PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
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OPEN ACCESS Pakistan Journal of Nutrition

ISSN 1680-5194
DOI: 10.3923/pjn.2017.236.241

Research Article
Effects of Different Feed Restrictions on Kacang Goats

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Abstract

Objective: This study aimed to determine the effects of different feed restrictions and refeeding on feed intake, digestibility, body weight gain and feed cost in goats. **Materials and Methods:** There were three treatment groups of goats had an average initial body weight of 20-25 kg. Control goats (R0) were fed 3.5% Dry Matter (DM) of body weight or underwent 1 month of feed restriction treatment (R1) and 2 months (R2) of 60% restrictions (DM base). After the restriction period, R1 and R2 groups were fed *ad libitum.* The variables measured include Dry Matter Intake (DMI), Organic Matter Intake (OMI), Crude Protein Intake (CPI), body weight gain, Dry Matter Digestibility (DMD), Organic Matter Digestibility (OMD), Crude Protein Digestibility (CPD) and feed cost. Data were analyzed using ANOVA based on a Completely Randomized Design (CRD) on SPSS program version 21 for windows. **Results:** Feed restriction had a significant effect on body weight gain, the DMI, OMI, CPI and feed cost. However, the treatments did not significantly affect body weight or DM, OM and CP digestibility. **Conclusion:** One month of feed restriction continued with 2 months of re-feeding (R1) can lead to compensatory growth such that the average daily gain is the highest.

Key words: Feed restriction, feed cost, gain, Kacang goat, re-feeding

Received: September 16, 2016 Accepted: February 18, 2017 Published: March 15, 2017

Citation: Bambang Suwignyo, Zein Ahmad Baihaqi, Ristianto Utomo, Sarmin and Irkham Widiyono, 2017. Effects of different feed restrictions on kacang goats. Pak. J. Nutr., 16: 236-241.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The demand of livestock products in the future will increase with the Indonesian population. The population of Indonesia in 2010, 2014 and 2015 was 237,641,326, 244,814,936 and 252,370,792, respectively[1]. Efforts to meet the demand of livestock products will continue to be implemented; one of these efforts includes improving the production of Kacang goats.

Kacang goats are one of many animal commodities that produce meat. Those who raise Kacang goats encounter some obstacles, such as limited quality and quantity of forage during the dry season when there is low availability and poor quality of forage that does not meet the feed requirements of the goats. Forage fodder is integral in the development of livestock, especially ruminants[2] however, the main problem in raising ruminants like goats is forage availability.

Feed restriction and re-feeding is a potential solution that can be used to improve the efficiency of feed management to increase productivity of goats during the dry season. Feed restriction followed by re-feeding may trigger compensatory growth.

MATERIALS AND METHODS

This study was conducted for 7 months (July, 2014 to January, 2015) in the animal house (cage) of Animal Feed and Nutrition Science Department and Laboratory of Forage and Pasture Science, Faculty of Animal Science, Universitas Gadjah Mada. Analysis of the feed chemical composition was done from February-May, 2015 at the Laboratory of Forage and Pasture Sceience, Faculty of Animal Sciences, Universitas Gadjah Mada.

Materials

Animals and trial cages: Nine male Kacang goats were used in this study, with an average age of 8 months and initial body weight of 20-25 kg. The goats were divided into three groups as follows: Control goats (R0) were fed based on Dry Matter (DM) of 3.5% of body weight, goats underwent feed restriction treatment for 1 month (R1) or 2 months (R2).

The goats were placed in individual cage-shaped stages with individual plot sizes of 1.5×0.75 m with additional feed and drinking water buckets placed outside but adhered to the cage. The floor was made of wood and was arranged within a 2 cm space to simplify the process of cage cleaning.

Diets: The goats were fed with 60% forage (peanuts straw) and 40% pelleted concentrate (Gemuk-A® produced by PT., Japfa Comfeed Indonesia Tbk.). The nutrient content of the concentrate was as follows: 12% water, 14% Crude Protein (CP), 3-7% crude fat, a maximum of 8% Crude Fiber (CF), a maximum of 10% ash, 0.8-1.0% calcium and 0.6-0.8% phosphorus. The nutrient content of peanut straw was as follows: 21.08 Dry Matter (DM), 14.63 ash, 7.56 crude fat, 16.09 Crude Protein (CP), 24.86 Crude Fiber (CF) and 36.86 NFE. Feed was provided based on 3.5% dry matter of body weight. The goats were restricted for 60% feed (offered 40% of the dry matter requirements) under 1 month of restriction (R1) and 2 months restriction (R2), while control goats (R0) were fed 3.5% of DM body weight. Drinking water was provided *ad libitum* and replaced every morning and afternoon.

Equipment: The equipment used were scales with brand Camry models EK3250 with a capacity of 5 kg with a sensitivity of 1 g to weigh feed, weight scales brands Camry models EB9872 with a capacity of 150 kg with a sensitivity of 100 g to weigh goats, Wiley mills with a 1 mm sieve diameter to grind feed and feces samples, choppers and buckets. Digital analytical balance brands denver instrument XL 410 with a capacity of 410 g and sensitivity 0.001 g was used to weigh the feed and feces samples for analysis. A set of proximate analysis equipment was also used.

Methods

Pre-restriction: The pre-restriction stage was conducted for 1 month. All goats were fed *ad libitum* based on 3.5% DM of body weight). The goat's initial body weight was measured in the morning before they were fed. Feed was given twice a day at 07.00 pm and 16.00 pm. Body weight was measured weekly. Feed offered (peanut straw and concentrate) and remaining feed were sampled daily and then composited weekly to be weighed, dried and ground for analysis.

Restriction stage: The restriction stage was carried out over two phases within 3 months. The first phase included 30 days (R1) and 60 days (R2) of feed restriction. The amount of feed was offered at only 40% of the total daily requirement based on 3.5% DM of body weight for both of peanut straw and concentrate. The second phase involved re-feeding the goats *ad libitum*. Thirty days of feed restriction was (R1) followed by re-feeding for 60 days; 60 days of feed restriction was followed by re-feeding for 30 days. Forage from peanuts straw or rendeng and concentrate was provided *ad libitum* during the re-feeding phase. Reduction of feed from pre-restriction to restriction was conducted gradually, as well as the transition from the restriction phase to the re-feeding (full feeding) phase.

Data collection: The data collected during the study included feed intake, digestibility, body weight gain or Average Daily Gain (ADG) and feed costs.

Feed intake: Feed intake is the amount of feed given minus the amount of feed remaining, or feed that was not consumed. Feed offered (peanut straw and concentrate) and the remaining were weighed, sampled daily, composited weekly, dried and grounded prior to analysis (dry matter, organic matter and crude protein).

Digestibility: Sampling was conducted for 7 days during the last day of feed restriction and during re-feeding. Feces were collected for 24 h and then weighed. Feces samples were taken as 10% of the total; then, they were dried in the sun and in the dry oven at 60°C. Dried feces were grounded with a Wiley mill with a 1 mm sieve screen. Feces samples were analyzed for composition of dry matter, organic matter and crude protein. Dry Matter Digestibility (DMD) and Organic Matter Digestibility (OMD) of feed were calculated using the following formula:

$$\text{DMD (\%)} = \frac{\text{TDMI feed-TDM feces}}{\text{TDMI feed}} \times 100$$

$$\text{OMD (\%)} = \frac{\text{TOMI feed-TOM feces}}{\text{TOMI feed}} \times 100$$

Where:

DMD = Dry matter digestibility
OMD = Organic matter digestibility
TDMI = Total dry matter intake
TDM = Dry matter value
TOMI = Total organic matter intake
TOM = Organic matter value

Body weight gain: Goats were weighed every week in the morning before they were fed in order to measure weight before feeding.

Cost of feed (feed cost): Total consumption of forages and concentrated (kg) was multiplied by the price of forages and concentrate during treatment (IDR), profits were calculated from the price per kilogram of the animal (IDR) minus the cost of production (IDR).

Data analysis: Data was analyzed using ANOVA based on using Completely Randomized Design (CRD). Significant differences among the treatments underwent the Least Significance Difference (LSD) test using Statistical Product and Service Solution (SPSS) version 21.0 for windows.

RESULTS AND DISCUSSION

Nutrient intake: The nutrient intake of Kacang goats includes the total nutrients consumed by the goats during restrictions and re-feeding phases and was calculated based on the reduction of the amount of feed offered and remaining multiplied by nutrient content. The average of DM, OM and CP consumption of control treatment (R0), feed restriction 1 month (R1) and feed restriction of 2 months (R2) is shown in Table 1.

Dry matter intake: Total consumption of feed is an important factor that may affect animal productivity. The amount of feed needed is influenced by the body weight of the animal, the greater the animal body weight, the greater feed needed in both males and females. Consumption per unit kilogram of animal body weight decreases with the increasing size of the animal, such that DM feed consumption is based on body weight metabolic (g kg^{-1} b.wt.$^{0.75}$ day^{-1}) in order to minimize the influence of body weight on the animal[3]. Based on the results Table 1, treatments R1 and R2 had a significantly lower effect ($p<0.05$) on DM in the Kacang male goat compared with R0, this was consistent with studies showing that DM consumption levels of Bligon goats declined with feed restriction[4].

Organic matter intake: Organic materials are composed of carbohydrates, lipids, proteins, vitamins and substrates for

Table 1: Average of DM, OM and CP intake of Kacang goats R0, R1 and R2

	Treatments		
Variables	R0	R1	R2
DM intake (g $head^{-1}$ day^{-1})	686.30±3.44^{a}	552.26±11.75^{b}	474.73±19.22^{c}
DM intake (g kg^{-1} b.wt.$^{0.75}$ day^{-1})	66.59±0.67^{a}	51.81±3.23^{b}	46.41±1.88^{c}
OM intake (g $head^{-1}$ day^{-1})	612.21±39.36^{a}	493.23±10.33^{b}	423.51±17.4^{c}
OM intake (g kg^{-1} b.wt.$^{0.75}$ day^{-1})	59.41±0.53^{a}	46.27±2.86^{b}	41.40±1.65^{c}
CP intake (g $head^{-1}$ day^{-1})	58.82±1.76^{a}	41.88±0.24^{b}	30.64±1.20^{c}
CP intake (g kg^{-1} b.wt.$^{0.75}$ day^{-1})	5.23±0.21^{a}	3.93±0.24^{b}	2.99±0.12^{c}

$^{a-c}$Different superscripts in the same row and column show significance at $p<0.05$

microbial fermentation in the rumen[5]. Based on the results in Table 1, OM consumption in R1 and R2 was significantly lower ($p<0.05$) compared to control. The OM consumption pattern normally follows the pattern of DM consumption, since OM is part of DM[4].

Crude protein intake: Crude Protein (CP) intake is closely correlated with animal growth performance. Protein supports basic living, production and reproduction[6]. Based on the results in Table 1, the average CP intake of goat controls was significantly higher compared with R1 and R2. Crude protein intake is not only influenced by the DM consumption but also by digestibility of feed, fermentation in the rumen, enzymes, microorganisms and feed quality[7].

Feed digestibility: Digestibility is the amount of feed materials that can be digested in the tractus digestivus[8]. Digestibilities measured in this study include Dry Matter (DM), Organic Matter (OM) and Crude Protein (CP). Digestibility of the control Kacang goats R0, R1 and R2 can be seen in Table 2.

Measuring the quality of the feed *in vivo* is considered the best method for displaying the values of feed palatability, intake and digestibility[9]. Feed digestibility measurements *in vivo* were conducted to determine the response of the animal when it was given feed as required or restricted at either 1 or 2 months.

Dry matter digestibility: The Dry Matter (DM) digestibility coefficient is a main indicator in assessing the quality of feed[10]. Based on the results in Table 2, average DM digestibility, OM digestibility and CP digestibility were not significantly different among the control group and in those under restrictive treatment; however, feed digestibility values in R1 were higher compared with R2 and R0.

The R2 goats had a lower DM digestibility than R1 but higher than R0, this might be due to the length of feed restriction. The value of feed digestibility was affected by the length and level of restriction[4]. High percentage levels and excessive length of feed restriction can cause rumen microbes to grow suboptimally so that the digestibility of the feed is diminished. The highest digestibility occurred in the group that underwent restricted feed that was slightly lower than the basic needs of life[5].

Organic matter digestibility: Most Organic Matter (OM) is a component of dry matter, such that the digestibility coefficients of the dry matter tend to the same with DM coefficient digestibility[5]. Based on the results in Table 2, the average OM digestibility coefficient pattern was similar to DM digestibility, such that R1 was the higher followed by R2 and R0. Organic matter digestibility is associated with dry matter digestibility[4]. There is a positive relationship between the dry matter and organic matter digestibility with feed DM intake[11].

Table 2: Average of DM, OM and CP digestibility of R0, R1 and R2

	Treatments		
Variables	R0	R1	R2
DM digestibility^{ns}	76.37±5.80	80.52±0.61	78.35±6.84
OM digestibility^{ns}	84.61±4.13	87.48±0.72	87.34±5.45
CP digestibility^{ns}	50.00±0.45	54.45±11.20	51.99±10.59

ns: Non-significant difference

Table 3: Average initial body weight (BW), final body weight and ADG pf R0, R1 and R2

	Treatment		
Variables	R0	R1	R2
Initial body weight (kg)	22.45	23.53	22.27
Final body weight (kg)	28.35	31.92	24.48
ADG (g day^{-1})	75.00±0.416^{a}	65.49±26.907^{a}	15.58±4.149^{b}

^{a,b}Different superscripts in the same row show significance at $p<0.05$

Protein digestibility: Ration digestibility is influenced by material components, the higher the digestibility value of feed ingredients, the better the rations[12]. Table 2 shows that the average CP digestibility of R1 was the highest followed by R2 and R0; however, in this study, the CP digestibility value was 24.73% during the feed restriction phase for 1 month. Upon re-feeding for 2 months, the CP digestibility value increased to 53.68% (R1). While the CP digestibility value was 21.55% during animal in the feed restrictions in phase for 2 months, upon re-feeding for 1 month, CP digestibility increased to 61.1% (R2). The percentage and duration of feed restriction affected CP digestibility. The percentage of feed restriction and extended time can cause rumen microbes to grow suboptimally so that the digestibility of the feed is diminished[4].

Body weight gain: Average Daily Gain (ADG) is one of the parameters can be used to express the growth of livestock within a certain period of time. The ADG is performed by weighing livestock repeatedly by body weight every day or every week[5]. The average daily gain R0, R1 and R2 is shown in Table 3.

The ADG of R0 was significantly higher compared to R2 ($p<0.05$) but not compared to R1. The ADG in R0 was highest due to the absence of feed restriction and was in accordance with the finding that ADG will tend to be higher (higher body weight gain) when animals consume more feed and nutrients

Table 4: Average of feed cost (IDR)

	Treatments		
Variables	R0	R1	R2
Feed costs	510,952.50±29344.22[a]	406,054.67±14,420.35[b]	299,151.67±15,323.15[c]
Profit	67,547.50±60458.34[a]	332,678.67±94629.83[b]	56,515±57,175.84[a]

[a-c]Different superscripts in the same row show significance at p<0.05

(DM, CP, CF and TDN)[13] animals fed *ad libitum* will have increased body weight and increased ADG[14]. Deficiency of feed will cause a reduction in growth rate[15] the better quality and the higher quantity of rations, the more efficient creation of energy to produce high gains[16].

Feed cost: The cost of feed was calculated based on the amount of consumption during the three months of treatment multiplied by the price of feed. The cost of feed in this study came from commercial concentrates and peanuts straw with the, respectively prices of IDR 5.500.00 kg^{-1} and IDR 1.500.00 kg^{-1}. The average of feed costs R0, R1 and R2 is shown in Table 4.

Feed restriction has a significant effect on feed cost ($p<0.05$). The feed cost of R0 was the highest (Table 4) so the profit was low, even though feed can produce higher weight gains (Table 3). The R1 produced the optimal profit ($p<0.05$) followed by R0 and R2. Goats that under longer feed restriction treatment will provide the lowest cost of feed but will also have the lowest productivity (gain) that will not provide optimum profit. There are several considerations that need to be taken related to the economic efficacy of raising goats[17].

CONCLUSION

Based on the research results, it can be concluded that 1 month of feed restriction continued with 2 months of re-feeding (R1) can lead to compensatory growth such that the average daily gain is highest followed by R0 and R2. Goats treated with R1 would provide optimum profit since they consume enough feed (DM, OM and CP) and produce high gain, although they have a higher feed cost.

SIGNIFICANCE STATEMENT

This study found that compensatory growth will occur in goats after experiencing stress or illness and also found the relationship between efficiency and feed management. Feed restrictions for a month will be more beneficial than 2 months, this restriction may help business practitioners and goat farming.

This study also provides a critical analysis of optimal time restriction duration for goats. Thus, these results may contribute to a new theory on efficiency in feed goat management through feed restriction.

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