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Genetic Study on Relative Growth Rate in Sirohi Goats under Field Condition

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A B S T R A C T

A study was conducted to estimate the pre- and post-weaning relative growth rates (RGR) in Sirohi goats born during 2005 to 2017 under field conditions. The overall least-squares mean for pre-weaning (0-3M) and post weaning (3-12M) relative growth rate were 1.79±0.02 and 0.263±0.005 percent per day, respectively. Sire, type of birth, sex of kid and cluster had highly significant (P≤0.01) effect on both pre- and post-weaning relative growth rates whereas season of birth and parity had highly significant effect (P≤0.01) only on pre-weaning relative growth rate. Year of birth had highly significant effect (P≤0.01) on pre-weaning relative growth rate whereas its effect was significant (P≤0.05) on post-weaning relative growth rate. Heritability estimates for pre- and post-weaning relative growth rate were 0.58±0.06 and 0.40±0.06. Genetic and phenotypic correlation between two traits was negative.

Introduction

Among all species of farm animals, Goats have the widest ecological range and have been poor people's most reliable livelihood resource since their domestication. Goat plays a significant role in providing supplementary income and livelihood to millions of resource poor farmers and landless laborers of rural India. Sirohi goat breed is distributed in central and southern Rajasthan covering the Arawali hills area. It has the quality of disease resistance, adaptability in dry and hot climates and ability to perform under adverse climatic conditions.

Goats are basically meat animals and meat production is affected by growth rate. Hence, the studies on growth in the animal production have been increasing and commercial goat rearing has drawn big attention during last few decades. Rapid

growth until slaughter weight is an important goal for increased meat production. Growth rate at different ages help to determine the right marketable age of kids' for higher economic return and carcass quality. Higher growth rate in goat farming is essential not only for profit but also for higher production and reproduction efficiency. It facilitates better survivability and faster genetic improvement by decreasing generation interval and increasing replacement rate (Singh *et al.*, 2009). Within the limits set by the hereditary factors, rate of growth has a direct bearing on the age of maturity, which is a genetic trait, and is correlated with lifetime production and reproduction. Growth rate is a useful check of the system of feeding and management (Sharma, 2005).Growth rate traits also indicate about feeding, management or health conditions of animals.

Relative growth rate (RGR) is the true measure of growth rate and expresses the percent weight gain per unit of time. It eliminates the physiological and physical unit of time and can be directly used for comparing growth of individual with widely different weights or even across species (Sharma, 1994). It is essential to have knowledge of genetic parameters for these economically important traits to formulate optimum breeding strategies for better production. Growth traits are influenced by direct additive genetic effect. Keeping in view the above economic consequences of growth traits, the present investigation was planned to estimate the pre- and post-weaning relative growth rate and genetic and non-genetic factors affecting them with genetic parameters in Sirohi goats under field condition.

Materials and Methods

The data were collected from farmers' flock of Sirohi goat registered under ICAR sponsored All India Co-ordinated Research Project (AICRP) on goat improvement, Sirohi Field Unit, Livestock Research Station, Vallabhnagar, Udaipur, Rajasthan during the period 2005 to 2017. The animals with known pedigree and complete records were included for this study.The Sirohi goats are being maintained under field grazing (Extensive system) in project area. Goats remained on pasture every day six to eight hours for grazing. Kids are weaned at the age of 3 months.

For the study, sire was taken as random effect whereas year of birth, season of birth, sex of kid, type of birth, cluster and parity were taken as fixed effects. Season of birth was classified as rainy (July- October), winter (November- February) and summer (March-June). Sex was classified as male and female, type of birth as single and multiple, cluster as Vallabhnagar, Railmagra, Deogarh, Nathdwara, Bhadsoda, Karget, Bojunda and Salumber and Parity as 1 to 5.

Relative growth rate was calculated by following formula:-

$RGR = (\log_e W_2 - \log_e W_1) \times 100 / (t_2 - t_1)$ percent per day

Where
W_2 = Body weight at t_2 time
W_1 = body weight at t_1 time

Since the subclass numbers were unequal and disproportionate, data were analyzed through Mixed Model Least-Squares and Maximum Likelihood method designed by Harvey (1990) to estimate the least-squares means and genetic parameters.

The model used for analysis was as follows:

$$Y_{ijklmnop} = \mu + A_i + B_j + C_k + D_l + E_m + F_n + G_o + e_{ijklmnop}$$

Where,

$Y_{ijklmnop}$ = performance record of the p^{th} progeny of i^{th} sire belonging to j^{th} cluster, k^{th} season of birth, l^{th}year of birth, m^{th} parity, n^{th} type of birth and o^{th} sex.

μ = Population mean

A_i= Random effect of sire

B_j= Fixed effect of j^{th} cluster (j = 1,2,3,4,5,6,7,8)

C_k= Fixed effect of k^{th} season of birth (k = 1, 2, 3)

D_l= Fixed effect of l^{th} year of birth (l = 1, 2, 3, 4…13)

E_m= Fixed effect of m^{th} parity (m= 1,2,3,4, ≥ 5),

F_n= Fixed effect of n^{th} type of birth(n = 1, 2)

G_o= Fixed effect of o^{th} sex(o = 1, 2)

$e_{ijklmnop}$= Residual random error associated with $Y_{ijklmnop}$ and assumed to be identically and independently distributed with mean zero and constant variance.

Duncan's Multiple Range Test (DMRT) as modified by Kramer (1957) was used to make pair wise comparison among the least squares means.

Results and Discussion

The overall least-squares mean for pre-weaning (0-3M) and post weaning (3-12M) were 1.79±0.02 and 0.263±0.005 percent per day, respectively which are shown in Table 1. These results revealed that relative growth rate was higher during suckling stage than post weaning period. This might be due to effect of dam's milk during suckling stage which serves as a complete nutritious food for kid. The finding during pre-weaning period was in close agreement with Khadda (2017) in Pantja goats as 1.75±0.02 percent per day. However higher estimates was recorded by Sharma (2005) in Sirohi goats as 1.89±0.04 percent per day and lower estimates byMenezes *et al.,* (2016) as1.30±0.03 percent per day in Boer goats during 0-3M. The mean during post-weaning period was similar to Kesbi and Eskandarinasab (2018) as 0.224 in Afshari sheep. Variation in performance might be due to difference in population under study.

Effect of sire

Sire had highly significant effect (P≤0.01) on pre- and post-weaning relative growth rates in Sirohi goats under field condition. Similar results were found by Sharma (2005) in Sirohi goats and Khadda (2017) in Pantja goats.

Effect of year of birth

Year of birth had highly significant effect (P≤0.01) on pre-weaning relative growth rate whereas its effect was significant (P≤0.05) on post-weaning relative growth rate. Pre-weaning relative growth rate was the maximum in year 2017 whereas it was the minimum in year 2007. Post-weaning relative growth rate was higher in year 2011 whereas it was the minimum in year 2006. Thus, it was clear that relative growth had somewhat increasing trend from 2005 to 2017 which might be due to continuous selection programme. The difference in performance for RGR over the years may be due to variation in climatic conditions and availability of forage.

Sharma (2005) also recorded highly significant effect of year of birth on RGR (0-3M) in Sirohi goats, Kesbi and Tari (2015) in Zandi sheep, Kesbi and Gholizadeh (2017) in Baluchi sheep and Kesbi and Eskandarinasab (2018) in Afshari sheep on RGR1 (0-3M) and RGR2 (3-12M).

Effect of season of birth

Season of birth had highly significant effect (P≤0.01) on pre-weaning RGR but non-significant on post-weaning RGR. For 0-3M

age, RGR was higher of kids born during winter or summer season and lower in rainy season which might be due to more stress condition and parasitic load in rainy season. Sharma (2005) in Sirohi goats and Jeichitra *et al.,* (2014) in Mecheri sheep also reported significant effect of season of birth on RGR (0-3M). However, non-significant effect of season was reported by Devendra *et al.,* (2014) in Madras red sheep and Khadda (2017) on RGR (0-3M) in Pantjagoats.

Effect of type of birth

Type of birth had highly significant (P≤0.01) effect on both pre- and post-weaning relative growth rates in Sirohi goats. For both age durations, kids born as multiples had higher relative growth rate than single born due to compensatory growth phenomenon. Similar findings were recorded by Khadda (2017) in Pantja goats, Kesbi and Tari (2015) in Zandi sheep, Kesbi and Gholizadeh (2017) in Baluchi sheep and Kesbi and Eskandarinasab (2018) in Afshari sheep. Contrary to this, Sharma (2005) found non-significant effect of type of birth on RGR (0-3M) in Sirohi goats.

Effect of sex of kid

Sex of kid had highly significant (P≤0.01) effect on both pre- and post-weaning relative growth rates in Sirohi goats. During 0-3M age, female had higher RGR whereas during 3-12M, RGR was higher in males.It might be due to compensatory growth effect in females during pre-weaning stage and increase in testosterone hormone level in males during post-weaning period.

The results were in concordance with Devendra *et al.,* (2014) in Madras Red sheep for RGR (0-3M), Kesbi and Tari (2015) in Zandi sheep, Kesbi and Gholizadeh (2017) in Baluchi sheep, Kesbi and Eskandarinasab (2018) in Afshari sheep and Kadda (2017) in Pantja goats. Non-significant effect of sex was observed by Sharma (2005) in Sirohi goats, Menezes *et al.,* (2016) in Boer goats and Jeichitra *et al.,* (2014) in Mecheri sheep on RGR(0-3M). The difference may be due to variation in population under study.

Effect of cluster

Cluster had highly significant (P≤0.01) effect on both pre- and post-weaning relative growth rates in Sirohi goats. For RGR (0-3M) Railmagra was first whereas Karget stood first regarding post-weaning RGR. Sharma (2005) found similar results for Sirohi goats. The estimate of post-weaning RGR for cluster 'Salumber' could not be calculated due to non-availability of 12M body weight data.

Effect of parity

Parity had highly significant (P≤0.01) effect on pre-weaning RGR whereas its effect was non-significant on post-weaning RGR. Relative growth rate was higher in kids born in early parities which might be due to optimum physiological stamina of dam during early age to produce more milk. After weaning, growth rate chiefly depends on grazing that's why; the effect of parity in post weaning RGR was non-significant.

However, Sharma (2005) in Sirohi goats and Khadda (2017) in Pantja goats did not find significant effect of parity on pre-weaning RGR which may be due to spatial or temporal difference in sample.

Genetic parameters

Heritability estimates of both traits were estimated from sire component of variance by paternal half sib relationship by Mixed Model Least-Squares and Maximum Likelihood method designed by Harvey (1990).

Table.1 Least square means (±SE) of Relative growth rate (percent per day) in Sirohi goat

Effect	RGR1 (0-3M)	RGR2 (3-12M)
Overall	1.79±0.02 (6748)	0.263±0.005(3070)
Sire	**	**
Year of birth	**	*
2005	1.66±0.03^{a} (321)	0.255±0.011^{abc}(191)
2006	1.69±0.03^{b} (395)	0.251±0.009^{a}(183)
2007	1.64±0.03^{a}(467)	0.267±0.008^{ef}(305)
2008	1.73±0.02^{c}(566)	0.253±0.008^{ab}(267)
2009	1.84±0.02^{e}(540)	0.253±0.007^{ab}(189)
2010	1.84±0.02^{e}(473)	0.263±0.008^{bdf}(209)
2011	1.88±0.02^{fg}(528)	0.274±0.008^{f}(203)
2012	1.86±0.02^{ef}(602)	0.264±0.007^{cef}(218)
2013	1.78±0.02^{d}(417)	0.267±0.007^{ef}(177)
2014	1.79±0.02^{d}(385)	0.260±0.009^{ade}(192)
2015	1.86±0.03^{ef}(757)	0.272±0.009^{f}(348)
2016	1.84±0.03^{e}(774)	0.271±0.009^{f}(358)
2017	1.89±0.03^{g}(523)	0.271±0.01^{df}(230)
Season of birth	**	NS
Rainy- July to Oct	1.78±0.02^{a}(2450)	0.261±0.005(1037)
Winter-Nov to Feb	1.80±0.02^{b}(3039)	0.264±0.005(1470)
Summer- March to June	1.80±0.02^{b}(1259)	0.264±0.005 (563)
Type of birth	**	**
Single	1.66±0.02^{a}(4423)	0.251±0.005^{a}(2199)
Multiple	1.93±0.02^{b}(2325)	0.275±0.005^{b}(871)
Sex	**	**
Male	1.78±0.02^{a}(3366)	0.269±0.005^{b} (1002)
Female	1.80±0.02^{b}(3382)	0.257±0.005^{a} (2068)
Cluster	**	**
Vallabhnagar	1.92±0.03^{de}(289)	0.247±0.013^{c}(54)
Railmagra	2.03±0.02^{f}(834)	0.233±0.008^{bc}(328)
Devgarh	1.90±0.02^{d}(3275)	0.229±0.008^{b}(1905)
Nathdwara	2.02±0.03^{f}(169)	0.189±0.015^{a}(40)
Bhadsoda	1.94±0.02^{e}(1333)	0.270±0.008^{d}(311)
Karget	1.31±0.03^{a}(319)	0.408±0.011^{e}(169)
Bojunda	1.36±0.03^{b}(436)	0.265±0.010^{d}(263)
Salumber	1.86±0.04^{c} (93)	----
Parity	**	NS
1	1.82±0.02^{c}(1513)	0.266±0.005(802)
2	1.80±0.02^{b}(1346)	0.263±0.005(632)
3	1.80±0.02^{b}(1201)	0.264±0.005(537)
4	1.78±0.02^{a}(891)	0.261±0.005(403)
5 & above	1.78±0.02^{a}(1797)	0.261±0.005(696)

Heritability estimates for pre- and post weaning relative growth rate were 0.58±0.06 and 0.40±0.06. The results showed that pre- and post weaning RGR are medium to high heritable traits. The heritability estimates provides a scope that individual selection alone may be used for selection in case of non-availability of other information.

Lower estimates of heritability were reported by Sharma (2005) in Sirohi goats as 0.352±0.123 and Khadda (2017) in Pantja goats as 0.22±0.08 for RGR (0-3M). For RGR (3-12M), lower estimates were reported by Kesbi and Tari (2015) as 0.12±0.04 in Zandi sheep, Kesbi and Gholizadeh (2017) in Baluchi sheep as 0.05±0.02, Kesbi and Eskandarinasab (2018) in Afshari sheep as 0.05±0.02which may be due to spatial or temporal difference in sample.

The genetic correlation between two traits was -0.71±0.10 whereas phenotypic correlation was -0.46. thus both the correlation were negative showing that kids having higher RGR in pre-weaning stage had lower RGR during post-weaning stage which might be due to compensatory growth effect. Similar findings were reported by Sharma (2005) in Sirohi goats, Khadda (2017) in Pantja goats, Kesbi and Tari (2015) in Zandi sheep, Kesbi and Gholizadeh (2017) in Baluchi sheep and Kesbi and Eskandarinasab (2018) in Afshari sheep.

In conclusion, the present investigation revealed that in Sirohi goats, pre-weaning relative growth rate was very higher than post-weaning relative growth rate. Multiple born kids had higher relative growth rate which suggest for setting of breeding plan to get multiple births which would provide more economic gain to farmers. Medium to high heritability of relative growth rate offer a scope for individual selection for further genetic improvement.

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