Feed intake, feed efficiency, growth and their relationship with Kleiber ratio in Lori-Bakhtiari lambs

M. A. Talebi[1]

Department of Animal Science, Agriculture and Natural Resources Research Center, Shahrekord, Iran

SUMMARY

The aim of the present study was to investigate feed intake, feed efficiency and gain in feedlot Lori-Bakhtiari lambs and their relationship with post-weaning Kleiber ratio. Data recording was performed on 92 male lambs from Lori-Bakhtiari sheep breeding station. The lambs were weaned at 90 ± 5 days of age. After weaning, lambs remained in drylot until end of finishing at six months of age. Data were analyzed using statistical analysis system software. Average and standard deviation feedlot traits were 50.76 ± 5.33, 1.71 ± 0.14, 8.81 ± 2.60 and 10.77 ± 2.15 for final body weight (FBW), daily feed intake (DFI), feed conversion ratio (FCR), and Kleiber ratio in feedlot period (KR). The correlations among FBW and DFI, KR, feed efficiency (FE), gain in feedlot (GF) were high and positive and ranged from 0.54 to 0.81. The correlation between Kleiber ratio and daily feed intake was 0.47 ± 0.03. Feed efficiency and gain in feedlot had strong positive correlations with Kleiber ratio (0.95 and 0.81). Feed conversion ratio and Kleiber ratio had a strong negative correlation (-0.88). In concluded, increasing Kleiber ratio in post weaning can be lead to improve the feed efficiency and gain.

Keywords: feed intake, feed efficiency, growth, Kleiber ratio, sheep

INTRODUCTION

For all livestock production systems feed is a major expense, ranging from 60 to 80% of the total costs across the most common farm animals species (Montanholi et al., 2008). It is accepted that feed intake and growth are the most important economic components when calculating profitability in a growth period. The inclusion of feed intake and gain information in selection decisions would facilitate genetic improvement of efficiency and profitability of meat sheep production. In order to include efficiency of feed intake and gain information in selection decisions, appropriate measurements of these traits

[1] Corresponding author e-mail: maitalebi@yahoo.com

are required. Feed intake is an economically important trait that is difficult to measure in the all production systems (Ponzoni, 1986). Therefore, the Kleiber ratio, defined as growth rate/metabolic weight, has been suggested to be a useful indicator of growth efficiency and an indirect selection criterion for feed conversion (Kleiber, 1947; Köster et al., 1994). Scholtz et al. (1990) indicated that the Kleiber ratio, expressed as post-weaning average daily gain/mature mass$^{0.75}$, could be used as an indirect selection parameter for feed conversion. Arthur et al. (2001) reported that the Kleiber ratio is highly correlated (r = -0.81) with feed conversion efficiency in beef cattle. Phenotypic correlation between pre-weaning average daily gain and pre-weaning Kleiber ratio were reported to be 0.93 in Dormer sheep by Van Wyk et al. (1993). Abegaz et al. (2005) estimated a phenotypic correlation of 0.41 between post-weaning Kleiber ratio and body weight at six months of age in Horro sheep. Snowder and Duckett (2003) showed that feed efficiency did not differ among breed types considered in their study.

Lori-Bakhtiari is a fat-tailed breed of sheep, with a population more than 1.7 million, which is well adapted to hilly and mountain ranges of Bakhtiari region, west of Isfahan stretched out to Southern Zagros Mountain. Relative to other Iranian fat-tailed breeds Lori-Bakhtiari is a large breed, reared for meat production (Talebi et al., 2007). Profitability of sheep production for meat depends to a great extent on lamb growth, carcass traits and feed efficiency. The objective of this study was to estimate feed intake, feed efficiency and gain in feedlot and investigate their relationship with Kleiber ratio in Lori-Bakhtiari male lambs at six months of age.

Material and Methods

This study was carried out with 92 male lambs from Lori-Bakhtiari sheep breeding station in Chaharmahal and Bakhtiari province, Iran. Data were included initial body weight (IBW), final body weight in feedlot (FBW), daily feed intake (DFI), feed conversion ratio (FCR), feed efficiency (FE), Kleiber ratio in feedlot period (KR), gain in feedlot (GF) and daily gain feedlot (DGF). The station flock was kept generally from December to May inside the barn and the sheep were fed with alfalfa, barley and wheat stubbles, and they were grazed on range and cereal remainder in other months of the year.

The breeding season was from late August to late October and ewes were assigned randomly to the rams. About 15 days after parturition, the lambs were creep-fed during the suckling period. The creep-ration consisted of 50% barley, 10% cotton seed meal, 20% wheat bran, 18% dried sugar beet pulp, 1% bone meal, 0.5% salt and 0.5% vitamin, mineral and antibiotic supplement. The

ration was ground, mixed and fed *ad libitum*. Lambs had also access to free choice alfalfa hay.

The lambs were weaned at 90 ± 5 days of age, of which their body weights were measured and recorded. After weaning, female lambs were kept on pasture and male lambs remained in drylot until end of finishing. Individual pens were 1× 3 m. All male lambs were adjusted over a 14 days period. Similar environmental and husbandry conditions were provided to the lambs. During the study the lambs were routinely checked for any health problems. They were drenched against internal parasites at specific intervals and vaccinated against enterotoxaemia diseases. Lambs were individually fed for 80 $\pm$ 9 days to measure individual feed efficiency. The ration in feedlot, fed to male lambs, contained alfalfa hay, barley, dried sugar beet pulp, wheat bran, cotton seed meal, salt and mineral supplements, which were ground and mixed. The feedlot ration fed *ad libitum*. The diet contained 14.04% crude protein, 2.50 MCal ME/Kg dry matter and 7.4% Ash. Fresh water was freely available. Body weight of individual lambs was recorded at the start and end the feedlot period, and average daily gain for each animal was calculated from the difference between the start and the end of feedlot body weight divided by the number of days on feedlot. At the end of the feedlot period, lambs were weighed after fasting for 18 h with free access to water.

Feed consumption was recorded weekly with a scale sensitive to 0.1 kg. Daily feed intake was measured on a dry matter basis by the difference between supplied and leftover feed, and feed conversion ratio was calculated as average feed intake divided by average daily gain. The Kleiber ratio was computed as the ratio of average daily gain in feedlot period ($ADG_{feedlot\ period}$) to metabolic body weight ($BW^{0.75}$) in end the feedlot period. Data were analyzed using statistical analysis system software (SAS, 2002) and were expressed as mean, standard deviation (SD) and phenotypic correlations between traits. Standard error of phenotypic correlations was calculated by using the formula of $[\sqrt{(1-r^2)}/(n-2)]$, where r^2 is phenotypic correlation and n the equal to sample size.

RESULTS AND DISCUSSION

The average, standard deviation and coefficients of variation for IBW, FBW, DFI, FCR, FE, KR, GF and DGF of the lambs are presented in Table 1. Lambs had DFI of about 1.71 kg/d, FCR of 8.81 kg of feed per kg of gain and FE of 12.03 kg of gain per kg of feed. The average for feed efficiency in this study was in the range reported by Snowder and Duckett (2003) that indicated means 10, 12 and 11 for FE in Columbia, Dorper and Suffolk sire breed, respectively. Kleiber ratio was 10.8 for feedlot period in Lori-Bakhtiari lambs.

Abegaz et al. (2005) reported 4.4 for post-weaning Kleiber ratio in Horro sheep. The highest values of the Kleiber ratio indicate increases in weight gain with the same metabolic weight ($BW^{0.75}$), that means that higher growth is obtained without the increase in the cost of energy for maintenance (Tedeschi et al., 2006).

The coefficients of variation for DFI, FCR, FE, KR, GF and DGF were 7.95, 29.52, 21.70, 20.01, 26.80 and 24.43 percent, respectively. The coefficient of variation for FBW was 10.5 percent, which was in the range (10.6 to 12.8%) reported by Safari et al. (2005) for post weaning weight in sheep breeds. The coefficient of variation for daily feed intake was low. Average coefficient of variation for feed intake in sheep breed was reported 20.3% by Safari et al. (2005) that is very higher then coefficient of variation for feed intake in this study. It is important to note, that considerable variation exists for FCR, FE, KR, GF and DGF traits.

Table 1. Descriptive statistics of the performance, feed conversion ratio, feed efficiency and Kleiber ratio traits considered in the study

Trait acronym	Trait	No. of records	Means ± S.D.	C.V. (%)
IBW	Initial body weight (kg)	92	34.2 ± 3.2	9.3
FBW	Final body weight in feedlot (kg)	92	50.8 ± 5.3	10.5
DFI	Daily feed intake (kg/d)	92	1.7 ± 0.1	8.0
FCR	Feed conversion ratio	92	8.8 ± 2.6	29.5
FE	Feed efficiency	92	12.0 ± 2.6	21.7
KR	Kleiber ratio	92	10.8 ± 2.2	20.0
GF	Gain in feedlot (kg)	92	16.6 ± 4.5	26.8
DGF	Daily gain feedlot (g/day)	92	206 ± 50	24.4

Phenotypic correlations and standard error among FBW, DFI, FCR, FE, KR, GF and DGF are shown in Table 2. Coefficients of correlation indicate the association grade (low < 0.40 < average< 0.70 < high) and direction (positive/negative) of the relationship between two random variables. The phenotypic correlations among FBW and DFI, FE, KR, GF were significantly high and positive and ranged from 0.54 to 0.81. Improvement in final body weight and gain in feedlot is associated with some increase in feed intake. This estimate indicates that lambs having potential to grow faster will also utilize and convert feeds more efficiently than slow growing lambs. The high and negative correlation (-0.63) between FBW and FCR is considered a favorable indication for the possibility of simultaneous improvement of gain and feed efficiency. Similarly, the negative phenotypic correlation between feed efficiency and FBW and GF indicates that fast growing lambs have better feed utilization. Aziz et al. (1995) reported that individual selection can be an

appropriate method for selection for better feed efficiency, lower feed intake and higher gain among Awassi lambs during the post-weaning period. The correlation between FBW and post-weaning Kleiber ratio was 0.54 ± 0.03. Abegaz et al. (2005) indicated that phenotypic correlation of 0.41 and 0.69 between post-weaning Kleiber ratio and body weight at six months of age and average daily gain in Horro sheep.

Table 2. Phenotypic correlation (± standard error) between growth, feed intake, feed efficiency and Kleiber ratio in Lori-Bakhtiari male lambs

Trait	FBW	DFI	FCR	FE	KR	GF
FBW	1	-	-	-	-	-
DFI	0.66 ± 0.02***	1	-	-	-	-
FCR	-0.63 ± 0.02***	-0.40 ± 0.04***	1	-	-	-
FE	0.62 ± 0.02***	0.30 ± 0.05***	-0.90 ± 0.01***	1	-	-
KR	0.54 ± 0.03***	0.47 ± 0.03***	-0.88 ± 0.01***	0.95 ± 0.01***	1	-
GF	0.81 ± 0.01***	0.63 ± 0.02***	-0.77 ± 0.01***	0.82 ± 0.01***	0.81 ± 0.01***	1
DGF	0.73 ± 0.02***	0.57 ± 0.03***	-0.86 ± 0.01***	0.95 ± 0.01***	0.96 ± 0.01***	0.90 ± 0.01***

*** Significant at level 0.001

Feed efficiency, gain in feedlot and daily feed intake had strong positive phenotypic correlations with Kleiber ratio. Feed conversion ratio and Kleiber ratio had a strong negative phenotypic association (-0.88 ± 0.01). There are very few reports in the literature on phenotypic correlations among Kleiber ratio and measures of feed intake and efficiency feed consumption in sheep. Greeff et al. (1993) found a negative phenotypic correlation between Kleiber ratio and feed conversion ratio (-0.79) when the animals had reached 50 kg live mass. Arthur et al. (2001) reported that the Kleiber ratio is highly correlated (r = -0.81) with feed conversion efficiency in beef cattle. Badenhorst (1990) reported that the correlation between average daily gain and feed efficiency consumption during feedlot period was only 0.64 in comparison with the correlation of 0.87 between the Kleiber ratio and efficiency of feed consumption. In this case the Kleiber ratio therefore predicted feed conversion 36% more accurately than average daily gain. Hoque et al. (2007) obtained high phenotypic correlation of FCR with KR (-0.76) for Japanese Black cattle. As well they have concluded, selection for Kleiber ratio will improve most of the energetic efficiency traits (feed conversion ratio and relative growth rate) with

no effect on feed intake traits (daily feed intake and TDN intake). In general, estimates of correlation between any pair of traits suggest that selection for one trait can lead to an indirect response in the other trait.

Conclusions

It is important to note, that considerable variation exists for FCR, KR, GF and DGF traits. Improvement in final body weight and gain in feedlot is associated with some increase in feed intake. The Kleiber ratio can be used as a reliable indication of efficiency, especially for gain and feed efficiency under feedlot conditions. In concluded, increasing Kleiber ratio in post weaning can be lead to improve the feed efficiency and gain.

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