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Comparative Study on Wool Yield and Wool Quality in Sheep Reared at Livestock Reach Station Jaba and Lalazar Alpine Pasture

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Abstract: An experiment in 2^3 factorial design involving two pasture locations, two sheep breeds and two age groups of sheep was conducted over 99 days during June to September, 2003. A total of 107 ewes (2 to 5 years age) and 79 lambs (one year age) of Rambouillet and Ramghani (F1, Kaghani×Rambouillet) were randomly divided in two groups. One group of 42 adult ewes and 21 lambs were kept at the Livestock Research Station (LRS) Jaba and the remaining ewes and lambs were shifted to Lalazar alpine pasture in Kaghan valley. The animals at the LRS Jaba were grazed on the station pasture and received a commercial concentrate 500 g/day/head while those at the alpine pasture did not receive any supplement and entirely subsisted on grazing. Nutritive value of alpine pasture was higher than that of LRS Jaba. Crude protein was 22.9 and 13.44% in DM, mineral matter (ash) was 14.32 and 8.2% in DM and *in vitro* DM digestibility was 52.81 and 45.47%, in herbage samples collected at monthly intervals from alpine and LRS Jaba pastures, respectively. The difference between the two locations was highly significant ($p<0.001$) for all the above parameters. The *in vitro* DM digestibility was positively correlated with crude protein ($R^2 = 0.72$) and ash ($R^2 = 0.56$) contents in the pastures. Midside wool yield and wool quality were significantly affected by locations ($p<0.001$) and age ($p<0.001$) of the grazing sheep. Midside clean wool yield was higher ($p<0.001$) in sheep at alpine than LRS Jaba and averaged 11.29 and 9.7 g/96cm^2, respectively. Both staple length and bulk of wool varied due to locations ($P<0.001$) and age of the animals ($P<0.001$). Mean staple length was 2.07 and 2.37 cm and bulk of wool was 11.27 and 12.82 cm^3/g, at LRS Jaba and alpine pastures, respectively. Across the two locations and breeds, staple length (cm) and bulk of wool (cm^3/g) averaged 2.31, 12.95 and 2.20, 11.41 in adult ewes and lambs, respectively.

Key words: Wool yield, livestock reach station, comparative study

INTRODUCTION

Livestock plays an important role in the economy of the country and serves an integral part of the mixed agricultural farming system in Pakistan. Out of the total livestock population of 130.7 million, there are 77.4 million sheep and goats, which provide 702 thousand tons of mutton, 40.3 million number of skins and 59.6 thousand tons of wool and hair. The contribution of livestock in the rural economy can be judged from the fact that more than 30-60% household income is derived from livestock. Livestock is an important sector of agriculture in Pakistan and accounts for 39% of the agricultural value added and about 9.4% of the GDP. Its net foreign exchange earnings were to the tune of 51.5 billion rupees in 2002-03, which was almost 11.4% of the overall, export earnings of the country[1]. Small ruminants provide 25 million tons of mutton and 4.87 million tons of wool and hair annually in NWFP. The number of sheep and goats in NWFP are 2.8 and 6.8 million heads, respectively. Flock owners with little or no land resources raise sheep and goats in the northern mountainous areas of Swat, Dir, Buner and Chitral districts of Malakand division and Mansehra, Battagram and Kohistan districts of Hazara division. There are 3.05 million small ruminants in the above-mentioned areas, which provide livelihood to 289262 households[2].

Sheep heavily depend on grazing land for their feed source. The North West Frontier Province has a large area of 25.1 million acres, out of which 12.7 million acres are rangeland that constitutes about 50.6% of total area of the province. The small ruminants such as sheep and goats are owned by land-less farmers and subsist entirely on these rangelands. Sheep are habitually grazing animals. They are very fond of pasture grasses and are highly efficient in utilizing it

Objectives: The objectives of the study were as follows:

- To compare the affect of seasonal migration to alpine pasture on wool growth and quality in sheep.
- To evaluate pasture quality of LRS Jaba and Lalazar alpine pasture in upper Kaghan during summer months.

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MATERIALS AND METHODS

Animals and experimental design: A 2×2×2 factorial experiment involving two pasture locations, two breeds and two age groups of sheep was conducted during the months of June to September 2003. A total of 107 adult ewes (2-5 years of age) and 79 lambs (>1 year) of Rambouillet and Ramghani (F1 Kaghani x Rambouillet) were selected from the flock kept at Livestock Research Station (LRS) Jaba. The adult and lambs were randomly divided in two groups and were randomly assigned for grazing to LRS Jaba and Lalazar alpine pasture of upper Kaghan valley. All the animals were treated for ecto and endo parasites a weak before the commencement of the study. Sheep to Lalazar alpine pasture were transported in trucks. The study lasted for a total period of 99 days.

Feeding and management: The two groups of adult ewes and lambs were kept on their respective pastures, according to the routine management adopted by the LRS Jaba over the last year. The animals kept at LRS, Jaba were offered commercial mixture (Anmole Vanda) 500g/day/animal and those kept at the alpine pasture did not receive any supplement and entirely dependent on grazing the pasture.

Wool yield and wool quality: Samples of wool were collected according to the midside patch technique[3]. Wool was sheared from the pre-measured and demarcated area of 8×12 cm (96 cm^2) above the shoulder region using an electric shearer. The wool clipped initially on the first day of the experiment was discarded while the wool sheared at the end of the experiment was saved for individual animal in a pre labeled polythene bag. After recording weight of the wool, the samples were taken to the wool analysis laboratory of National Agricultural Research Centre (NARC) Islamabad for quality measurements. Clean wool yield, staple length and bulk of the wool samples were determined according to the standard procedures adopted by the laboratory.

Sampling of vegetation from the pastures: Samples of vegetation at both the pastures (LRS Jaba and Lalazar alpine pastures) were collected at monthly intervals. Each pasture was divided randomly into four different sub-locations representing East, West, North and South as replicate sites on the same pasture. Two primary samples were collected from each sub-location. Efforts were made to collect a representative sample at random using a quadrate (1 square feet). A total of 48 pasture samples from the two locations were collected. These samples were brought on the same day to the Animal Nutrition laboratory, NWFP Agricultural University, Peshawar for chemical analysis as described below. The samples were air dried in an oven at 60°C for 48 h and were ground in a grinding mill (Thomas-Wiley Laboratory Mill, USA) to particle size of one millimeter. These were analyzed for crude protein and ash according to the standard procedures of[4]. *In vitro* dry matter digestibility (IVDMD) was determined as described by Tilley and Terry[5] using a single stage fermentation method without pepsin digestion[6].

Dry matter and ash: About 2 g samples air dried and ground in duplicate were taken in clean and pre-weighed crucibles. The crucibles were then placed in laboratory oven for 24 h at 100°C. After drying, the samples were cooled in a desiccator for thirty min and reweighed. The dry matter was calculated using the following formula;

$$DM(\%) = \frac{C - A}{B - A} X100$$

A = weight of empty crucible
B = weight of crucible + sample (pre drying)
C = weight of crucible + sample (post drying)

The dried samples were incinerated in a muffle furnace at 550°C for six h to estimate its ash content. After incineration the samples were cooled in a desiccator and re-weighed. Ash was calculated as under:

$$Ash\,(\%) = \frac{D - A}{C - A} X100$$

A = weight of empty crucible
C = weight of crucible +sample after drying
D = weight of crucible+ sample after ashing

Crude protein: Crude protein (N×6.25) was determined with the Kjeldahl method of[4]. Samples were digested with concentrated sulphuric acid, followed by distillation and titration. Samples (about 0.2 g) in duplicate were taken in the Tecator digestion tubes and added with 3 g catalyst (Potassium sulphate 93%, Copper sulphate 7%) and 5 mL concentrated sulfuric acid. Acetanilide (0.1 g) was processed as a standard for checking the recovery of nitrogen and realibility of the results. The digestion tubes were heated in a Tecator digestion block at 420°C for one hour.The tubes were then allowed to cool at room temperature.

About 15 mL distilled water was added to the tubes containing digested samples. After dispensing 25 mL of sodium hydroxide soloution (40% w/v) the tubes contents were distilled for about 7 min in a Labconco distillation unit. The resulting ammonia was collected in a conical flask containing 10 mL boric acid and 3-4 drops of methylene red as an indicator. Titration of the distillate was carried out with 0.02N sulfuric acid. To determine the blank values, duplicate tubes containing 15 mL distilled water and 5 mL sodium hydroxide solution without sample were processed for distillation and titration.

The percentage of nitrogen was calculated as under:

$$N(\%) = \frac{(V1 - V2) x 14.01 x \text{ Normality of Titrate}}{\text{Sample in mg}} X100$$

V1= Titration reading of sample
V2 = Titration reading of blank
14.01= Atomic wight of Nitrogen.

Crude protein was determined from the nitrogen contents of the sample by multiplying the nitrogen value with the factor 6.25. The results were corrected for dry matter as given under:

$$N(\%) \text{in DM} = \frac{N\% \text{in sample}}{DM\% \text{in sample}} X100$$

***In vitro* dry matter digestibility:** *In vitro* Dry Matter Digestibility (IVDMD) was measured with the procedure described by[5], with slight modification using a single stage incubation of 48 h without pepsin as adopted in this laboratory[6]. Samples (about 0.30 g) in triplicate were incubated in 60 mL centrifuge tube fitted with Bunsen valve. Rumen liquor was collected from a rumen fistulated animal fed maize fodder. Rumen liqour was filtered through double layers of muslin cloth and mixed with buffer solution in 1:3 proportion. An aliquot 40 mL was dispensed in each tube with simultaneous flushing of carbon dioxide to establish anaerobic conditions in the tubes. The tubes were closed and incubated in a laboratory incubator at 37°C for 48 h. Triplicate tubes containing rumen fluid without sample were also included in each run for determination of blank values. During incubation all possible measures were adopted to maintain microflora of rumen liquor alive during collection, filtration and dispensing of rumen liquor. The contents during incubation were mixed two times by gentle shaking at twelve h interval. On termination of the incubation, the tubes were centrifuged at 3000 rpm for 15 min in a centrifuge. The supernatant was discarded carefully. The tubes with the precipitate were dried in an oven at 70°C for 72 h or until complete drying. Finally, after cooling in a disiccator the tubes were weighed. The IVDMD was calculted as under:

$$IVDMD(\%) = \frac{A - (B - C)}{A} X100$$

A = weight of sample (DM)
B = weight of undigested dried residues
C = weight of undigested dried residues of rumen fluid in the blank tube.

Statistics: The data was recorded in a computer using Excel work sheet. The data was analyzed with ANOVA using 2×2×2 factorial procedure[7]. The GLM procedure on[8] was used for the data analysis. Means were compared with the LSD procedure. The statistical model was given as follow;

$Yijkl = \mu + \beta j + \Upsilon k + (\beta x \Upsilon)_{jk} + EIjkl$

Where;

Yjkl	=	Is the j-th breed, k-th age group and I-th location,
μ	=	Population constant and is common to all observations.
αi	=	The effect of i-th location; i=1(Jaba), 2(Alpine)
βj	=	The effect of j-th breed; j=1(Rambouillet), 2(Ramghani)
Υk	=	The effect of k-th age group; k=1(adult), 2(lamb)
$(\beta x \Upsilon)_{JK}$	=	The interaction of j.th breed and k-th age group.
Eijkl	=	error term assumed to be distributed NIID with mean zero and unit variance.

Similar model was used for analysis of the results on wool yield, wool quality parameters .

RESULTS AND DISCUSSION

Nutritive value of herbage: Mean results of ash, organic matter, crude protein and *in vitro* dry matter digestibility of plant materials collected at three intervals from Livestock Research Station (LRS) Jaba and Lalazar alpine pastures are presented in Table 1. Ash and organic matter contents varied due to location ($p<0.001$) and sampling time ($p<0.001$). Ash contents were considerably higher and organic matter was lower in alpine pasture than LRS Jaba pasture. Mean ash and organic matter values on DM basis across the three sampling times in alpine and LRS Jaba pastures were 22.90, 77.10% and 13.44, 86.56%, respectively. These differences in ash contents could be

Table1: Nutritive value of herbage at two different experimental locations. (Mean±standard deviation, each value is a mean of 12 observations)

	LRS Jaba pasture	Alpine pasture	Significance of difference
Ash g/100 g DM	13.44±1.03	22.90±1.30	p<0.001
Organic matter g/100 g DM	86.55±1.03	77.10±1.30	p<0.001
Crude Protein g/100 g DM	8.2±0.51	14.32±0.58	p<0.001
In vitro DM digestibility %	45.47±0.93	52.81±0.94	p<0.001
Calculated ME (MJ kg^{-1} DM)	6.00±0.08	7.11±0.14	p<0.001

LRS = Livestock Research Station, DM = Dry matter, ME = Metabolizable energy calculated from *in vitro* DM digestibility results as suggested by[17]

Table 2: Mean wool yield, staple length and bulk of wool in response to different locations, age and breed. (Mean ± standard deviation)

(A) Location effect			
Parameters	LRS Jaba Pasture	Alpine Pasture	Significance of difference
Dirty wool yield g/96cm^2	15.02±0.33	16.95±0.32	p<0.001
Clean wool yield g/96cm^2	9.707±0.27	11.20±0.18	p<0.001
Staple length (cm)	2.07±0.05	2.37±0.04	p<0.001
Bulk (cm^3 /g)	11.26±3.57	12.82±0.64	p<0.001
(B) Age effect			
Parameters	Adult	Lamb	Significance of difference
Dirty wool yield g/96cm^2	17.72±0.31	14.36±0.26	p<0.001
Clean wool yield g/96cm^2	11.29±0.21	9.88±0.22	p<0.001
Staple length (cm)	2.31±0.05	2.20±0.04	p<0.05
Bulk (cm^3 /g)	12.95±2.99	11.41±2.93	p<0.001
(C) Breed effect			
Parameters	Rambouillet	Ramghani	Significance of difference
Dirty wool yield g/96 cm^2	16.17±0.28	16.51±0.45	NS
Clean wool yield /96 cm^2	10.81±0.19	10.49±0.29	NS
Staple length (cm)	2.28±0.04	2.24±0.06	NS
Bulk (cm^3 /g)	12.10±2.82	12.61±0 3.46	NS

LRS = Livestock Research Station. NS = Non significant (p>0.05)

attributed to variation in plant species at the two pastures locations. In LRS Jaba the grass species consisted *Digitaria decumbens*, *Themedia anatheria, Chrysopogan aucheri*, *Setaria italica*, *Conyza canadense* and *Aristida adsensionis* and legumes were identified as *Vicia ervilia*, *Lespedeza sericea*, *Erigeron strgosus* and *Medicago lupuline*. Legumes accounted small proportion and were about 33% of the total herbage found in LRS Jaba. Conversely, the alpine pasture consisted only legumes and the species identified were *Frageria vesca*, *Polygonum avculare*, *Sercico chrysanthemum*, *Ranunculus lactus* and *Medicago lupuline.* Ash contents in pasture mainly represented mineral contents. The other constituents of ash were consisting of silica and soil contamination, which were generally low in pasture samples[9].

The high ash contents in alpine pasture suggested higher availability of minerals to grazing animals, especially calcium. Georgievkii[10] reported that legumes are always high in calcium than grasses. There was a

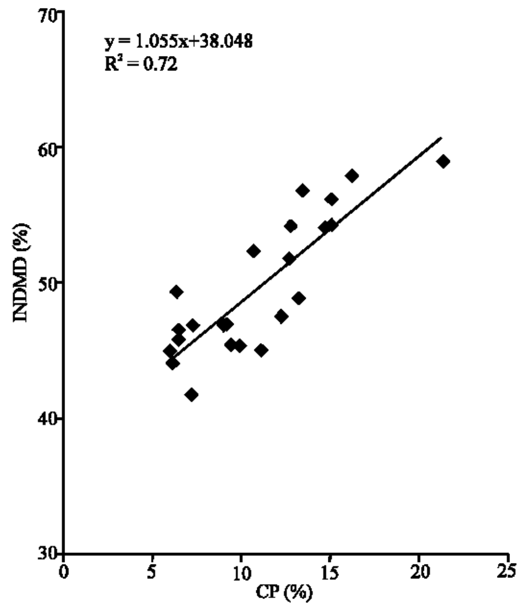

Fig. 1: Relationship between Crude Protein (CP) contents and *in vitro* Dry Matter Digestibility (IVDMD) of herbage samples

positive relationship (R^2 = 0.56) between ash contents and IVDMD of herbage in the present study. This suggested that higher ash contents, such as in alpine pasture, supported higher IVDMD, through supply of mineral matter for microbial digestion. Crude Protein (CP) value of herbage is of particular importance to ruminant animals both for proper rumen function and for synthesis process in the animal body. Preston and Leng[11] suggested that for ruminants the optimum level of CP in herbage should be about 10% on DM basis. In the present study, CP in LRS Jaba and alpine pastures averaged 8.20 and 14.32% on DM basis, respectively and the difference was statistically significant (p<0.001). The higher CP in alpine pasture was due to legume dominant plant species as stated earlier. Generally, legumes are high in CP contents.

Rahim[12] reported that CP value of alpine legumes in Malakand Divison varied from 15 to 23% in DM. The present results also agree with Mubashar[13] who found that CP concentration in alpine pasture of Kaghan valley ranged from 12.34 to 14.77%. Habib and Bashir[14] analyzed pasture samples of LRS Jaba and found that CP varied from 3 to 7% in DM. It is assumed that higher CP in alpine pasture may have supported efficient rumen fermentation in term of improved digestibility and microbial protein synthesis[15]. This presumably improved the production performance of sheep grazing alpine pasture as illustrated in Table 2. The above statement is supported by the positive relationship (R^2 = 0.72) between crude protein and *in vitro* Dry Matter Digestibility (IVDMD) of the herbage samples analyzed in the present study, the relationship is depicted in Fig. 1. These observations are in line with the findings of Niazi[16] who reported a positive correlation between CP and IVDMD in forages.

In vitro dry matter digestibility results were significantly influenced by difference in the two locations and remained higher ($p<0.001$) in the alpine pasture as reported in Table 1. The IVDMD in LRS Jaba and alpine pasture averaged 45.47 and 52.81%, respectively. The difference was due to variation in the plant species present of the two locations. Nevertheless, IVDMD values were primarily influenced by the CP contents in the herbage as suggested by the relationship illustrated in Fig. 1. On the basis of IVDMD results, the calculated Metaboliable Energy (ME) averaged 6.00 and 7.11 MJ kg^{-1} DM in LRS Jaba and alpine pasture, respectively. These results explain that greater supply of CP and ME from alpine pasture supported accelerated growth and wool yield in the grazing sheep as reported in Table 2.

Wool yield and wool quality: Wool yield and wool quality parameters in the experimental animals recorded at LRS Jaba and Lalazar alpine pastures are summarized in Table 2. Mean midside yields of dirty and clean wool at LRS Jaba were 15.02 and 9.07 g/96 cm^2 and 16.95 and 11.20 g/96 cm^2 at alpine pasture, respectively. The difference between the two locations was highly significant ($p<0.001$) for yield of both dirty and clean wool. These results demonstrated that sheep grazing on alpine pasture produced 2.13 g/96 cm^2 more clean wool than those stationed at LRS Jaba. Such an increase of about 19% is highly valued in term of improved animal performance and presumably resulted with improved nutrition of the sheep gazing alpine pasture as discussed earlier. Preston and Leng[11] suggested that wool growth in sheep is an index of quantity and quality of protein especially availability of sulphur containing amino acids absorbed in the small intestine of the animals. Therefore, it could be assumed that the quality of forage protein supplied by legume dominant pasture at alpine was a major factor that stimulated wool growth in the present sheep. In line with the present findings, Habib[18] reported that improved nutrition of growing sheep in the Swat valley resulted in high wool yield. In the present study yields of both dirty and clean wool were also significantly affected by age ($p<0.001$) but did not respond to difference in the breed ($p>0.05$). No interaction of age×breed could be detected for wool yield, showing that wool yield was consistently influenced by age of the experimental animals. Midside yields of dirty and clean wool as g/96 cm^2 averaged 17.72 and 11.29 in adult and 14.36 and 9.88 in lambs, respectively (Table 2). Wool yield did not vary due to difference in the sheep breed. As shown in Table 2, in Rambouillet and Ramghani sheep, mean dirty wool yield was 16.17 and 16.51 g/96 cm^2 respectively and clean wool yield was 10.81 and 10.91 g/96 cm^2, respectively. The above findings are in closed agreement with Oddy and Annison[19] who reported higher wool yield in adult than lambs. The present results also agree with Robards[20] who reviewed voluminous research data and reported that differences in wool yield due to breed of sheep in Australia were inconsistent and in many comparisons, no difference was found in wool yield among different breeds or crosses of sheep.

Results on staple length of wool in experimental animals are summarized in Table 2. Fiber length is another parameter, which determines the value and use of wool. Staple length provides reasonably good estimate of the fiber length and is easier and time saving to measure. It is measured from the skin to the outward tip. The mean staple length of wool recorded at LRS Jaba and Lalazar alpine pasture was 2.07 and 2.37 cm, respectively (Table 2) and the difference was highly significant ($p<0.001$). Staple length in adult and lamb averaged 2.31 and 2.20 cm, respectively (Table 2) and the results were also significantly influenced by age ($p<0.001$). Staple length did not vary due to difference in the sheep breed. Mean staple length of wool in Rambouillet and Ramghani was 2.28 and 2.24 cm, respectively (Table 2). Mean staple length of 2.31 cm recorded in the present study was lower than that reported by[21]. The author reported that staple length in Rambouillet averaged 5.6 cm and that of local sheep breed in Pakistan varied from 5.6 to 7.5 cm. Nevertheless, in the present study the staple length was measured on wool grown over an experimental period of 99 days that was less than 6 months of normal shearing interval and may have resulted in lower staple length.

Average bulk values and their standard deviation for wool from sheep kept on two different pastures in relation to age and breed of the sheep are presented in Table 2. Like other wool quality parameters, wool bulk was affected by locations ($p<0.001$), age ($p<0.001$) but did not vary due to breed difference. Bulk of wool as cm^3/g averaged 11.26 and 12.82 at LRS Jaba and Lalazar alpine pasture, respectively. Mean wool bulk values for adult sheep and lambs were 12.95 and 11.41 cm^3/g, respectively and those of Rambouillet and Ramghani averaged 12.10 and 12.61 cm^3/g, respectively. Wool bulk is of main interest to carpet industry and is defined as wool space filling ability. Wool with higher bulk results in bulk yarn, which in turn produces thicker carpet cover. Conversely, low bulk means that more fibers are required for a given yarn thickness. Although the mean bulk value reported in the present study was lower than that reported by[21]. The results demonstrated that wool of high bulk was produced by sheep grazing the alpine pasture.

CONCLUSION

- The herbage composition of the alpine pasture was different than the pasture at LRS Jaba and the nutritive value in term of mineral matter, crude protein and *in vitro* dry matter digestibility was superior for alpine pasture than LRS Jaba.
- Based on the result of the present study it is recommended that the productive performance of sheep at LRS Jaba could be significantly increased through migration of the flock to alpine pasture during summer months (June to September) this will significantly contribute to reduction of rearing cost incurred on supplementary feeding of concentrate at LRS Jaba.
- The quality of the existing pasture at LRS Jaba needs improvement through reseeding of suitable high quality grasses and legumes together with implementation of improved grazing management such as rotational grazing.
- Long term study is needed to monitor subsequent performance of sheep during the post migration period at LRS Jaba.

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