Research Article

Restricted Feeding and Re-Alimentation: An Approach to Improve Growth Performance of Beetal Kids Under High-Input Feeding System

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Abstract | The high input feeding system has been found most efficient in fodder-scarce areas of Pakistan. However, the economic worth of the system is questionable due to the high feed conversion ratio (FCR) of the goats. The current study was planned to improve the Beetal male kid's performance using a compensatory growth tool. A total of twelve male Beetal kids with an average weight of 20±2 kg and approximately 6 months old were randomly selected and kept for 85 days including 15 days of an adjustment period. There were two phases of the experiment. During the restriction phase; the animals were divided into three groups i.e. T1=feeding @2% of body weight (BW), T2=feeding @3% of BW, and T3=feeding @4% of BW. In the re-alimentation phase; all the animals were fed ad-libitum. The animals were kept in individual pens and were offered total mixed pelleted ration by following NRC recommended feeding standards. All the animals had free access to fresh and clean water. They were kept under the same husbandry practices. The results showed that ADG was highest (P<0.001) in T3 (887 g/d) followed by T2 and T2 due to higher intake during restriction phase. However, this was reversed in re-alimentation phase where the ADG was highest (P<0.001) in T1 (153 g/d) followed by T2 (112.10 g/d) and T3 (100.08 g/d) mainly due to compensatory growth phenomena. The ADFI data also support the ADG trend as it was higher in the groups showing higher gains. This trend was also followed by body measurements. The FCR was significantly (P=0.014) lower (6.83) in the T1 group during the re-alimentation period followed by T2 and T3. Total feed cost was also significantly (P<0.05) lower in T1 (Rs. 1938). Serum glucose was also higher (P=0.04) in group T1 (63.11 mg/dl) and least in T3 (55.97 mg/dl). This is also confirming the physiological modification in feed restricted animals that are responsible for compensatory growth. It is concluded that the growth performance of Beetal male kids can be improved by giving them restricted feeding @2% BW followed by re-alimentation which also improves the feed efficiency.

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Introduction

Pakistani small ruminants (sheep and goats) have an advantage over large ruminants because of their high productive rate, small size, and lower cost than large animals for meat production (Khan *et al*., 2014). The goat meat is the most expensive in the market and owing to this; the business has fair chances of development. Traditionally, the goats are reared in pastures and wastelands. However, some studies indicated that animal catches lower growth because of traditional feeding systems in goats (Sarwar *et al*., 2002).

Some recent studies showed more efficiency of high-input feeding systems in elaborating the growth routine of small ruminants by intensifying the availability of nutrients (Kashif *et al*., 2016; Sarwar *et al*., 2012; Mukhtar *et al*., 2010). The higher feed conversion ratio (FCR) is the main hindrance regarding the adoption of high-input feeding technology in farmers. The FCR of goats has been reported in a range of 6-10 (Nisa *et al*., 2013) whereas it is desired to be lowered to 4-5.

Various researchers worked out approaches to improve feed efficiency. A researcher (Abouheif *et al*., 2013) found that restricted feeding modifies the rate of metabolic energy consumption and is more feasible and economical as compared to traditional feeding. Iranian investigator (Dashtizadeh *et al*., 2008) reported that the goats consumed 13% less feed during the feed restriction period. They additionally reported that during the re-alimentation period, the goats consumed only 2% more feed while they found a 60% improvement in FCR of 75 days restricted goats. Feed restriction is a condition when animals are conserved under less sustained feed for a certain period. After feed restriction, there is a period of re-alimentation in which animals catch up on their upping growth because of compensatory growth phenomena (Mitchell, 2007; Hornick *et al*., 2000). This technique may be used to optimize the FCR in goats under a high-input feeding system.

However, there are some research questions that require investigation, especially for goats reared under a high-input feeding system. What will be the efficacy of restricted feeding under a high-input feeding system? At which stage feed restriction may be used in meat-type goats?

To get answers to the above mentioned research questions, the current study was planned with the hypothesis that feed restriction followed by re-alimentation may be used as an approach to improve the production performance of meat-type goats under a high input feeding system. The research output would help farmers to decrease the FCR and to improve the feed cost-benefit ratio of goats reared under a high-input feeding system.

Materials and Methods

Location of the study

The study was conducted at Yaqoob goat farm (Pvt.) situated in District Hafiz Abad.

Feeding management

The duration of the study was 85 days including 15 days of an adaptation period. A total of 12 Beetal kids were selected for the study. The age of the animals was approximately 9 months, while the weights were 20±2 kg. All the animals were dewormed before the start of the trail. There were two phases of the experiment, 35 days restriction period and re-alimentation period of 35 days. During the restriction phase; the animals were divided into three treatment groups i.e., T1= feeding @2% of body weight (BW), T2=feeding @3% of BW, and T3=feeding @4% of BW. In the re-alimentation phase; all the animals were fed *ad-libitum*. The animals were kept in individual pens and were offered total mixed pellets. The ration was formulated while following the feeding standard recommended by NRC (2007). Only one type of pelleted total mixed ration was formulated (Table 1) to ensure that rations are iso-caloric and iso-nitrogenous. However, the intake was varied to induce the fasting effect among various treatment groups. All the animals were given free access to fresh and clean water while all other husbandry conditions remained the same. The study was approved by the ethical committee of our department.

Data collection

Data were collected on daily basis on feed intake (FI), fortnightly weight gain (WG), FCR, and feed cost, while average daily gain (ADG) and average daily feed intake (ADFI) were calculated at the end of the experiment by following methods described by scientists (Brown, 1973; Sen *et al*., 2004).

Table 1: *Ingredient and chemical composition of ration.*

Ingredient name	Inclusion level (%)
Barley	11
Cotton seed cake	10
Maize gluten feed	15
Rice polishing	22
Wheat bran	13
Molasses	6
Oats	5
Oil	5
Limestone	1
Bentonite	1
Urea	1
Wheat straw	10
Chemical composition (Proximate composition)	
Crude protein	17.42
Crude fiber	16.87
Ether extract	5.33
Ash	8.61
NDF	39.13
ADF	15.65
ME (MJ/kg)	2.80

Reference: NRC, 2007.

The grab fecal samples were a collection from the rectum for the determination of the digestibility of formulated feed using acid-insoluble ash as a marker in the last 5 days of the experiment. For digestibility, the feed and feces samples (weighed 5.0±0.0040 g each) were taken in a previously tare crucible. It was dried overnight in a hot air oven at 100°C. Then crucibles were cooled in desiccators and again weigh. They were ash for 6 hours at 600°C in a muffle furnace. After that ash was put in a 600 ml Berzelius beaker added 100 ml of 2N HCl solutions. The beaker was boiled for 5 minutes on a fiber rack. After boiling, filtered hot hydrolysate through Whatman filter paper and then washed with hot distilled water. The filter paper was transferred back into the crucible and ash for 6 hours at 600°C in a muffle furnace. The crucible was then placed in an air oven at 100°C to dry. Then the crucible was cooled in a desiccators for 5 minutes. The crucible was weighted again. The percentage of acid-insoluble ash was calculated by using (Van Keulen and Young, 1977) formula given below:

$$Acid\ Insoluble\ Ash\ (\%) = \frac{(Weight of crucible + Ash) - Weight of crucible}{Sample dry weight} \times 100$$

This acid-insoluble ash was used as a marker to determine the digestibility of experimental feed.

The blood was collected from the jugular vein using an aseptic syringe. For serum, the blood was centrifuged (3000 rpm) to remove the blood cells to avoid hemolysis and was frozen at -20°C till the final analysis (Nudda *et al*., 2013). The serum was thawed and used for the determination of serum glucose and serum protein. The kits of serum glucose and serum protein were manufactured by MERCK, France. Serum glucose was determined by the GOD-PAP method by following Burmin and Price (1985). The blood hemoglobinwas determined by using Sahil's methods. The analysis was performed at the University Institute of Biochemistry and Biotechnology, PMAS-Arid Agriculture University, Rawalpindi.

Experimental design and statistical analysis

All the experimental units were exposed to treatments under a completely randomized design (CRD) with a fixed effect model. The data collected was analyzed for analysis of variance (ANOVA) using *the "aov"* function run in R software except for body measurement which was analyzed by using the "*nlme*" function. The means were compared using Turkey's HSD test during the post-hoc test for the comparison of treatments at a 5% level of significance (R Core Team, 2021).

Results and Discussion

The data were analyzed and mentioned in Table 2. In the average daily feed intake (ADFI) during the restriction stage, a significant impact (P<0.001) was observed. The ADFI was calculated in all three groups and found that the T1 group shows the lowest T1 (469.4g) than T2 (593.6 g) and the last T3 (887.7 g). The ADFI during the re-alimentation period was highest in T1 (1039.0 g) than inT2 (979.8g), and last T3 (899.7g) and. In average daily gain during restriction (ADG) it was observed a significant decrease in T1 (64.00g/d) followed by T2 (88.01g/d) than T3 (121.89g/d). But during re-alimentation, the average daily gain was found more (P<0.0001) in T1 (153.00 g/d) followed by T2 (112.10 g/d) and last in T3 (100.08 g/d). The feed conversion ratio (FCR) during the restriction was non-significant (P>0.05) however during re-alimentation it was significantly lower (P<0.606) in T1 (6.835) followed by T2 (8.833) and T3 (8.988). In the study, we also calculated the total feed cost (FC) of all groups. The FC was observed significantly lower in T1 (Rs. 1758) than in T2 (Rs. 1938) and T3 (Rs. 2172.7). We also measured body heart girth and length. Body heart girth measurement

Table 2: *Effects of restriction and ad-libitum feeding during re-alimentation on growth performance of goats.*

Parameters	@2% of BW	@3% of BW	@4% of BW	SEM	P-value
a. Restriction phase					
Average daily feed intake (g/d)	469.4^{b}	593.6^{b}	887.7^{a}	53	0.001
Average daily gain (g/d)	64.00^{c}	88.01^{b}	121.89^{a}	4.591	0.001
Feed conversion ratio	7.371	6.748	7.294	0.6608	0.6063
b. Re-alimentation phase					
Average daily feed intake (g/d)	1039.0^{a}	979.8^{ab}	899.7^{b}	36.94	0.013
Average daily gain (g/d)	153.00^{a}	112.10^{b}	100.08^{b}	7.686	0.0001
Feed conversion ratio	6.835^{b}	8.833^{a}	8.988^{a}	0.6388	0.014
Total feed cost (Rs.)	1758	1938	2172.7	268.6	0.345
Digestibility (%)	70.33	68.94	67.29	10.76	0.154
Serum glucose (mg/dl)	63.11^{a}	60.56^{ab}	55.97^{b}	2.438	0.040
Serum protein (mg/dl)	6.50	6.27	6.75	0.2211	0.150
Blood hemoglobin (g/dl)	9.88	9.23	9.83	0.7317	0.600
Heart girth (cm)	26.54^{b}	25.08^{c}	26.70^{a}	0.4181	0.0001
Body length (cm)	23.70^{b}	22.54^{c}	24.08^{a}	0.369	0.0001

BW, body weight.

was highest in T3 followed by T1 than T2 and body length was highest in T3 followed by T1 than T2.

The result of the study showed improvement in feed intake in more restricted kids. Feed restriction is a condition when animals are conserved under less sustained feed for a certain period (Khan *et al.*, 2014). A researcher (Dashtizadeh *et al.*, 2008) calculated the effect of restricted feeding on goats and documented those goats consumed 13% less feed during the feed restriction period. However, the physiological adaptations affected the hypothalamus to increase feed intake during the re-alimentation period (Drouillard *et al.*, 1991). This was the reason that the T1 group showed more intakes. Some studies also reported surpassing feed intake after a stage of feed restriction has been reported by scientists (Homem *et al.*, 2007). Same as our expectations that we noticed in group T1 increased by 15% more feed intake than T3 (not restricted) due to appetite behavior.

In average daily gain group T1 was maximum restriction bear due to this reason in the re-alimentation period they were maximum ration intake and convert into the body easily. Goats must adjust and control their feeding behavior to the types of diet they receive (Abijaoude *et al.*, 2000). After feed restriction, there is a period of re-alimentation in which animals catch up with their upping growth. This feeding system has been reported more systematically concerning growth performance and feed effectiveness (Khan *et al.*, 2014).

The result of the current study shows improvement in FCR due to restriction. An investigator (Abouheif *et al.*, 2013) reported that restricted feeding modifies the rate of metabolic energy consumption and is more feasible and economical as compared to traditional feeding. Similarly, an Iranian group of scientists (Dashtizadeh *et al.*, 2008) reported that during the re-alimentation period, the goats consumed only 2% more feed, and they found a 60% improvement in FCR of 75 days of restricted goats. Some modern studies showed more efficiency of high input feeding scheme in elaborating the growth presentation of small ruminants by intensifying the nutrient accessibility (Nasir *et al.*, 2010; Sarwar *et al.*, 2012; Nisa *et al.*, 2013; Ishaq *et al.*, 2016). Similarly, feed cost was lowest in T2 because of less feed used during the study and improvement in digestibility.

During the experiment, the digestibility showed a non-significant (P>0.05) impact of restriction whereas it was found highest in T1 (70.33%) followed by T2 (68.94%) and T3 (67.29%). The results of blood analysis showed a significant effect (P<0.04) on glucose but other responses were non-significant. The serum glucose was higher in T1 (63.11 mg/dl) than in T2 (60.56 mg/dl) and T3 (55.95 mg/dl).

The increase in digestibility was due to rumen ability due to fasting as an adaptive mechanism to set high metabolism during re-alimentation after restriction (Drouillard *et al.*, 1991). The high levels

of serum glucose in T1 group show the physiological modification in response to fasting in an effort to ensure glucose supply by gluconeogenesis while this is not needed in T3 group where the glucose was least and mainly because of the normal physiological response (Zaheer *et al*., 2022; Solaiman *et al*., 2010).

Conclusions and Recommendations

Feed restriction and re-alimentation had some effects on the performance of goats under a high-input feeding system. In light of the results in the current study, it is concluded that feed restriction @ 2% BW has many effects on the performance of Beetal goats and it is recommended that feed restriction and re-alimentation may be one of the good approaches in getting a more economical return from Beetal male kids reared under high input feeding system.

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Novelty Statement

The research is novel as restricted feeding was used first time in goat kids reared under a high input feeding system in Pakistan for improvement of growth performance.

Authors Contribution

Muhammad Umar Farooq: Execution of study, collection of data and lab works.
Kashif Ishaq: Planning research, supervision of study, data analysis, interpretation, write up.
Muhammad Imran Khan: Planning research, supervision of the study.
Muhammad Farooq Iqbal: Planning research, supervision of study, and assistance in the lab.
Tanveer Ahmad: Planning research, supervision of the study, and arrangement of supplies.
Jamil Akbar: Data collection, execution of the study.
Asim Faraz: Planning research, assistance in write up and arrangement of supplies/funds.
Sara Naeem and Aansa Latif: Manuscript write-up, formatting and analysis.

Conflict of interest
The authors have declared no conflict of interest.

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