



Growth performance and fiber quality of Chyangra goats in High-altitude Rangelands of Nepal

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Abstract

Chyangra goat is important in the crop-livestock farming system for poverty reduction, livelihood, and nutritional security for smallholder farmers at high altitudes in Nepal. These goats are mainly raised for meat, fiber, and as pack animals. The study primarily aims to assess the effect of non-genetic factors on the growth performance and quality of fiber of Chyangra goats in different rural municipalities of the Mustang district. Kagbeni village of lower Mustang; and Lomanthang and Charang village of upper Mustang were the sampling sites. Chyangra fiber length was measured using a measuring pad and ruler and fiber diameter was analyzed using the Optical Projection Microscope Method whereas weight of different age groups was measured using a digital weighing balance. The fixed effect model was used to analyze the least square mean for fiber length, diameter, and weight from different sexes, locations, and age groups. The overall least square mean and standard error for fiber diameter and fiber length were $15.4 \pm 0.7 \mu\text{m}$ and $44.2 \pm 0.2 \text{ mm}$ respectively. In contrast, the body weight of 530 Chyangra for one, two, three, four and more than four years were 12.4, 18.7, 23.9, 26.3 and 20.0 kg respectively. Males were heavier than females in all age groups. The results exhibited a wide variation in growth performance and fiber quality parameters indicating the potentiality to improve Chyangra growth rates and fiber quality by adopting proper management and selection methods.

Introduction

Chyangra goats (*Capra hircus*), also known as Himalayan goat, occupies an important place in crop-livestock farming system for poverty reduction, livelihood, and nutritional security for smallholder farmers across Nepal. Goats can be used for production of meat, milk, manure, fiber (*Pashmina or Cashmere*), leather, and as a means of transportation in the mountainous region of Nepal. Demand for goat meat increases during religious festivals of Nepalese people and fetches good price during these periods (Joshi et al. 2018). Four indigenous breeds of goat in the country have been identified and characterized so far: Terai, Khari, Sinhal and Chyangra (Pokharel et al. 2012; Gorkhali et al. 2022). Chyangra goats is the dominant breed across northern trans-Himalayan regions from an altitude of 2500–5000 mean above sea level (masl) from east to west. Chyangra goat population is estimated to

be around 1% of the total goat population, i.e. 0.15 million heads in Nepal (MoALD 2024). Though these goats are reared primarily for their high-quality fiber, they are also sought for their meat. Only a limited number of studies have been conducted to determine fiber quality, and the small sample sizes used in these studies constrain their validity and reliability (Bhattarai 2017). Hence, the present study aims to assess the growth performance of Chyangra goats and to assess the effect of non-genetic factors on the fiber quality of Chyangra goats (diameter and length) in different locations of Mustang district.

Methods

Data on growth performance, fiber quality, and production systems were collected from different locations of Mustang district: Lomangthang-5 and Charang (upper elevation) and Kagbeni (lower elevation). Upper Mustang has a trans-Himalayan climate, while lower Mustang has a sub-alpine to alpine climate. Mustang is generally cool and semi-arid, with low rainfall (250–400 mm). A detailed questionnaire and data sheet were used to assess the Chyangra goats' production system, weight, fiber, and livestock management, including nutrition, health, breeding, and housing. Goats were weighed using a digital scale, and age and sex were recorded.

Growth performance from 530 Chyangra goats of different age groups (up to one, two, three, four, and above four years) from two altitudes were measured. Similarly, thirty-eight goats from Upper Mustang and twenty two from Lower Mustang were sampled, with 30 males and 35 females. Fiber samples were collected from each goat and stored in separate Ziploc bags, with location, age, and sex recorded. The sampled animals were assumed unrelated and aged 1-4 years. Sampling took place in early spring (mid-March to mid-April) in 2022 and 2023, before the molting season. Fiber samples were collected using a special combing device, with 5 grams taken from each goat (Figure 1).



Figure 1. Comb, Combing, and collection of fiber and sampling

Statistical analysis of the production system data was conducted using SPSS version 23. To address the issue of disproportionate subclass numbers, growth performance and fiber quality were analyzed using the Least Squares and Maximum Likelihood Method proposed by Harvey (1990), based on the Henderson (1953) model. Mean comparisons were performed using Duncan's Multiple Range Test (Duncan 1955). The fixed effect model was applied to analyze the least square means for various non-genetic factors (location, sex, and age group) in relation to the growth performance and fiber quality of Chyangra goats. The model is outlined as follows:

$$Y_{ijk} = \mu + a_i + b_j + c_k + e_{ijkl}$$

Y_{ijk} =body weight, fiber length, diameter, wax percentage; μ =overall mean; a_i =fixed effect of i^{th} location (i =Upper and Lower); b_j =fixed effect of j^{th} sex (j =male and female); c_k =fixed effect of k^{th} age (k =<1yr,2yr,3yr,4yr,>4yr); e_{ijkl} =random error

Results

Body weight of Chyangra goat

Among the 530 observations recorded the overall mean body weight was 20.3 kg, with animals from Lower Mustang being heavier. Males weighed more than females, and the highest weights were observed in the 37–48-month age group, followed by 25–36 and 13–24 months. Weights in the 13–24 month group were similar to those over 48 months, with the lowest weights in 4–12 month old animals (Table 1). Chyangra from Lower Mustang had higher weights. Males were heavier than females, showing sexual dimorphism. Body weight increased with age but declined after 48 months (see Table 1).

Table 1. Least Square Mean and Standard Error of Mean (SEM) of body weight (kg) of Chyangra goats from different locations of Mustang district

Factors	Number of observations	LSM±SE
Overall Mean	530	20.3±2.42
Location		P<0.05
Upper	359	19.6±3.58
Lower	171	20.9±3.40
Sex		P= <0.001
Male	126	22.8±3.89
Female	404	17.7±2.86
Age(months)		P= <0.001
Up to 1 year	78	12.4±0.497 ^d
13 to 24	52	18.7±0.615 ^c
25 to 36	56	23.9±0.596 ^b
37 to 48	58	26.3±0.578 ^a
Above 48	286	20.0±0.383 ^c
CV%		23.76

Fiber quality of Chyangra goat

The overall mean fiber length was found to be 44.2±0.2 mm. Significant differences in fiber length were observed between locations and sexes, with goats from Upper Mustang having longer fibers compared to those from Lower Mustang. However, no significant difference in fiber length was found with respect to age. The overall mean fiber diameter was observed to be 15.4±0.7 μm . There were no significant variations in fiber diameter by location, age, or sex across these regions. However, samples from Lower Mustang showed lower values compared to those from Upper Mustang.

Table 2. Least Square Mean and Standard Error of Means (LSM±SEM) for fiber diameter and length in different

Factors	n	Fiber length(mm)	Fiber Diameter (µm)
		LSM±SE	
Overall	60	44.2±0.2	15.4±0.7
Location		P <.001	NS
Upper	38	45.2±0.10 ^a	15.6±0.4
Lower	22	41.1±0.10 ^b	15.1±0.5
Sex		P<0.05	NS
Male	35	44.6±0.06 ^a	15.4±0.4
Female	25	42.5±0.08 ^b	15.5±0.5
Age (yrs)		NS	NS
1	12	44.8±0.13	14.9±0.9
2	12	43.2±0.20	15.9±0.8
3	12	45.9±0.09	15.7±0.5
4	12	44.8±0.12	14.9±0.7
>4	12	44.6±0.11	15.5±0.7
CV (%)		14.5	09.3

n=total number of goats from which samples were taken, each sample were replicated 10 times for analysis. NS=Non-Significant, p=p value, LSD=least significant difference, different alphabet in superscription signifies significance

Discussion

Bhattacharya et al. (2004) reported similar weights in Ladakh for Changthangi goats (20.0 ± 2.1 kg for males and 18.7 ± 1.9 kg for females at 300 days) as in our present study. The findings align with studies by Pokharel et al. (2012) and Gorkhali et al. (2022). Fiber diameter and length vary based on the goat's breed, age, and sex, with genetics playing the primary role and environmental factors such as feeding, housing, and management contributing to these traits. Thinner diameter fibers are often genetically linked to shorter fiber length (McGregor 2003). The present study demonstrates that Chyangra cashmere fiber is of high quality, with a diameter ranging from 14 to 18 µm (Gorkhali et al. 2023) similar to the finest cashmere produced by Chinese and Mongolian goats (14.5-16.5 µm) (Gurkan et al. 2023). The fiber diameter of Chyangra aligns closely with that of cashmere goats from China, Mongolia, and Afghanistan, which have diameters of 15.1 µm, 15.5 µm, and 15.15 µm, respectively (Kerven & Shrestha 2024; Couchman & McGregor 1983). Fiber length is vital for producers, as longer fibers have high value and directly increase market price. Gorkhali et al. (2023) observed similar findings in Chyangra goats from Mustang. The average fiber length determines its suitability for worsted (spin long, fine fibers into smooth, strong yarn – 30 to 50 mm) or woolen systems (spin shorter, coarser fibers into a bulkier, softer yarn - < 30 mm), with fibers under 30 mm being unsuitable for worsted processing (Ryder 1987). Female goats typically have shorter fibers, likely due to differences in feeding practices (Khan et al. 2012). Nutrition is a key factor in fiber quality (Summer & Bigham 1993), supporting findings by Bhattacharya et al. (2004). Although earlier studies linked fiber length to age, sex, and reproduction (Tuncer 2018), this study found no age-related effects. Seasonal reductions in fiber growth may result from nutrient competition during pregnancy and lactation (Khan et al. 2012), though increased feed intake can mitigate these effects (Oddy & Annison 2000).

Conclusions and implications

Non-genetic factors, including location, sex, and age, significantly influence the fiber quality and growth performance of Chyangra goats. These findings suggest that targeted improvements can be achieved by implementing effective management strategies and selection practices within a flock. By focusing on these factors, farmers can optimize the rearing conditions and selectively breed goats with desirable traits, ultimately enhancing both fiber production and overall growth performance in Chyangra goats.

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