, Mastung, Kalat, and Khuzdar were selected for sampling based on the distribution of the population, size of the herd, commitment of the districts to farmers, and the accessibility of transportation. Collecting phenotypic information on the animals, five flocks from each area containing more than 250 Balochi sheep breeds were discovered and selected. Ten animals, two males and eight females, were selected at random from each flock to collect phenotypic data (Table 1).

Data collection procedure

Prior to the initiation of data collection, farmers in each surveillance unit were guided for data collection and study objectives. Additionally, open discussions and conversations were conducted in an arbitrary way. Data was acquired and compiled by field observation, measurements, and estimations, supplemented augmented by secondary and optional sources. Field estimates and perceptions were implemented and carried out in accordance with FAO. The existence or absence of horns, horn form, horn orientation, and facial (head) profile, among other qualitative and morphometrical evaluations, were seen and noted. Body weight (BW), withers height (WH), heart girth (HG), belly (BL), neck length (NL), neck girth (NG), testicular length (TL), testicle diameter (TD), uterine height (UH), uterine circumference (UC), teat length (TL), and teat diameter (TD) were the quantitative characteristics and traits measured. Body weight was measured using a weight measuring tape, and body measurements were taken using a measuring tape.

Table 1. Detail of district wise data collection of Balochi sheep

District	Farmers	Ram	Ewe	Total
Quetta	5	10	40	50
Sibi	5	10	40	50
Mastung	5	10	40	50
Khuzdar	5	10	40	50
Kalat	5	10	40	50

Data compilation

The data collection process according to FAO outline standards and protocols for recording quantitative and qualitative information from a population of 250 adult sheep, consisting of 50 rams and 200 ewes (FAO Yearbook, 2013). Quantitative measurements were performed in the early morning, before the provision of food and water, during a period when the animals were calm and positioned upright on level terrain. Body estimates and measures were obtained based on phenotypic traits in Balochi sheep. A weight measuring tape was utilized to ensure accuracy in measuring body weight, while a flexible measuring tape, commonly known as a tailor tape, was used to record various body dimensions. The following factors were measured and documented: age, body weight, stature, chest, belly, neck length, neck girth, ear length, ear width, testicular length, testicular diameter, udder height, udder circumference, teat length, and teat diameter. Body colour, wool type, fiber diameter, ear type, ear colour, and ear position at rest were all observed, as well as the presence of horns and the colour of the head, nose, muzzle, and face.

Data management and statistical evaluation

All the data obtained through field observations and estimations were encoded and entered into the Microsoft Excel spreadsheet. The research survey and data information were analyzed to provide descriptive instances (mean, standard deviation, frequency, and percentage). Identification of criteria for the documentation of ranking and placement metrics for the selection and determination of rams and ewes was a requirement for registration. The documentation of feed suppliers, sheep production goals and objectives, and any production limitations that might be relevant were also included in the registration. Following the use of the statistical analysis system recurrence methods, the qualitative data information was analyzed (Garcia-Galan *et al.,* 2011). The investigation and analysis of quantitative components and variables used the SAS General Linear Model (GLM) approach and method.

Statistical analysis

The normality of the data was evaluated for all animals, and the data relevant to morphometric features was analyzed using proper statistical procedures to estimate the mean, range, coefficient of variation, and standard deviation. The UNIVARIATE method approach of Statistical Analysis Software (SAS) 9 was used to identify and locate outliers as well as assess the normality of quantitative estimates and data (Garcia-Galan *et al.,* 2011). In order to establish the mean, the range, the coefficient of variation, and the standard deviation, the data pertaining to morphometric features were examined for normalcy across the board for all animals.

Statistical Analysis Software (SAS)'s UNIVARIATE process technique was used to identify outliers, discover them, and assess the normality of the quantitative estimations and data.

RESULTS

Livestock composition and holding pattern

The present investigation has revealed that households residing in the areas rely on sheep as their primary and vital livestock for sustenance but exhibit inadequate management practices in terms of production and environmental conditions. The age-wise sheep flock organization and temperamental nature of the current investigation are shown in. Balochi sheep have a mostly temperate temperament, with docile and wild temperaments coming in second and third. The age percentage of male and female lambs from 1 to 1.5 years, 1.6 to 2 years, 2 to 2.5 years and more than 2.5 years were recorded 12%, 57.2%, 14.4% and 16.4% respectively as shown in. The extent of breeding male (ram) to ewe proportion was 1:24.

Table 2. Descriptive statistics of Balochi sheep population

Balochi Sheep Population	Least squares mean (LSM±SE)
Breeding rams	6.60±0.17
Ewes	64.20±2.05
Female Young Stock	34.00±0.38
Male Young Stock	26.60±1.10

Table 3. Morphological attributes of male Balochi sheep population

Wool (Fiber diameter) µ	37.47±0.06
Weight (kg)	39.76±0.87
Height (inch)	35.20±0.13
Chest girth (cm)	50.16±0.74
Belly girth (cm)	55.48±0.62
Neck length (cm)	7.84±0.46
Neck girth (cm)	17.89±0.07
Testicle length (cm)	8.94±0.43
Testicle diameter (cm)	4.01±0.14

Table 4. Morphological attributes of female Balochi sheep population

Wool (Fiber diameter) µ	37.47±0.06
Weight (kg)	34.02±0.27
Height (inch)	34.03±0.11
Chest (cm)	47.27±0.49
Belly (cm)	51.36±0.49
Neck length (cm)	7.84±0.22
Neck girth (cm)	17.89±0.03
Udder height (cm)	7.86±0.02
Udder circumference (cm)	11.83±0.03
Teat length (cm)	2.99±0.00
Teat diameter (cm)	1.03±0.01

Breeding rams, ewes, female young stock, and male young stock had average population sizes of 6.60±0.17, 64.20±2.05, 34.00±0.38, and 26.60±1.10, respectively (Table 2). In male Balochi sheep, several typical morphological characteristics were observed, included wool fiber diameter averaging 37.47±0.06µm, body weight at 39.76±0.87 kg, height 35.20±0.13 inches, chest size of 50.16±0.74 cm, belly circumference of 55.48±0.62 cm, neck length at 7.84±0.46 cm, neck girth of 17.89±0.07 cm, testicle length 8.94±0.43 cm, and testicle diameter of 4.014±0.14 cm (Table 3). Similarly, in female average values for wool fiber diameter were 37.47±0.06 µm, body weight was 34.02±0.27 kg, height 34.03±0.11 inches, chest size was 47.27±0.49 cm, belly circumference was 51.36±0.49 cm, neck length was 7.84±0.22 cm, neck girth was 17.89±0.03 cm, udder height was 7.86±0.20 cm, udder circumference was 11.83±0.3 cm, teat length was 2.99±0.00 cm, and teat diameter was 1.03±0.01 cm (Table 4).

Purpose of sheep farming

The study identified the underlying reason of sheep husbandry is that male lambs are primarily reared for the purpose of generating cash and mitigating risks, while female lambs are specifically fostered and nurtured for breeding and reproduction. The main objective of sheep farming is dual, with 54.5% of sheep being kept for milk production and the remaining 45.5% being raised for meat purposes. The study documented a predominance of extended feeding practices, accounting for 93.5%. Breeders and owners have their own males for breeding purposes, making up 93.5% of the population. The months of October and March, with lambing rates of 65% and 75% respectively, were the busiest. In the current study, 93.5% and 6.5%, respectively, of the production system were discovered to be nomadic (Table 5).

Qualitative characteristics

The general phenotypes may be found in (Table 6), which includes coat colour frequency and percentage, face/head colour, nose type, eye shape and colour, ear location and colour, horns leg, neck, and belly colour. In the study area under observation, 62% of the sheep had a slightly Roman nose shape, while 38% had a medium Roman nose shape. The colour of the face and head was 85% white and 15% partly black. 89.5% of the eyes were almond-shaped, and 10.5% had black eyelashes around them. The coloration of the ears was noted as brown (26.5%) and white (73.5%). 89.5% of ears are semi-pendulous, 7% are pendulous, and 3.5% are erect when at rest. The most frequent and

widely observed coat colour type was mostly white. Roughly 90% of the sheep are partially black and partially white in colour. While most female sheep were hornless, almost all male sheep possessed horns, with 56% of them curled and 44% straight. Eighty-six percent of sheep have nearly white legs with black spots, while ninety-five percent have necks with black dots. 90% of the belly colour was recorded, with 10% having brown or black patches (Table 6).

Table 5. Details of Balochi sheep in five districts of Balochistan

Primary purpose of keeping the breed	Frequency Percent
Meat	45.5%
Milk	54.5%
Production System	
Stationary	6.5%
Nomadic	93.5%
Feeding	
Intensive, no grazing	6.5%
Extensive, just grazing	93.5%
Housing	
No housing	41%
Housed at night	34%
Housed day and night	25%
Breeding	
Own male	93.5%
Purchased locally	6.5%
Lambing% Season 1	
March	75%
April	25%
Lambing% Season 2	
September	35%
October	65%

DISCUSSION

Role of sheep to produce meat, milk, and wool makes them an important species of livestock. The primary criteria used in the selection and breeding of meat sheep breeds are their quick weight increase and capacity to generate a high-yield, lean, and muscular carcass (Girmay et al., 2023). The goal of the current study was to collect detailed information about the authentic traits of the indigenous Balochi sheep breed in regions. Results of the present study revealed that the Balochi sheep breed has a dominant white coat color pattern with black spots, which is consistent with previously reported by(Ahmad *et al.,* 2019). Moreover, this study showed that many male sheep have curved horns, while most females are hornless. The average observed traits such as body weight, heart girth, belly, neck length, neck girth, and wool fiber diameter for male and female Balochi sheep were also recorded.

Table 6. Observed phenotypes of coat color frequency and percentage of Balochi sheep

Observed Phenotype	Percentage Frequency
Body Coat Color	
White	95%
Black	05%
Nose	
Slight Roman	62%
Medium Roman	38%
Face / Head Color	
White	85%
Partially black	15%
Eye Shape and Color	
Almond Type	89.5%
Black Lashes	10.5%
Ear Color	
White	73.5%
Brown	26.5%
Ear Position at Rest	
Pendulous	7%
Semi pendulous	89.5%
Erected upward	3.5%
Horns	
Straight	44%
Curved	56%
Legs	
White	10.5%
Brown	2.5%
Black	1%
White with Black spotted	86%
Neck Color	
White	90.5%
White with Black spotted	9.5%
Belly Color	
White	90%
White with other marking	10%

The results of the present study is in line with study conducted by (Zaborski *et al.*, 2019) which reported that the majority of male Balochi sheep have curved horns, while most females are hornless. The average observed traits such as body weight, heart girth, and wool fiber diameter were also consistent with previous studies(Ali *et al.*, 2013; Mirzaei *et al.*, 2021). The results of this study have important implications for the management and conservation of the Balochi sheep breed. The poor management practices observed in this study can lead to decreased productivity and profitability, which can threaten the survival of the breed. Therefore, there is a dire need to improve the management practices for the production of these sheep. Furthermore, it is imperative to prioritize the conservation of the Balochi sheep breed in order to uphold its genetic variety and preserve its ability to adapt to the indigenous habitat.

These results highlighted the significance of small-scale farmer role in livestock production in Balochistan. It is also important to note that

cattle and buffaloes are the main sources of milk production in India, with the country being the world's largest milk producer. The significant presence of goats and sheep in the livestock population also suggests potential for meat production and diversification of livestock products in the country.

It was observed in the present study that Balochi sheep is the essential animal for the livelihood of families in the districts of Balochistan. However, the management practices for the production of these sheep were found to be poor (Amin *et al.*, 2020), which can lead to decreased productivity and profitability.

A study was conducted to analyze the morphometric traits of Balochi sheep in the Mastung district of Balochistan. It was reported that the Balochi sheep had medium body sizes, short ear lengths, and thin tails, which are typical characteristics of the breed. The researchers also reported that the Balochi sheep showed resistance to common sheep diseases and had a high fertility rate (Ahmed *et al.*, 2022).

Another study was conducted to evaluate the meat quality of different breeds of sheep in Balochistan. The researchers compared the meat quality of Balochi, Kajli, and Lohi sheep breeds and found that the Balochi sheep had the highest meat quality, followed by the Kajli and Lohi breeds (Khan *et al.*, 2019).

A study conducted to analyze the genetic diversity of Balochi sheep in the Kharan district of Balochistan. The researchers reported that the Balochi sheep showed high genetic diversity and a unique genetic structure compared to other Pakistani sheep breeds(Khater *et al.*, 2018).

By understanding the composition and holding pattern of livestock in Balochistan can provide insights into the country's agriculture sector and help policymakers develop strategies for sustainable livestock production and rural development (Mahmood *et al.*, 2021). The above results indicated that the majority of the livestock holdings in the study area were small-scale, with an average flock/ herd size of less than 10 animals (Baltenweck *et al.*, 2020). This suggested that sheep production in the area is mainly carried out by small-scale farmers who keep a few animals for subsistence or for sale at the local markets (Hauck *et al.*, 2016). In terms of the sheep flock structure, the study found that most of the flocks were composed of females, with males being kept mainly for breeding purposes (Laouadi *et al.*, 2018). This is in line with the traditional practice of keeping male sheep for breeding and females for milk and meat production (Sow *et al.*, 2021). Furthermore, the study revealed that most of the sheep flocks were of mixed breed, with a few purebred flocks (McHugh *et al.,* 2016). This suggests that there is a lack of focus on breeding and genetic improvement among small-scale farmers in the area. The results indicate that sheep production in the study area is predominantly carried out by small-scale farmers with a focus on subsistence and local market sales (Fredriksson *et al.*, 2017). The sheep flock structure is mainly composed of females, with males being kept for breeding, and there is a lack of focus on breeding and genetic improvement (Haile *et al.*, 2019).

CONCLUSION AND RECOMMENDATION

This study offers significant insights into the distinctive morphological attributes of the Balochi sheep breed within the region of Balochistan. These findings have the potential to enhance the efficacy of management strategies applied in sheep production, as well as contribute to the preservation of this breed for future. The study revealed that there are variations in qualitative and quantitative features within the sheep population. As a result, there exist remarkable prospects and potential for genetic enhancement by means of deliberate determination and selection of rams from within the population. The findings of this study could potentially offer essential initial data for further investigation into the genotypic or molecular level characterization of the sheep breed in Balochistan. This exploration aims to examine the normal characteristics of the sheep breed and estimate its genetic potential. These insights would be valuable for the development of future plans and policies related to the sheep breed in the region.

It is recommended to prioritize the implementation of thorough and meticulously designed station-based phenotypic characterization and representation of Balochi highland sheep. It is advisable to do additional research at the molecular level to ascertain and comprehend the inherent traits of sheep, as well as to assess their genetic capacity.

CONFLICT OF INTEREST

The creators announce no irreconcilable circumstance with any monetary association in regard to the material discussed in the original manuscript for publication.

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AUTHOR'S CONTRIBUTION

A. N. Khosa: Conceptualization and design methodology.
C. Wajid: Writen first draft of manuscript.
J. Ahmed: Data analyzed.
S. A. Fazlani: Revised manuscript and help in data analyzed.
S. Mohammad: Data collection.

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