The effects of feed restriction severity on compensatory growth of goat kids in Bushehr Province Iran[1]

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ABSTRACT: In order to study the effects of the different severity of feed restriction and consequence compensatory growth on carcass and diet digestibility of goats and possibility use of this strategy in alternate droughts and feeding cost reduction, 40 black native goat kids (about 7 to 8 month old) were used. All goat kids were divided randomly into 4 groups in a CRD plan: 1) Control 2) M=Maintenance 3) SM1=Sub-maintenance 1 and 4) SM2=Sub-maintenance 2 with the same feed of control group in the re-alimentation period. Each group had 10 replicates (goats). Control group were fed with a ration supporting 50 gr of daily weight gain and restricted groups were fed with a maintenance ration. The duration of restriction was considered 75 days and after that feeding with controlled concentrate and ad libitum straw feeding started until the average of restricted goats approached that of control. The results showed that there was not significant difference in carcass DM and gross energy (P>0.05). Significant increase in carcass ash of M group rather than other groups was observed (P<0.05). Ether Extract of control (39.28) and SM2 (39.64) were significantly increased (P<0.05). Feed restriction severity significantly decreased digestibility of DM, OM, CP and gross energy (P<0.05) whereas after re-feeding (compensatory growth), there was not significant effect in DM, OM, CP, Ether Extract and gross energy (P>0.05). There was significant difference in pelvic fat weight (P=0.06) and percentage of pelvic fat/EBW (P=0.07).

Key words: severity restriction, carcass, compensatory growth, digestibility, goat kids

INTRODUCTION

Goats are able to thrive in a variety of environments, many of which entail periods of low nutrient intake. Low nutritional planes reduce heat production or energy expenditure (EE) by cattle and sheep (Freetly et al., 2002, 2003). Reduced EE has also been observed in desert goats with sever feed restriction (Silanikove, 1986, 1987; Choshniak et al., 1995). Food restriction and compensatory growth are an important phenomenon in temperate conditions with food shortage in winter and re-alimentation in spring and summer (lason et al., 1993). Conversely in arid and semi-arid areas, food shortage occurs in summer associated with thermal stress. Stubble grazing is the main food resource; animals have to walk to find food, increasing their maintenance energy requirement. Studies on the compensatory phenomenon in temperate regions are abundant, but information about this phenomenon in sheep of semi-arid condition is lacking (Mahouachi and Atti, 2005). Sheep production systems, in arid and semi-arid areas, depend in mostly on natural vegetation of range and farm lands. Seasonal fluctuations cause a periodical restriction in food quality and quantity. The natural food restriction may be resolved by supplementary feeding. Alternatively, the growth may be delayed until an adequate food supply is available in the next wet season when there will also be beneficial compensatory effects (Keenan et al.,1969; Drew and Reid, 1975; Kamalzadeh and Aouladrabiei., 2009), in terms of food intake and growth.

Goats are important grazing ruminants in many countries that face periodic shortages of feed availability in their natural habit. There are about 25 million goats in Iran which are mainly dependent

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on natural vegetation and crop residues. The objective of this study was to evaluate the effects of severity of feed restriction and consequence compensatory growth and possibility use of this strategy in alternative droughts and feeding cost decrease in goat fattening.

MATERIALS AND METHODS

The experiment was conducted at Tangestan Animal Science Station, Bushehr province, I. R. Iran located at 29˚ 59′ 30 ″ N latitude and 51˚ 16′ 30 ″ E longitude, 80 m above mean sea level. The climatic condition of the location is hot and semi-arid.

Forty native male goats (8- month- old; 20.67 ± 0.74 kg body weight) were used. The animals were came from one of the flocks established for preservation and breeding of local livestock in Dashtestan area, Bushehr province, Iran. They were initially fed for 30 days with a mixed ration which was calculated to supply the maintenance requirement as well as a daily gain of 50 g (NRC, 1981). The goats were randomly allotted into four groups of 10 animals. The duration of feed restriction considered 75 days (Dashtizadeh, et al., 2008). The treatments were; 1) Control (C), 2) Maintenance (M) 3) 15% under maintenance (SM1) 4) 15% under maintenance with equal diet of control group in the re-alimentation period. The goats of control group were fed with a ration that supplied the requirements for maintenance as well as 50 g daily gain. Table 1 shows the treatments diet. The M, SM1 and SM2 in the restriction period did not consume barley (concentrate). Water was freely available at all times.

Table 1. The ingredients and chemical composition of experimental feeds

	Feed restriction period				Re-alimentation period		
	C	M	SM1	SM2	M	SM1	SM2
Composition							
Crude protein, g/kg DM	55.4	42	35.73	35.73	49.7	49.7	55.4
Metabolizable energy, Mcal/ kg DM	1.37	1.027	0.873	0.873	1.23	1.23	1.37
Ingredients, g							
Wheat straw	248	479	408	408	231	231	248
Alfalfa hay	50	165	140	140	50	50	50
Barley	292	-	-	-	251	251	292
Salt	10	10	10	10	10	10	10
MVS*	10	10	10	10	10	10	10

* MVS: Mineral-Vitamin-Supplement (Containing): 500000 IU Vit A,100000 IU Vit D3, 0.1 gr Vit E, 180 gr Ca, 90 gr P, 20 gr Mg, 60 gr Na, 2 gr Mn, 3 gr Fe, 0.3 gr Cu, 3 gr Zn, 0.1 gr Co, 0.1 gr I, 0.001 gr Se, 3 gr Antioxidant.

During the experiment, the apparent digestibilities were measured in two separate stage of 10 days. Digestibilities were measured in two periods; the median of restricted feeding period (35 to 45 days) and one month after re-alimentation period had begun. For measuring digestibility, 4 goats from each treatment were housed in individual cages. Samples from rations, refusals, and faeces were taken daily to measure digestibility. Refusals were collected daily at 08.00 h, weighed, sampled, and then stored. Total daily faecal output for each animal was collected, weighed and homogenized. Then two samples, one of 100 g was dried for 24 h at 105 ˚C to measure faecal DM and second of 40 g was kept at -15˚ C (Atti, et al. 2004). Apparent digestibility of DM, OM, CP, EE, and GE of diets were determined (Givens et al. 2000).

At the end of experiment five goats in each group were slaughtered. The goats were slaughter according to the local practices (Zamiri and Izadifard, 1994). Complete carcasses were freezed and then minced and mixed thoroughly and samples were kept at -20 ˚C until analyzed (AOAC. 1975) for dry matter, ether extract (fat) and nitrogen contents (expressed as crude protein).

Samples of meat, hay and portions of individual pooled samples of refusals and faeces were dried (50˚ C), ground (1 mm screen), and stored for subsequence analysis. DM was determined by drying at 105 ˚

C for hay (feed and refusal) and 80 ˚C for meat and faeces until constant weight. Nitrogen in hay, concentrate, meat and faeces was determined by kjeldahl method (CP= N × 6.25).

RESULTS AND DISCUSSION

Carcass Chemical Composition

Chemical characteristics of carcass determined on whole carcass are given in Table 2. There were not significantly differences in DM, CP and GE of the treatments. Carcass of goats fed restricted diet contended more ash (P<0.05) and carcass of goats fed maintenance diet had higher EE percentage compared to meat of goats from other diet groups.

Table 2. Effects of different feed restriction severity and re-alimentation on chemical composition of whole carcass in goats (mean±SD)

	Treatments				
	Control	M	SM1	SM2	Diet effect
No. of goats	5	5	5	5	-
DM, %	37.50 ± 2.35 [a]	37.06 ± 2.48 [a]	35.50 ± 2.02 [a]	37.73 ± 2.2 [a]	NS
CP, %	44.07 ± 2.53 [ab]	45.67 ± 1.9 [a]	43.91 ± 1.45 [ab]	42.29 ± 2.47 [b]	NS
Ash,%	12.35 ± 1.71 [b]	15.34 ± 1.23 [a]	14.62 ± 1.21 [a]	14.51 ± 1.71 [a]	*
GE, cal/gr	6218 ± 403 [a]	5951 ± 376 [a]	6113.4 ± 213 [a]	6228.2 ± 147 [a]	NS
EE, %	39.28 ± 2.87 [a]	35.07 ± 2.84 [b]	38.25 ± 0.85 [ab]	39.64 ± 2.71 [a]	*

* (P<0.05), NS, P> 0.05 [a]: Means in rows with the same superscripts (a,b) are not different (P< 0.05)

Digestibility

Apparent digestibility of DM, OM, AP, EE and energy is presented in Table 3. Digestibility coefficient value for DM, OM, CP and GE were significantly higher in C than M, SM1 and SM2 in feed restriction period. All measures of digestibility on the C diet were higher than those on kids with restricted feeding (M, SM1 and SM2).
In re-alimentation period there was no significant different in apparent digestibility of DM, OM, CP, EE and energy (P>0.05).

Table 3. Effects of different feed restriction severity and re-alimentation on nutrient digestibility (%) in young male goats

	Treatments											
	Feed restriction period						Re-alimentation (Compensatory)					
	Control	M	SM1	SM2	Diet effect	CV	Control	M	SM1	SM2	Diet effect	CV
DM	75.17 [a]	59.90 [b]	60.05 [b]	51.79 [b]	*	13.1	73.89 [a]	69.61 [a]	72.84 [a]	77.34 [a]	NS	8.5
OM	71.60 [a]	51.23 [b]	50.57 [b]	49.28 [b]	**	10.6	75.69 [a]	71.70 [a]	73.77 [a]	77.43 [a]	NS	6.1
CP	62.11 [a]	38.30 [b]	41.21 [b]	35.50 [b]	**	18.3	62.92 [a]	65.42 [a]	68.07 [a]	71.45 [a]	NS	7.3
EE	82.22 [a]	68.33 [a]	69.32 [a]	61.05 [a]	NS	18.7	82.50 [a]	80.18 [a]	86.97 [a]	84.10 [a]	NS	7.2
GE	72.80 [a]	52.04 [b]	49.95 [b]	48.22 [b]	*	15.2	73.88 [a]	72.19 [a]	72.41 [a]	74.52 [a]	NS	5.7

* P<0.01; ** P<0.001; NS, P> 0.05
[a]: Means in rows with the same superscripts (a,b) are not different (P< 0.05)

Fat Depots

Fat depots weight and as percentage of EBW are shown in Table 4. There was significant difference in pelvic fat weight (P=0.06) and percentage of pelvic fat/EBW (P=0.07). All the fat depots were not significantly lower in restricted animals than control group but there was significant difference in pelvic fat weight (P=0.06) and percentage of pelvic fat/EBW (P=0.07).

Table 4. Effects of different feed restriction severity and re-alimentation on internal fat weight and as percentage of EBW (mean±SD) of young male goats

	Treatments				
	Control	M	SM1	SM2	Diet effect
Fat weight (g)					
Kidney	42 ± 30.9 [a]	37 ± 19.8 [a]	38 ± 18.5 [a]	29 ± 13.4 [a]	NS
Pelvic	182 ± 83.8 [a]	125 ± 44 [ab]	111 ± 43.5 [ab]	79 ± 38.3 [b]	0.06
Heart	24 ± 15.1 [a]	13 ± 14.8 [a]	10 ± 7.1 [a]	12 ± 6.7 [a]	NS
GIT	693 ± 241.5 [a]	569 ± 144.2 [a]	506 ± 53.1 [a]	545 ± 70.9 [a]	NS
Total internal fat	941 ± 314 [a]	744 ± 204 [a]	665 ± 36 [a]	665 ± 102 [a]	NS
Proportion as % EBW					
Kidney	0.22 ± 0.15 [a]	0.19 ± 0.09 [a]	0.22 ± 0.1 [a]	0.17 ± 0.09 [a]	NS
Pelvic	0.91 ± 0.28 [a]	0.67 ± 0.19 [ab]	0.67 ± 0.26 [a]	0.46 ± 0.22 [a]	0.07
Heart	0.11 ± 0.06 [a]	0.06 ± 0.07 [a]	0.06 ± 0.04 [a]	0.06 ± 0.03 [a]	NS
GIT	3.52 ± 0.83 [a]	3.11 ± 0.73 [a]	3.05 ± 0.31 [a]	1.3 ± 0.43 [a]	NS
Total internal fat	4.77 ± 1.01 [a]	4.05 ± 0.94 [a]	4.01 ± 0.2 [a]	3.86 ± 0.64 [a]	NS

[ab] Means in rows with the same superscripts are different (P< 0.05)

Carcass Chemical Composition

Feeding level can affect the carcass composition (Murphy and Loerch, 1994; Murphy et al., 1994). Feed restriction of goats followed by refeeding was associated with an increase in ash and fat (ether extract) content of whole carcass tissue but DM, CP and GE were similar to the control goats. Dashtizadeh et al. (2008) reported that after re-alimentation of goats, the fat content was similar to control goats. Feed restriction of steers (Murphy and Loerch, 1994) and lambs (Murphy et al., 1994) was also associated with a decrease in fat and increase in protein and water contents. Mora et al. (1996) studied the effects of two periods (18 and 36 weeks) and two levels (60 and 80% vs. 100%) of feed restriction on non- lactating, non- pregnant, adult Nubian does. Chemical composition of soft tissue was not affected in that experiment. The discrepancy between our data and those of Mora et al. (1996) may be explained by the age (degree of maturity) of animals, and the period or severity of feed restriction (Aziz et al., 1992). Sahlu et al. (1999) reported that the level of feed intake during the restriction period did not affect the body composition of 14 -month- old Angora wethers that were restricted for 40 days followed by 41 days of re-alimentation.

In the study of Yambaymba et al. (1996) with beef heifers, the lower proportion of total side fat during feed restriction was associated with a higher proportion of side bone but similar proportion of side muscle after re-alimentation. Price (1977) found similar trend in restricted steers. Increase in the proportion of bone was also reported by Verbeek (1961), Seebeck and Tulloh (1968) and Dashtizadeh et al. (2008). In our experiment there was an increase in Ash content likely due to increase in bone as well.

Digestibility

During feed restriction period, there were differences in DM and GE (P< 0.05) and in OM and CP (P<0.01). Kouakou et al,. (2008) reported that sub-maintenance feeding decreased fiber, OM, and EE digestibility and BW. The digestibilities (%) of OM, ADF, NDF, EE, N and Energy were lower for animals when fed at 25% of maintenance than maintenance and ad libitum. Digestion of fiber (NDF and ADF), OM, and EE decreased when feed intake was reduced from maintenance to 25% of maintenance. Increases in digestibility at lower intakes have been attributed to higher mean retention time of particles in the rumen (Galyean and Owens, 1991). Higher digestibility of fiber at 20% of maintenance requirement due to higher retention time has been reported by Doreau and Doreau (2001) in sheep fed grass hay (8.8% CP and 67.5% NDF). However, decreased digestibility at intakes lower than maintenance levels have been reported in sheep (Keenan et al., 1969) and cattle (Agabriel et al., 1995; Grimaud. et al., 1998). Our results are similar to those reported by Grimaud et al. (1998) in cattle and Gingins et al. (1980) in sheep.

Digestibility of dry matter, organic matter, and crude protein was similar for the high and medium protein diets and was higher than that for the low diet (Atti et al., 2004). Digestibility coefficient values for DM and GE were significantly higher in high than in low energy density diet (Mahgoub et al., 2000).

Feed intake level can affect nutrient digestibility (Silanikove, 1992; Merchen and Bourquin, 1994), which appears associated with factors such as slower passage of digesta through the gastrointestinal tract (Van Soest, 1994) and (or) increased ratios of digestive/ absorptive enzymes to substrates (McAllister et al., 2001).

In the present study there were no differences (P>0.05) in DM, OM, CP, EE and GE during re-feeding period. Increases in digestibility during the re-feeding period may be due to higher efficiency of nutrient utilization as suggested by Grimaud et al. (1998). Digestibility of DM, OM, CP, EE and GE were similar among goats consuming feed adlibitum regardless of previous feeding regimen. Grimaud and Doreau (2003) reported that protein supplementation did not prevent a decrease in digestibility in underfed cattle suggesting that protein level is not critical for digestibility at intake below maintenance.

Fat Depots

When growth rate is reduced, there is a coordinated decrease in tissue turnover, but some tissues react more than others. Fat depots follow an order of depletion during feed restriction, opposite to the direction of their development (Hornick et al., 2000). In the present experiment, feed restriction was associated with decreases non- significantly in the weight and their proportion of fat in various fat depot whereas the pelvic fat only decreased significantly (P= 0.07).

Re-alimentation increased the contents of fat in various depots. During sever and prolonged feed restriction, the initial switch from protein to fat mobilization is initially observed but is rapidly followed by combined fat and protein losses (Hornick et al., 2000).

CONCLUSION

These findings suggest that harsh conditions in drought years that may lead to intake at or below maintenance may affect digestibility and body fat and protein mobilizations leading to weight loss and change in chemical composition of carcass and after re-alimentation period and compensatory growth there are not differences in BW and ADG.

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