A Genetic Assessment of the kleiber ratio and average daily gain in Chokla sheep grown in semi-arid Rajasthan

ABSTRACT

This experiment was conducted during year 2020, duration 2 year at the Divison of Animal Breeding and Genetics, Veterinary College, Bikaner, Rajasthan, India to genetical assessment of growth efficient parameters viz. average daily gain and kleiber ratio of Chokla sheep by study various inheritable factors and nonhereditary factors. In order to conduct a thorough assessment of effectiveness of growth of a semi-arid environment for Chokla sheep, data on 6785 lambs born to 459 sires over a 47-years period (1974–2020) were gathered from the Institute of Central Sheep and Wool Research, Bichwal, Bikaner, Rajasthan. This data was used to determine the sire's random effect and various determinate effects of birth year, season in which animal born, gender of lamb, and weight of ewe at lambing on the performance of these sheep. According to estimated least-squares averages, the average daily gains ADG1 (birth to weaning stage), ADG2 (weaning stage to 6 months of age), and ADG3 (6 months to 12 months of age) were, in order, 118.69±0.55 g day-1, 64.94±0.70 g day-1, and 30.60±0.49 g day-1. These values corresponded to Kleiber ratios KR1, KR2, and KR3, were 16.42±0.04, 6.79±0.06, and 2.69±0.06, respectively. In terms of sire, period of lambing, season of lambing, and sex of lamb, each factor was highly consequential ($p<0.001$) for every attribute under study. All age groupings showed that males were heavier than females. With the exception of ADG2 and ADG3, these traits significantly correlated with the ewe 's weight at lambing. In which every trait had a positive regression coefficient with the exception of KR2. It should be crucial to guide these significant factors to obtain higher growth performance of lambs for farm management. Significant effect of sire indicates presence of additive genetic variability among different traits by using that sires further enhancement possible in these traits.

Keywords: inheritable, nonhereditary factors, birth year, Season in which animal born, gender of lamb

1. Introduction

One out of few countries in the world that has made a significant contribution to the global livestock gene pool is India. Humanity gains from small ruminants in a variety of ways, such as increased soil fertility, high-protein food production, higher farmer incomes, and the creation of jobs in rural regions. Therefore, these animals are crucial to the socioeconomic advancement of our nation's small-scale farmers and laborers without land.

One of the first species to be domesticated was the sheep (Ovis aries), which brought to South-Western Asia some 12,000 years ago (Zeder et al., 2006). The Argali and Urial stocks are the sources of Indian sheep derivation. Agro-ecological conditions have allowed the most of breeds to organically evolve over generations, and this habitat adaptability is essential for viable sheep raising.

Among all sheep breeds Chokla is primarily found in the areas surrounding the Rajasthani districts of Churu, Jhunjhunu, Sikar, and Bikaner, Jaipur, and Nagaur. It is an Indian sheep with fine carpet wool that is mostly raised for its meat. It is suitable for the area where migration is a regular occurrence since it is sturdy and well-adapted to tropical dry and scorched conditions. Their body size is light to medium with small head. Appearance of animal is white with a neck that is either dark tan or reddish brown in color.

The growth of lambs can be used as a criterion for selecting individuals within breeds as well as between breeds, as it reflects the animal's adaptability and economic viability. Up until marketing age, their potential to produce meat is ultimately determined by their fast growth rate. The analysis of growth helps or even directs producers in identifying the best management techniques to maintain the gain at an ideal measure. Kleiber (1961) defined the Kleiber ratio as an efficiency metric that is independent of body size. Scholtz et al. (1990) proposed a term Kleiber ratio as average daily gain divided by mature metabolic body weight which is a potential indirect selection feature for feed conversion.

According to Badenhorst (2011), the Kleiber ratio has a positive correlation with ADG and can be calculated in the field conditions.

A genetically prime animal's performance is affected by non-genetic variables like year, season, sex, etc. As a result, it is challenging to determine the precise breeding merits of the sort outed animals. It is vitally important to inherently reevaluate the increase in body weight improvement and recognition of consequential affecting environmental as non-genetic factors and their associations in order to comprehend the genetic inclination and to choose and draw up a justifiable breeding program that considers the genetic variability in these populations.

Variations in humidity, rainfall, and ambient temperature from year-to-year affect pasture in both qualitative and quantitative ways. Proper growth of lambs also depends on the flock's health and management throughout time.

The impact of numerous nonhereditary influences such as year and season in which animal born and sex of lamb on growth rate as stated by various workers as Mandal *et al.* (2015) in Muzaffarnagri; Balan *et al.* (2018) in Mechari; Mahala *et al.* (2019) in Avikalin and Mallick *et al.* (2019) in Bharat Merino. Study of non-genetic factors on kleiber ratio were conducted by some researchers as Gowane *et al.* (2015) in Malpura; Mahala *et al.* (2019) in Avikalin; Mallick *et al.* (2019) in Bharat Merino and Khan *et al.* (2020) in Corriedale sheep.

The aim of the currently examination is to ascertain the inheritable and nonhereditary variables influencing growth efficiency to accomplish produce knowledge that can be used to improve the breed through management actions.

2. MATERIAL AND METHODS

Data related to flock born at Institute for Central Sheep and Wool Research, ARC, Bichwal, Bikaner was gathered for this investigation on Chokla sheep's growth efficiency. Over a 47-year span, from 1974 to 2020, growth data of 6785 animals belonging to 459 sires were gathered from this institute's records using the available pedigree information. During two years in 2020, the investigation was carried out. at the Veterinary College of Bikaner in Division of Animal Breeding and Genetics.

2.1. The traits being studied and their estimation

2.1.1. Average daily gain (ADG)

The change in body size over time, known as average daily gain (ADG) and sometimes referred absolute growth rate (AGR), was calculated in g per day as follows

$$ADG = (ya_2 – ya_1)/(a_2 – a_1)$$

Where, ya_1 and ya_2 referring to body weights at a_1 and a_2 stages of life in days respectively (Fitzhugh and Taylor, 1971).

The age groups that were studied in this study were ADG1 (birth to weaning stage), ADG2 (weaning stage to 6 months of age), and ADG3 (6 months to 12 months of age).

2.1.2. Kleiber ratio (KR)

In order to address the problem of measuring animal efficiency in rangeland animals, Arthur and co-workers (2001) stated that the kleiber ratio was created as a substitute ratio. The Kleiber ratio, or KR, was computed as follows. The Kleiber ratio describes how much ADG affects metabolic body weight.

$KR=ADG/(Wt)^{3/4}$

Where,

ADG=Average daily gain for which age interval KR is calculated (gm per day)

$(Wt)^{3/4}$= The metabolic body weight when KR is calculated at an older age

Pre-weaning was defined as the period of growth from birth to three months, while post-weaning growth periods included intervals of three to six and six to twelve months.

2.2 The standardized and classified treatment of data

A Software called Pedigree Viewer was utilized to eliminate animals that are either duplicate or bisexual from the data sheet. These data were divided into eleven periods; spring (January–June) and autumn (July–December) seasons based on the time of year the lambs were born and male and female group based on the gender of lamb.

2.3. Estimating the outcomes of growth traits and the influences of inheritable and nonhereditary factors

Conduct an investigation to study the impact of various inheritable and nonhereditary factors on every trait, a generalised linear model (GLM) was used to fit single trait analyses by using the software Anonymous VERSION 26.0 (2005). The sire was a random effect, whereas all other nonhereditary factors, such as the lamb's gender, weight of ewe at lambing, birth year and season in which animal born were included as fixed effects.

$Y_{mnopd}=\mu+S_m+A_n+B_o+C_p+b\ (DW_{mnop}-DW)+e_{mnopd}$

Where, Y_{mnopd}=Growth performance record of the dth progeny of mth sire born in nth period, oth season belonging to pth gender ; μ=overall mean; S_m=random effect of mth sire; A_n=fixed effect of nth birth year (n=1, 2, 3...11); B_o=fixed effect of oth season in which animal born (o=1, 2); C_p=fixed effect of pth gender of lamb (p=1, 2); DW_{mnop}= weight of ewe at lambing; DW=mean weight of ewe at lambing ;b $(DW_{mnop}-DW)$=The regression of the corresponding trait on weight of ewe at lambing; e_{mnopd}=residual random error under standard assumption which make the analysis valid, i.e. NID $(0, \sigma^2)$

Duncan's multiple range test was used to compare the differences between the least-squares averages of each subclass (Kramer, 1957).

3. RESULTS AND DISCUSSION

The average daily weight gains for ADG1 (birth to weaning stage), ADG2 (weaning stage to 6 months of age), and ADG3 (6 months to 12 months of age) were predicted as 118.69±.55 gm day-1, 64.94±.70 gm day-1, and 30.60±.49 gm day-1, respectively, based on the overall least-squares means as shown in Table 1.

As shown in Table 2, their corresponding KRs were estimated as 16.42±0.04, 6.79±0.06 and 2.69±0.06. The information leads to the conclusion that maximizing growth occurred during the first 3 months of life, infants require nutrition from their mother's milk and care while; after that, grazing is what allows them to gain weight. The animal's metabolic weight growth, or feed conversion efficiency, is shown by the Kleiber ratio. Considering this trait in a selection program is crucial. This finding suggests that animals lose their weight efficiency with age.

The coefficient of determination (R^2) for all included age groups ADGs and KRs respectively, were 39.3%, 23.6%, and 23.0%; 30.5%, 16.5%, and 12.0%. How well the model fits the data is shown by the value of this coefficient.

3.1. The sire's influence on growth efficiency traits

The sire's impact on every trait was highly significant ($p \leq 0.01$), suggesting that there is additive genetic variability among them. As a result, further improvement of these traits can be achieved with the use of a superior sire.

sire's significant impact has also been observed by Devendran and coworkers (2010) in Madras Red sheep on growth efficiency during 0-3 and 6-9 month of age. Similarly, Khan *et al.* (2020) observed significant influence of sire on ADG and KR at different age intervals in Corriedale sheep.

3.2. Effect of birth year

At all age intervals investigation, the birth years were very significant ($p \leq 0.001$) source of variation impacting the quantifications of ADGs and KRs. The changes in the physical environment, the availability of feed forage for grazing in different years, and the ram selection process could all contribute to the variability in different traits throughout time.

Kindred findings exhibiting a paramount influence of birth year on pre and post weaning ADG were optically observed by Gowane *et al.* (2015), Prakash (2016), Balan *et al.* (2018), Dass *et al.* (2019), Mahala *et al.* (2019) and Khan *et al.* (2020) in Malpura, Chokla, Mecheri, Muzaffarnagri, Avikalin and Corriedale breed of sheep, respectively. Jeichitra and Rajendran (2014) in Mecheri, Mohammadi *et al.* (2015) in Lori, Mahala *et al.* (2019) in Avikalin, Mallick *et al.* (2019) in Bharat Merino and Khan *et al.* (2020) in Corriedale also observed significant impact of period of birth for all age groups KR.

3.3. Effect of season in which animal born

Season in which animal born had a highly significant (P≤0.001) impact on KRs and ADG measures across all age groups examined. In the pre-weaning stage, lambs born in the autumn had more ADG and KR than lambs born in the spring. This shows how the nutritional requirements, supplements, and feed and fodder availability fluctuate in between two seasons.

A Significant impact of season of birth was also reported by Gowane *et al.* (2015) in Malpura, Prakash (2016) in Chokla, Kumar *et al.* (2017) in Deccani, Balan *et al.* (2018) in Mecheri, Mahala *et al.* (2019) in Avikalin and Mallick *et al.* (2019) in Bharat Merino for pre and post weaning average daily gain.

Similarly, the significant impact of season of birth was reported by Kumar *et al.* (2017) in Deccani Mahala *et al.* (2019) in Avikalin and Mallick *et al.* (2019) in Bharat Merino on all KRs.

3.4. Impact of lamb's gender

The effect of the lamb's gender was remarkably substantial (p≤0.001) on all ADGs and KRs and males exhibited superior ADG and KR than females throughout the entire study period in present study. Physiological distinctions in between two genders and the male and female endocrine systems are the main factors that contribute to the effect of sex, which result in males being heavier and growing more expeditious than females. The consequential effect of gender of the lamb was consistent at pre and post weaning stages ADGs with the findings of several authors, viz. Gowane *et al.* (2015) in Malpura; Kumar *et al.* (2017) in Deccani, Parihar *et al.* (2017) in Magra, Balan *et al.* (2018) in Mecheri, Dass *et al.* (2019) in Muzaffarnagar Mallick *et al.* (2019) in Bharat Merino Mahala *et al.* (2019) in Avikalin and Khan *et al.* (2020) in Corriedale sheep. Paramount impact of gender of lamb was reported by Prakash *et al.* (2012) in Malpura, Gowane *et al.* (2015 in Malpura, Mohammadi *et al.* (2015) in Lori, Kumar *et al.* (2017) in Deccani, Mahala *et al.* (2019) in Avikalin Mallick *et al.* (2019) in Bharat Merino and Khan *et al.* (2020) in Corriedale, on all age groups KRs.

3.5. Regression of growth efficiency traits on body weight of ewe at lambing

With the exception of ADG2 and ADG3, the ewe's weight at lambing had a highly significant ($p\leq0.01$) influence on studied traits as shown in Table 1& 2. Non- consequential impact from the dam's weight could be attributed to the maternal effect being ineffective after weaning. It is suggested that during the pre-weaning stage, lambs with a higher dam body weight had higher daily gains. It is because heavier ewes produce more milk, and pre-weaning weight gain is mostly influenced by milk output. With the exception of KR2, every trait had a positive regression coefficient. The positive regression coefficient for every trait showed that growth traits would likewise increase if selection improved the ewe's weight at lambing.

This result is consistent with the findings of Prakash (2016) in Chokla in which he visually examined consequential effect of dam's weight for ADG1 and non-paramount for ADG2 and ADG3. Mallick *et al.* (2019) also observed significant effect of dam's weight on pre weaning ADG and KR in Bharat Merino. Mahala *et al.* (2019) reported significant effect of dams weight for 0-3 and 3-6 months of ADG while non-significant for 6-12 ADG in Avikalin sheep. Although, Lalit *et al.* (2016) in Harnali, Kumar *et al.* (2017) in Deccani and Dass *et al.* (2019) in Muzaffarnagari, found significant influence of dam's weight on all age intervals average daily gain.

Table 1: least squares mean with standard error (SE) of average daily gains for effect of genetic and non-genetic factors in Chokla sheep

Details	ADG1	ADG2	ADG3
Overall mean	118.69±.55 (5687)	64.94±.70 (4626)	30.60±.49 (3098)
sire	**	**	**
period	**	**	**
P1 (1974-1978)	$94.31^{a}\pm2.95$ (96)	$44.03^{a}\pm4.72$ (39)	$26.60^{ab}\pm3.93$ (12)
P2 (1979-1983)	$127.44^{ef}\pm2.44$ (143)	$46.80^{a}\pm2.86$ (110)	$23.90^{a}\pm1.66$ (70)
P3 (1984-1987)	$117.16^{d}\pm2.09$ (190)	$61.17^{c}\pm2.44$ (149)	$29.06^{b}\pm1.34$ (106)
P4 (1988-1991)	$126.95^{e}\pm1.62$ (333)	$59.51^{c}\pm1.89$ (257)	$21.22^{a}\pm1.29$ (118)
P5 (1992-1995)	$104.70^{b}\pm1.46$ (394)	$53.74^{ab}\pm1.64$ (333)	$30.54^{b}\pm.94$ (221)
P6 (1996-1999)	$107.30^{bc}\pm1.31$ (519)	$54.05^{b}\pm1.41$ (483)	$23.86^{a}\pm.80$ (333)
P7 (2000-2003)	$109.44^{c}\pm1.20$ (682)	$72.71^{e}\pm1.30$ (647)	$32.49^{b}\pm.78$ (404)

P8 (2004-2007)	130.84^{f}±1.15 (679)	66.70^{d}±1.24 (628)	31.87^{b}±.71 (450)
P9 (2008-2011)	123.45^{e}±.86 (1089)	92.09^{h}±.98 (899)	31.75^{b}±.52 (684)
P10 (2012-2015)	123.90^{e}±1.18 (727)	79.40^{f}±1.48 (524)	46.90^{d}±.86 (354)
P11 (2016-2020)	140.12^{g}±1.09 (835)	84.25^{g}±1.37 (557)	38.46^{c}±.81 (346)
season	**	**	**
Spring (January-June)	109.67±.55 (3845)	67.56±.70 (3287)	33.77±.48 (2281)
Autumn (July-December)	127.71±.83 (1842)	62.32±1.02 (1339)	27.43±.67 (817)
Sex of lamb	**	**	**
Male	123.34±.66 (2859)	74.15±.82 (2291)	35.10±.56 (1391)
Female	114.05±.66 (2828)	55.73±.82 (2335)	26.12±.53 (1707)
Ewe weight at lambing	**	NS	NS
Regression coefficient	3.65±.09	1.04±.10	.62±.05
R^2 (%)	39.3	23.6	23.0
Ewe weight as covariate(kg)	29.52	29.49	29.73

** highly significant (p≤0.01); NS–Not significant (p>0.05); Subclass means with different superscripts are significantly different from each other; ADG1=average daily gain from birth to weaning; ADG2=average daily gain from weaning to six months; ADG3=average daily gain 6–12 months of age

Table 2: Least squares mean with standard error (SE) of Kleiber ratios (KR) for effect of genetic and non-genetic factors in Chokla sheep			
Details	KR1	KR2	KR3
Overall mean	16.42±.04 (5687)	6.79±.06 (4626)	2.69±.06 (3098)
sire	**	**	**
period	**	**	**
P1 (1974-1978)	14.84^{a}±.17 (96)	5.39^{a}±.37 (39)	2.80^{bc}±.30 (12)
P2 (1979-1983)	17.06^{e}±.14 (143)	5.12^{a}±.22 (110)	2.29^{bcd}±.12 (70)
P3	16.33^{c}±.12	6.72^{cd}±.19	2.77^{c}±.10

(1984-1987)	(190)	(149)	(106)
P4 (1988-1991)	17.04^{e}±.09 (333)	6.20^{b}±.15 (257)	1.98^{a}±.09 (118)
P5 (1992-1995)	15.57^{b}±.08 (394)	6.25^{b}±.13 (333)	2.91^{c}±.07 (221)
P6 (1996-1999)	15.64^{b}±.08 (519)	6.33^{bc}±.11 (483)	2.37^{bc}±.06 (333)
P7 (2000-2003)	15.76^{b}±.07 (682)	7.90^{e}±.10 (647)	2.86^{c}±.06 (404)
P8 (2004-2007)	17.23^{e}±.07 (679)	6.77^{d}±.10 (628)	2.76^{c}±.05 (450)
P9 (2008-2011)	16.84^{de}±.05 (1089)	8.63^{f}±.07 (899)	2.54^{bd}±.04 (684)
P10 (2012-2015)	16.68^{d}±.07 (727)	7.61^{e}±.11 (524)	3.52^{e}±.06 (354)
P11 (2016-2020)	17.64^{f}±.06 (835)	7.74^{e}±.11 (557)	2.92^{c}±.06 (346)
season	**	**	**
Spring (January-June)	15.96±.03 (3845)	7.22±.05 (3287)	2.95±.03 (2281)
Autumn (July-December)	16.89±.05 (1842)	6.35±.08 (1339)	2.44±.05 (817)
Sex of lamb	**	**	**
Male	16.60±.04 (2859)	7.30±.06 (2291)	2.90±.04 (1391)
Female	16.24±.04 (2828)	6.27±.06 (2335)	2.52±.04 (1707)
Ewe weight at lambing	**	**	**
Regression coefficient	0.16±.005	-.03±.008	.002±.004
R2 (%)	30.5	16.5	12.0
Ewe weight as covariate(kg)	29.54	29.51	29.75

** highly significant ($p \leq 0.01$); NS – Not significant ($p>0.05$); Subclass means with different superscripts are significantly different from each other; KR1=Kleiber ratio from birth to weaning; KR2=Kleiber ratio from weaning to six months; KR3=Kleiber ratio from 6 to 12 months

4. CONCLUSION

The gains in body weight per day and kleiber ratio demonstrated that the growth rate peaked between the ages of one and three months, after which it began to decline, suggesting that the growth rate during the juvenile stage was higher than that during the post-weaning period. To achieve improved growth performance of lambs, farm management should be focused on monitoring non-genetic parameters, such as lambing season, lamb sex, and ewe weight at lambing.

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